COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
IG-029/CENIPA/2025

OCCURRENCE:	**SERIOUS INCIDENT**
AIRCRAFT:	**PS-GPP**
MODEL:	**737-8 MAX**
DATE:	**12FEV2025**

NOTICE

According to the Law nº 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination, and execution of the activities of investigation and prevention of aeronautical accidents.

The elaboration of this Final Report was conducted considering the contributing factors and hypotheses raised. The report is, therefore, a technical document which reflects the result obtained by SIPAER regarding the circumstances that contributed or may have contributed to triggering this occurrence.

The document does not focus on quantifying the degree of contribution of the distinct factors, including the individual, psychosocial or organizational variables that conditioned the human performance and interacted to create a scenario favorable to the accident.

The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Final Report has been made available to the ANAC and the DECEA so that the technical-scientific analyses of this investigation can be used as a source of data and information, aiming at identifying hazards and assessing risks, as set forth in the Brazilian Program for Civil Aviation Operational Safety (PSO-BR).

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree nº 21713, dated 27 August 1946.

Thus, it is worth highlighting the importance of protecting the persons who provide information regarding an aeronautical accident. The utilization of this report for punitive purposes maculates the principle of "non-self-incrimination" derived from the "right to remain silent" sheltered by the Federal Constitution.

Consequently, the use of this report for any purpose other than that of preventing future accidents may lead to erroneous interpretations and conclusions.

N.B.: This English version of the report has been written and published by the CENIPA with the intention of making it easier to be read by English speaking people. Considering the nuances of a foreign language, no matter how accurate this translation may be, readers are advised that the original Portuguese version is the work of reference.

SYNOPSIS

This Final Report pertains to the February 12, 2025, serious incident involving the Boeing 737-8 MAX aircraft of registration marks PS-GPP. The occurrence was typified as “[RI] Runway Incursion and [ATM/CNS] Air Traffic Management/Communication, Navigation or Surveillance Service.”

During operations at SBGL (*Galeão - Antônio Carlos Jobim* – International Airport, *Rio de Janeiro*, state of *Rio de Janeiro*), the aircraft PS-GPP was cleared for takeoff from runway 10 while a night-lighting maintenance vehicle was still on the runway, resulting in a collision during the takeoff roll.

The aircraft sustained minor damage; the vehicle was destroyed.

The crew and passengers were unharmed, while the vehicle’s occupants sustained minor injuries.

As the United States of America is the State of Design and Manufacture of the aircraft, the NTSB (National Transportation Safety Board) appointed an Accredited Representative to participate in the investigation.

TABLE OF CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AAIB	Air Accidents Investigation Branch
ABNT	Brazilian Association of Technical Standards
ADC	Aerodrome Chart
AFIS	Aerodrome Flight Information Service
AIP	Aeronautical Information Publication
AMASS	Airport Movement Area Safety System
AMM	Aircraft Maintenance Manual
ANAC	Brazil's National Civil Aviation Agency
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
APP	Approach Control / TRACON
APP-BR	Brasília Approach Control
AR	Regional Authority
ASDE	Airport Surface Detection Equipment
ASEGCEA	Operational Safety Advisory of the Airspace Control System
ATAP	ASDE Taxiway Arrival Prediction
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATS	Air Traffic Service
ATSB	*Australian Transport Safety Bureau*
CA	Certificate of Airworthiness
CAT	Category
CAVOK	Ceiling and Visibility OK - Weather condition when base of clouds is above 5,000 ft and horizontal visibility is greater than 10 km
CCI	Firefighting vehicle
CIRCEA	Airspace Control Regulatory Circular
CLRD	Clearance Delivery
CLSO	Local Operational Safety Committee
CMA	Aeronautical Medical Certificate
CMT	Commander
CONTR	Control
COP	Operations Center
COR	Coordination
CRCEA-SE	Southeast Regional Airspace Control Center

CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
CWP	Controller Working Position
DECEA	Department of Airspace Control
DTCEA	Airspace Control Detachment
DTCEA-GL	*Galeão* Airspace Control Detachment
DVI	Detailed Visual Inspection
EAPRI	European Action Plan for the Prevention of Runway Incursions
EASA	European Union Aviation Safety Agency
EEAR	Command of Aeronautics' School of Aeronautical Specialists
EFS	Electronic Flights Strips
ER	Accountable Executive
FAA	Federal Aviation Administration
FAROS	Final Approach Runway Occupancy Signal
FDR	Flight Data Recorder
FMC	Flight Management Center
FPB	Flight Progress Board
GL	*Galeão* (International Airport)
GMC	Ground Movement Chart
GND	Ground
GNDC	Ground Control
GRSO	Management of Risks to Operational Safety
HS	Hot Spot
ICA	Command of Aeronautics' Instruction
ICAO	International Civil Aviation Organization
IFATCA	International Federation of Air Traffic Controllers' Associations
IFRA	Instrument Flight Rating - Airplane
IG	Serious Incident
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
km	Kilometers
kt	Knots
LABDATA	CENIPA's Flight Recorders Data Readout and Analysis Laboratory
LGE	Foam Generating Liquid
LRO	Occurrence Logbook
MCA	Command of Aeronautics' Manual
MDSO	Operational Safety Data Manual
METAR	Routine Meteorological Aerodrome Report
MGSO	Safety Management Manual (SMM)
MIG	Integrated Module of Management

MLTE	Multi-Engine Landplane Class Rating
MOp	Operational Model
NADSO	Operational Safety Performance Acceptable Level
NASA	USA's National Aeronautics and Space Administration
NBR	Brazilian Standard
NDT	Non-Destructive Testing
NGS	Nitrogen Generation System
NM	Nautical Miles
NOTAM	Notice to Airmen
NPA	Standard Operating Procedure (SOP)
NTSB	National Transportation Safety Board
OON	Normal Operations Observation
PACI	Forward Firefighting Post
PCINC	Aerodrome Firefighting Plan
PF	Pilot Flying
PFO	Operational Factors Survey
PIC	Pilot in Command
PLA	Airline Transport Pilot License – Airplane (ATPL-A)
PLEM	Aeronautical Emergency Plan
PN	Part Number
PPD	Runway
PPR	Private Pilot License - Airplane
PSNA	Air Navigation Service Provider (ANSP)
PSO-BR	Brazilian Civil Aviation Safety Program
R/T	Radiotelephony
RA	Resolution Advisory
RBAC	Brazilian Civil Aviation Regulation
RELPREV	Prevention Report
RESA	Runway End Safety Area
RI	Runway Incursion
RICEA	Airspace Control Investigation Report
RIF	Equipment/Systems Malfunction Report
RMK	Remarks
ROTAER	Air-Routes Auxiliary Manual
RSO	Operational Safety Recommendation
RST	Runway Safety Team
RTF	Radiotelephony
RTO	Rejected Takeoff
RVF	Fatigue Voluntary Report
RWSL	Runway Status Lights

RWY	Runway
SAOME	Advisory and Guidance Services in Aircraft Maintenance
SBBR	ICAO location designator for *Brasília* International Airport, Federal District
SBCT	ICAO location designator for *Curitiba* International Airport, *Paraná*
SBFZ	ICAO location designator for *Fortaleza* International Airport, *Ceará*
SBGL	ICAO location designator for *Galeão* International Airport, *Rio de Janeiro*
SBRJ	ICAO location designator for *Santos Dumont* Airport, *Rio de Janeiro*
SBSL	SBSL – ICAO location designator for *Marechal Cunha Machado* International Airport, *São Luís*, *Maranhão*
SBSP	ICAO location designator for *Congonhas* Airport, *São Paulo*
SBSV	SBSV – ICAO location designator for *Deputado Luís Eduardo Magalhães* International Airport, *Salvador*, *Bahia*
SDCPS	Safety Data Collection and Processing Systems
SDR	System Damage Report
SESCINC	Rescue and Firefighting Service
SFA	Aeronautical Fixed Service
SHERC	Sudden High Energy Runway Conflict
SIATO	Technical and Operational Instruction and Update Section
SIC	Second in Command
SIGCEA	Airspace Control Operational Safety Information Management System
SIPACEA	SIPACEA – Airspace Control Accident/Incident Investigation and Prevention Section
SIPAER	Aeronautical Accidents Investigation and Prevention System
SISCEAB	Brazilian Airspace Control System
SMA	Aeronautical Mobile Service (AMS)
SMS	Safety Management System
SN	Serial Number
SO	Operational Section
STA	Station
TATIC	Total Air Traffic Information Control
TCAS	Traffic Collision Avoidance System
TGC	Transcripts of Recorded Voice Communications
TPR	Regular Public Air Transport Registry Category
TRM	Traffic Resource Management
TWR	Aerodrome Control Tower or Aerodrome Control
TWR-BR	Brasília Aerodrome Control Tower
TWR-GL	*Galeão* Aerodrome Control Tower
TWY	Taxiway
UTC	Coordinated Universal Time
VCR	Visual Control Room
VHF	Very High Frequency

VMC	Visual Meteorological Conditions
VSO	Operational Safety Inspection

1. FACTUAL INFORMATION.

Aircraft	**Model:** 737-8 MAX **Registration:** PS-GPP **Manufacturer:** Boeing Company	**Operator:** *Gol Linhas Aéreas inteligentes S.A.*
Occurrence	**Date/time**: 12FEV2025 - 01:08 (UTC) **Location:** SBGL (*Galeão - Antônio Carlos Jobim* – Intl Airport) **Lat.** 22°48′36″ S **Long.** 043°15′02″W **Municipality – State:** *Rio de Janeiro* - RJ	**Type(s):** [RI] Runway incursion [ATM/CNS] Air traffic management (ATM) or communications, navigation, or surveillance (CNS) service issues

1.1. History of the flight.

At about 01:08 UTC, the aircraft was taking off from SBGL (*Galeão - Antônio Carlos Jobim* – International Airport, *Rio de Janeiro*, RJ), bound for SBFZ (*Pinto Martins* Airport, *Fortaleza*, CE), on a scheduled public air transport flight, with 6 crew and 103 passengers on board.

During the takeoff roll, the aircraft collided with a runway-lighting maintenance vehicle that was stationary at the center of runway 10, between taxiways BB and CC.

1.2. Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	2
None	-	103	-

1.3. Damage to the aircraft.

The SAOME (Advisory and Guidance Services in Aircraft Maintenance) technical reports No. 2025-002 SDR (System Damage Report) and structural SDR (Fuselage, Sections 44 and 46) recorded significant damage to multiple aircraft systems because of the ground collision. The inspections performed included a DVI (Detailed Visual Inspection) and the application of NDT (Non-Destructive Testing) to the affected critical components.

The systems that sustained the most significant damage were the hydraulic system, with damage to hoses, fittings, and the manifold; the air conditioning system, with compromise of the left-hand pack; the fuel system, which presented leaks in the supply lines; the inert gas system (NGS - Nitrogen Generation System), with damage to ducts, valves, and sensors; the landing gear system, which suffered damage to brake lines and structural supports; and the flight control system, with impairment in the flap transmission.

As for the airframe structure, the damage was primarily concentrated in sections 44 and 46, particularly in the wing-to-fuselage junction area. The fairings located in zones 191 to 194 sustained significant damage, including structural panels and brackets that required replacement or repair, as prescribed in the Boeing 737-800 Aircraft Maintenance Manual (AMM).

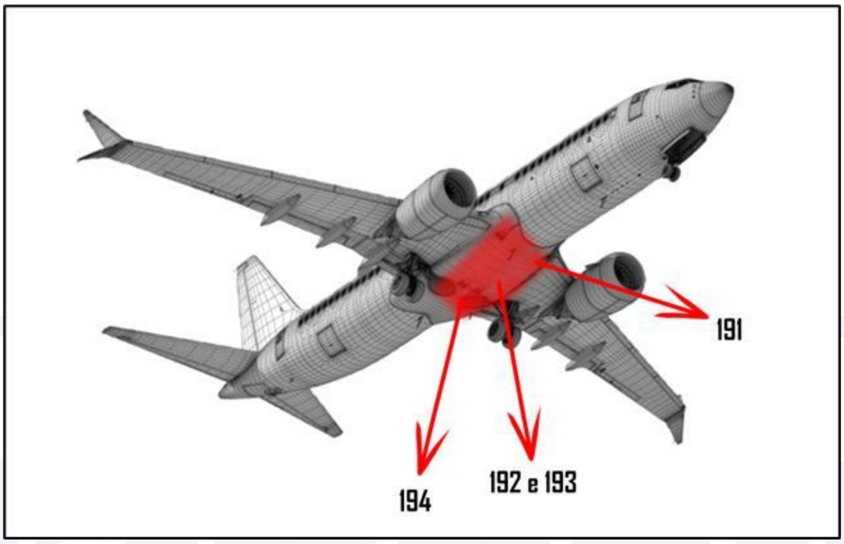

Figure 1 – Fairings damaged by the collision with the vehicle, located in zones 191 to 194.
Source: adapted from the AMM.

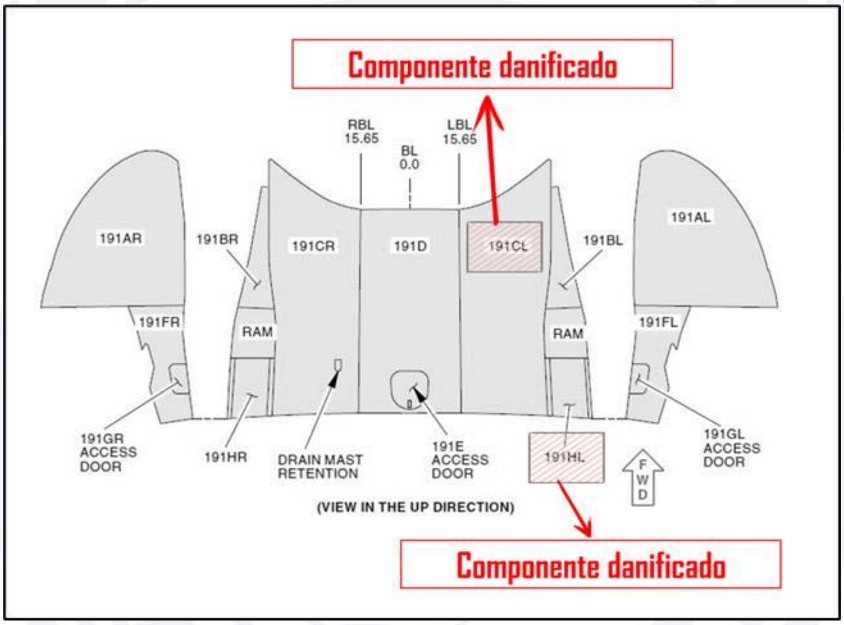

Figure 2 – Fairings damaged by the collision with the vehicle, located in zone 191.
Source: adapted from the AMM.

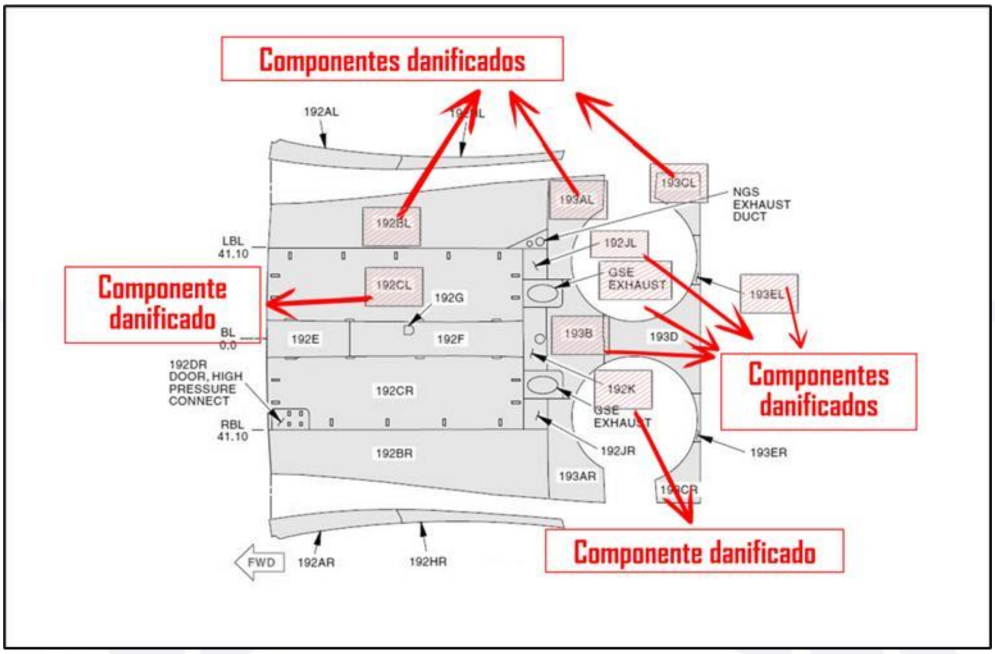

Figure 3 – Fairings damaged by the collision with the vehicle (zones 192 and 193).
Source: adapted from AMM.

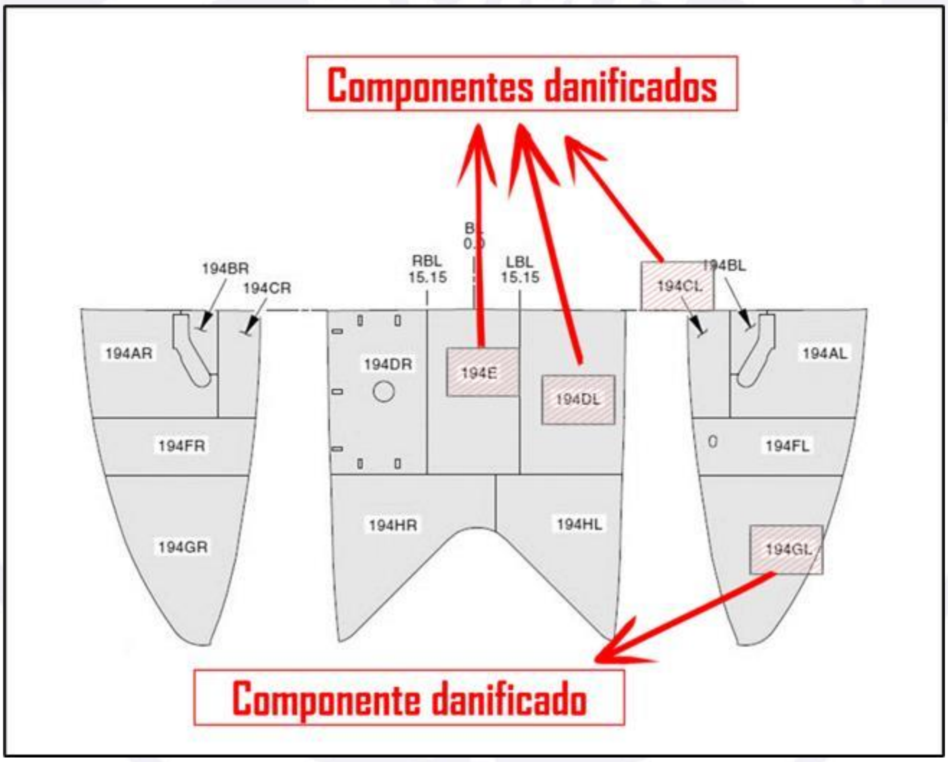

Figure 4 – Fairings damaged by the collision with the vehicle (zone 194).
Source: adapted from the AMM.

The aircraft fuselage sustained damage, including a deformation measuring 12 inches in length, 4.5 inches in width, and 0.135 inches in depth at STA (Station) 540, as well as a hole approximately 8 inches in diameter in the region between STA 727E and STA 727G.

Figure 5 - Damage to the aircraft’s lower fuselage fairings.

Although there was no direct impact between the vehicle and the aircraft's landing gear, debris resulting from the collision caused damage to various components of the left main landing gear.

1.4. Other damage.

The runway-lighting maintenance vehicle sustained substantial damage (Figures 6 to 10).

Figure 6 - Frontal view of the vehicle after the collision.

Figure 7 - Right-side view of the vehicle after the collision.

Figure 8 - Right-side view of the vehicle after the collision.


Figure 9 - Left-side view of the vehicle after the collision.

Figure 10 - Rear view of the vehicle after the collision.

1.5. Personnel information.

1.5.1. Crew's flight experience.

Hours Flown		
	PIC	SIC
Total	8,756:35	3,962:50
Total in the last 30 days	59:20	43:15
Total in the last 24 hours	2:00	2:30
In this type of aircraft	1,577:05	345:30
In this type in the last 30 days	59:20	43:15
In this type in the last 24 hours	2:00	2:30

Note: Flight-hour data obtained by means of information provided by the airline operating the aircraft.

1.5.2. Personnel training.

The Pilot in Command (PIC) completed the PPR course (Private Pilot – Airplane) in 1989, at *Aeroclube de Bauru*, state of *São Paulo*.

The SIC (pilot Second in Command) completed the PPR course in 2008, at *Aeroclube de São José do Rio Preto*, state of *São Paulo*.

The ATCOs (Air Traffic Controllers) manning the operational positions of Supervisor and TWR Control RWY 10/28 graduated from EEAR (Brazilian Air Force School of Specialists) in 2004 and 2007, respectively.

1.5.3. Category of licenses and validity of certificates.

The PIC and SIC held PLA Licenses (Airline Transport Pilot – Airplane), and valid ratings for the B737 type aircraft (including the model 737-8 MAX), MLTE (Multi-Engine Land Airplane), and IFRA (Instrument Flight – Airplane).

The ATCOs assigned to the Supervisor and TWR Control positions held valid licenses and ratings.

1.5.4. Qualification and flight experience.

The pilots were qualified and had experience in the type of flight.

1.5.5. Validity of medical certificate.

The pilots and ATCOs involved in the occurrence held valid CMAs (Aeronautical Medical Certificates).

1.6. Aircraft information.

The model 737-8 MAX aircraft, serial number 35836, was manufactured by Boeing Company in 2020, and registered in the Regular Public Air Transport Registry Category (TPR).

The aircraft had a valid CA (Certificate of Airworthiness).

The records of the aircraft technical maintenance logbooks were up to date.

In accordance with 737 MAX Airplane Characteristics for Airport Planning, Revision D, dated March 2019, the Boeing 737-8 MAX had the following dimensions:

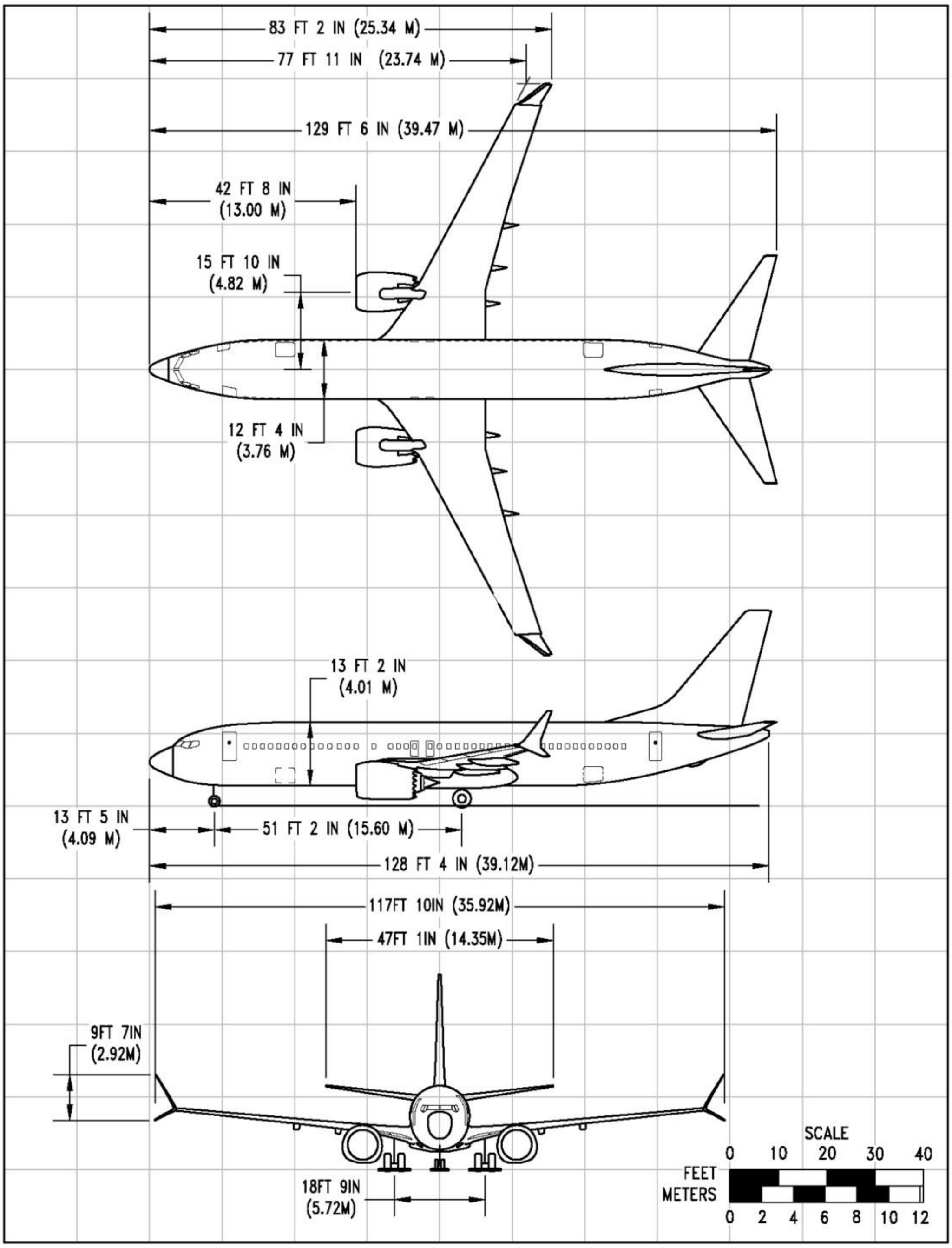

Figure 11 - Basic dimensions of the Boeing 737-8 MAX aircraft.
Source: 737 MAX Airplane Characteristics for Airport Planning.

1.6.1. Vehicle Information.

The vehicle involved in the occurrence was a mid-size pickup truck owned by *Predial Soluções Integradas* company (part of the GPS Group), responsible for providing infrastructure and maintenance services at *Galeão* International Airport.

According to the Owner's Manual, Section 2 – Technical Specifications, the vehicle's dimensions were as follows:

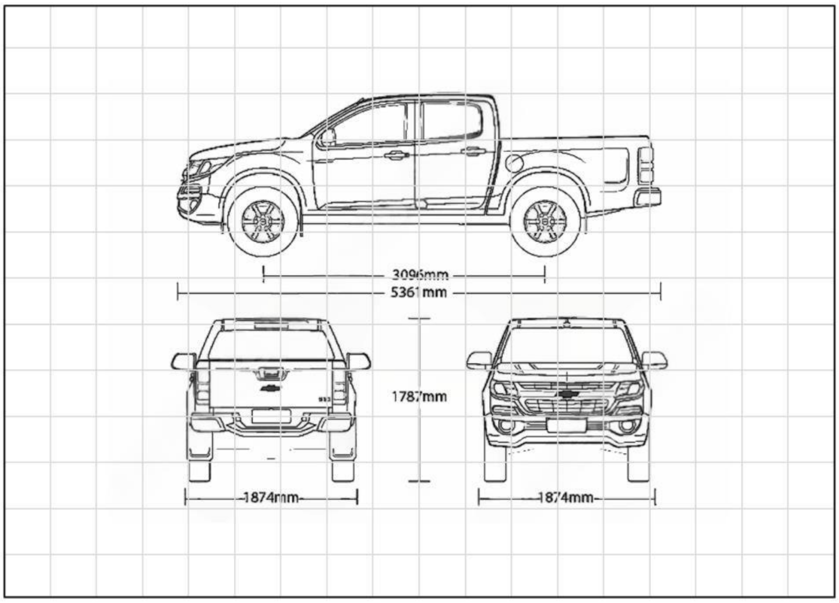

Figure 12 – Vehicle dimensions.
Source: Owner's Manual.

Figure 13 shows the lighting pattern used by the vehicle during operations, in accordance with the applicable requirements for aircraft movement areas, intended to alert pilots, controllers, and other operators of the vehicle's presence in critical areas – such as taxiways and runways.

The lighting system included amber flashing lights with 360° azimuth coverage and a flash rate of 90 flashes per minute, installed in a highly visible location, in compliance with ABNT NBR 8919 Standard – Aircraft – Ground support equipment – Signaling.

Figure 13 – Lighting pattern used by the vehicle involved in the aeronautical occurrence, featuring rotating and flashing beacons (lightbar) installed on the vehicle roof.

1.7. Meteorological information.

The SBGL Routine Meteorological Aerodrome Reports (METAR) contained the information below:

METAR SBGL 120000Z 10005KT CAVOK 29/21 Q1011=

METAR SBGL 120100Z 10003KT CAVOK 28/21 Q1011=

METAR SBGL 120200Z 13003KT 100V160 CAVOK 27/21 Q1012=

At the time of the serious aeronautical incident, the weather conditions were consistent with visual flights, as visibility was greater than 10 km with unlimited ceiling.

1.8. Aids to navigation.

NIL.

1.9. Communications.

According to the audio transcripts obtained from the ATS units, it was found that both the aircraft and the maintenance vehicle maintained radio contact with TWR-GL, with no technical anomalies identified in the communication equipment.

To support the analyses concerning the sequence of events leading up to the serious incident, the Investigation Committee analyzed the Oral Communication Recording Transcripts (TGC) 001 TWR SBGL and 005 TWR SBGL, dated February 12, 2025.

TGC 001 TWR SBGL and 005 TWR SBGL respectively address the coordination between TWR-GL and the maintenance vehicle for access to runway 10, and the coordination between TWR-GL and the aircraft PS-GPP flight crew for takeoff from the same runway.

1.10. Aerodrome information.

The aerodrome was public and under the administration of *Consórcio RIOgaleão*. It operated VFR and IFR during day- and night-time.

The runway on which the serious incident occurred was asphalt-sealed, featuring thresholds 10/28, measuring 4,000 m x 45 m, at an elevation of 28 ft. (Figure 14).

Figure 14- Satellite image showing an overview of SBGL, with the TWR-GL location, the runway 10/28 thresholds, and the point of collision between the aircraft and the vehicle.
Source: adapted from *Google Earth*.

On the date of the serious incident, the Aerodrome Chart (ADC) for SBGL indicated three locations with higher potential for runway incursions at the aerodrome, two of which were situated on runway 10/28: hot spots HS2 and HS3 (Figure 15).

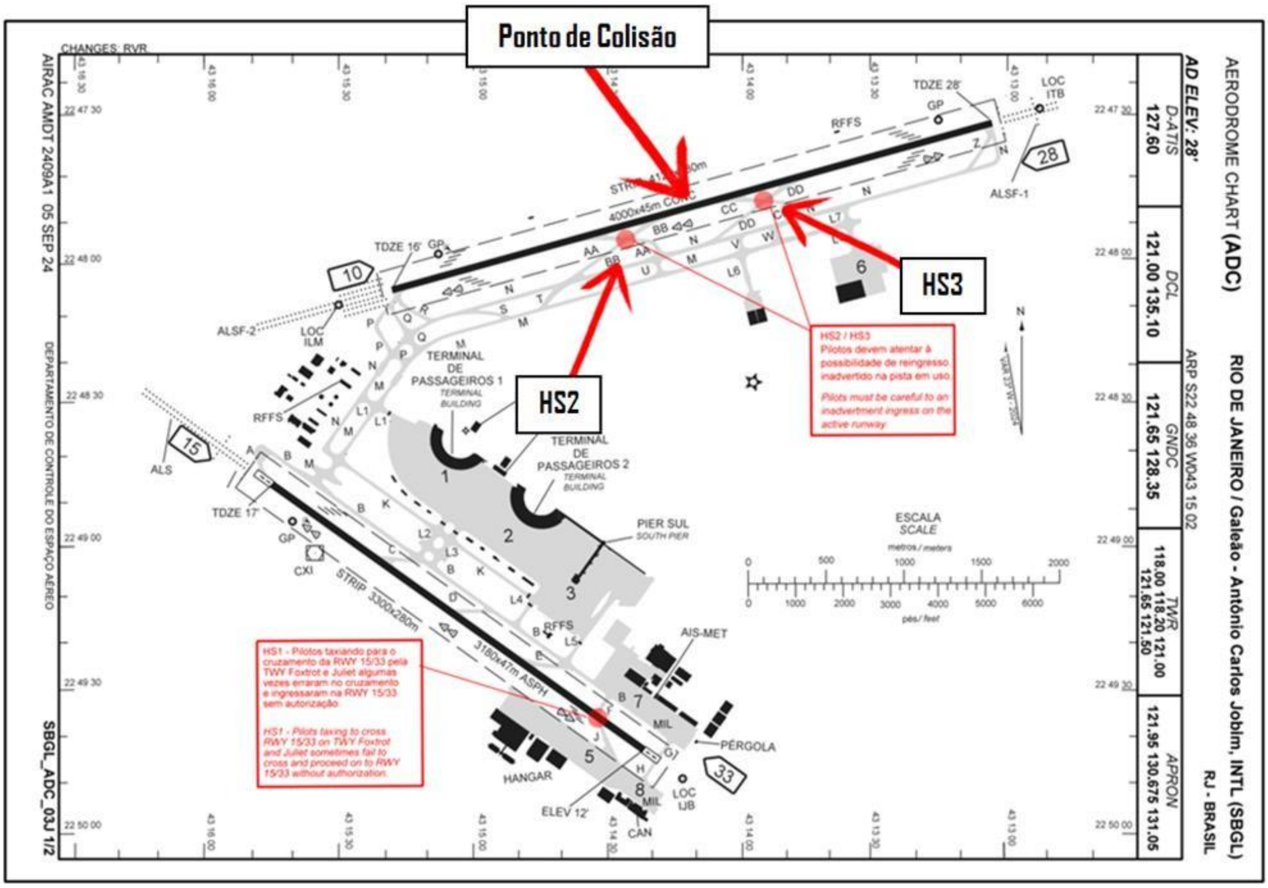

Figure 15 – Aerodrome Chart (ADC) of SBGL. The arrows indicate the point of collision between the aircraft and the maintenance vehicle, as well as the locations of hot spots HS2 and HS3. Source: AISWEB.

The main purpose of identifying these critical points was to raise the situation awareness of pilots, air traffic controllers, and vehicle drivers regarding areas with a higher likelihood of operational risk.

Galeão Airport had areas where the visibility of taxiways M and N was obstructed by nearby trees and vegetation, particularly during nighttime operations (Figures 16 to 18).

As can observed on the left side of Figure 17, this vegetation was already affecting visibility in a limited section of runway 10/28.

Figure 16 – Satellite image showing an overview of SBGL. In red, the blind spot sectors on taxiways M and N from the line of sight of the ATCO occupying the TWR Control operational position. Source: adapted from Google Earth.

Figure 17 - Blind spot sectors on taxiways M and N from the line of sight of the ATCO occupying the TWR Control operational position.

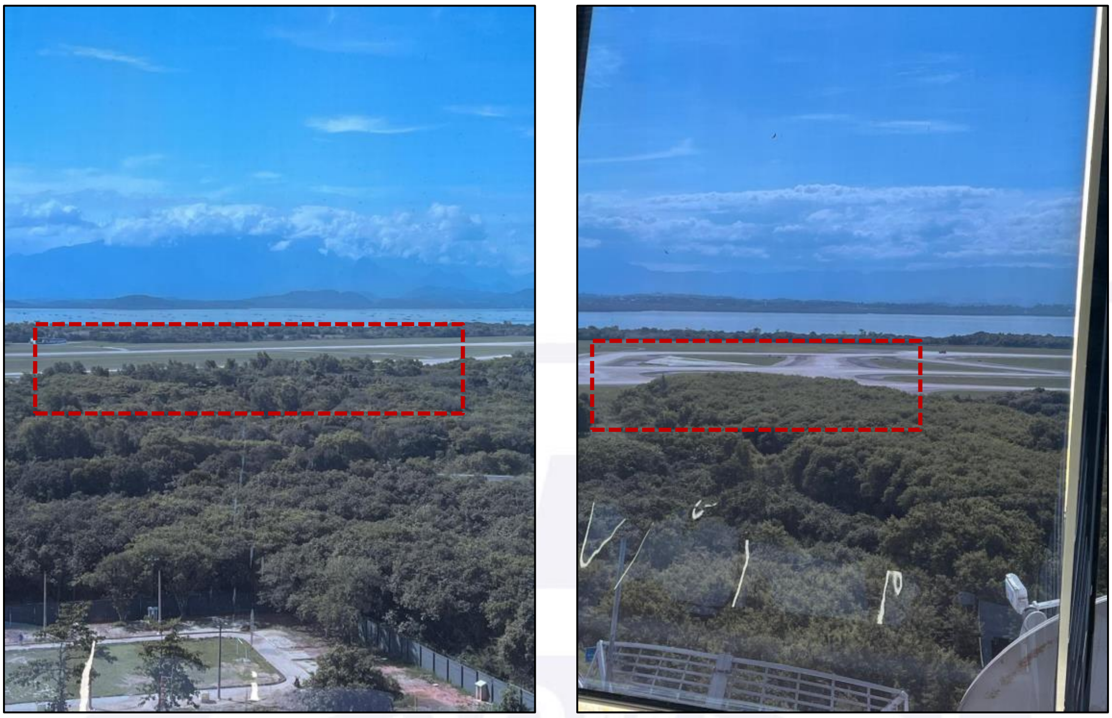

Figure 18 – Blind spot sectors on taxiways M and N from the line of sight of the ATCO occupying the TWR Control operational position.

1.11. Flight recorders.

The aircraft was equipped with a Honeywell Flight Data Recorder (FDR), model SSFDR (solid-state memory), Part Number (PN) 980-4700-042, Serial Number (SN) 5787, and a Honeywell Cockpit Voice Recorder (CVR), model FA2100 (solid-state memory), PN 2100-1020-00, SN 00657, with a recording capacity of two hours.

The FDR and CVR were sent to the Flight Recorders Data Readout and Analysis Laboratory (LABDATA) of the Center for Investigation and Prevention of Aeronautical Accidents (CENIPA).

Both recorders were operating normally at the time of the collision and contained data related to the occurrence flight.

To facilitate understanding of the operational context of the serious incident, relevant excerpts of the communications recorded by the CVR and the flight data captured by the FDR are presented in sections 1.12 *Wreckage and Impact Information* and 1.18 *Operational Information*, as they are directly related to the aircraft's operational parameters and contribute to comprehending the occurrence dynamics.

1.12. Wreckage and impact information.

The collision between the aircraft and the maintenance vehicle occurred at the center of runway 10, between the entries of taxiways BB and CC, at coordinates 22º 47' 49.2" S and 043º 14' 09.6" W.

The impact occurred 34 seconds after engine acceleration, at 2,039 meters from the threshold 10. The aircraft came to a complete stop on runway 10, at a distance of 1,101 meters beyond the point of collision, at coordinates 22º 47' 39.8" S and 043º 13' 32.3"W (Figure 19).

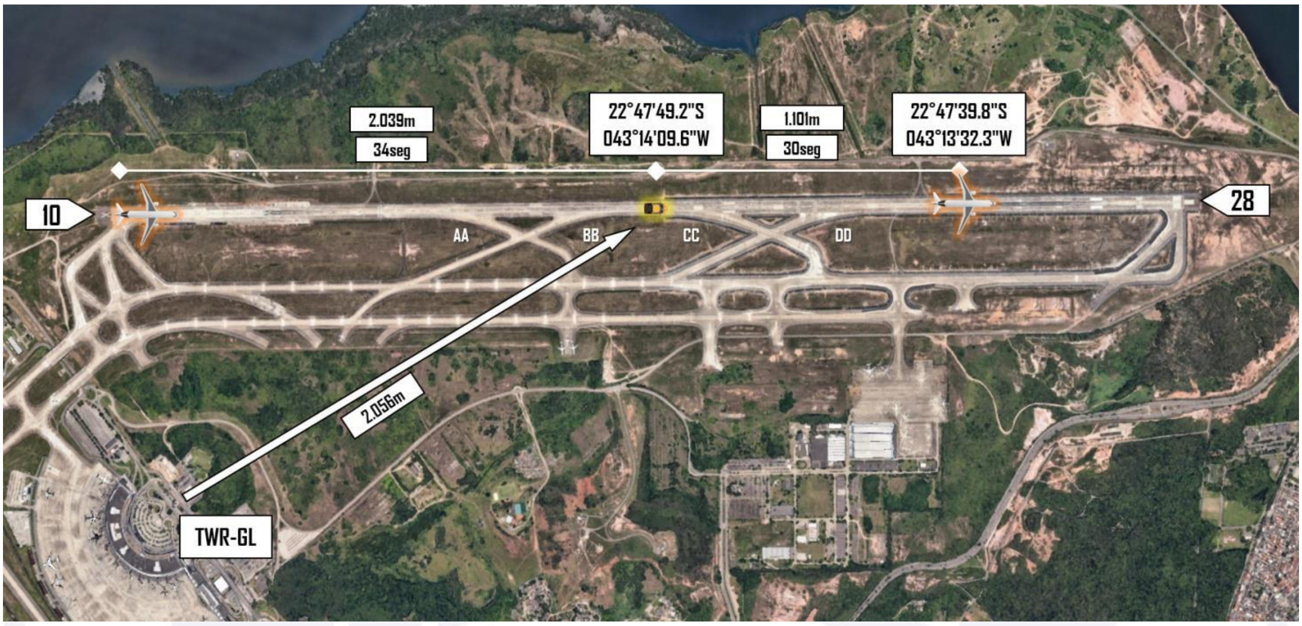

Figure 19 – Satellite image depicting the dynamics of the collision between the aircraft and the vehicle. Highlighted are the coordinates of the collision and stop points, the distances traveled and elapsed times before and after impact, as well as the distance from TWR-GL to the collision site (aircraft and maintenance vehicle not to scale for better visualization).
Source: adapted from Google Earth.

According to information collected at the occurrence site, upon sighting the vehicle stopped at the center of the runway, the Pilot Flying (PF) performed an abrupt right turn, avoiding a head-on collision between the nose landing gear and the rear section of the vehicle.

The maintenance vehicle passed underneath the aircraft fuselage, between the nose landing gear and the left main landing gear (Figures 20 and 21). The collision occurred as the aircraft approached rotation speed, at 156 kt.

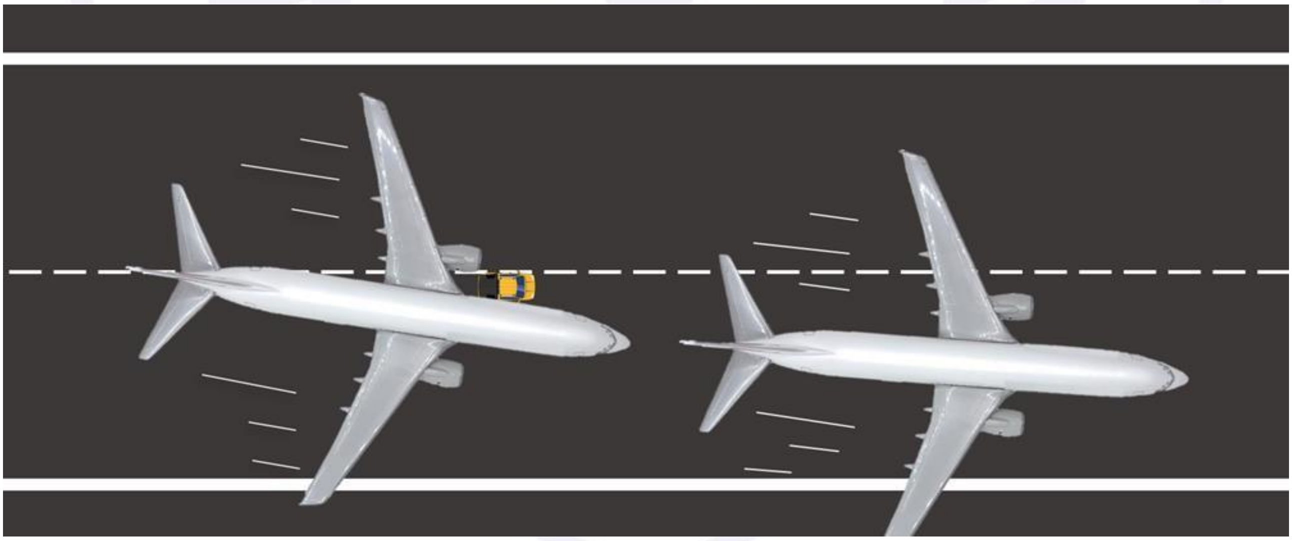

Figure 20 – Overhead view of the collision dynamics between the aircraft and the vehicle. Despite the evasive maneuver to the right, the aircraft remained within the runway lateral limits.

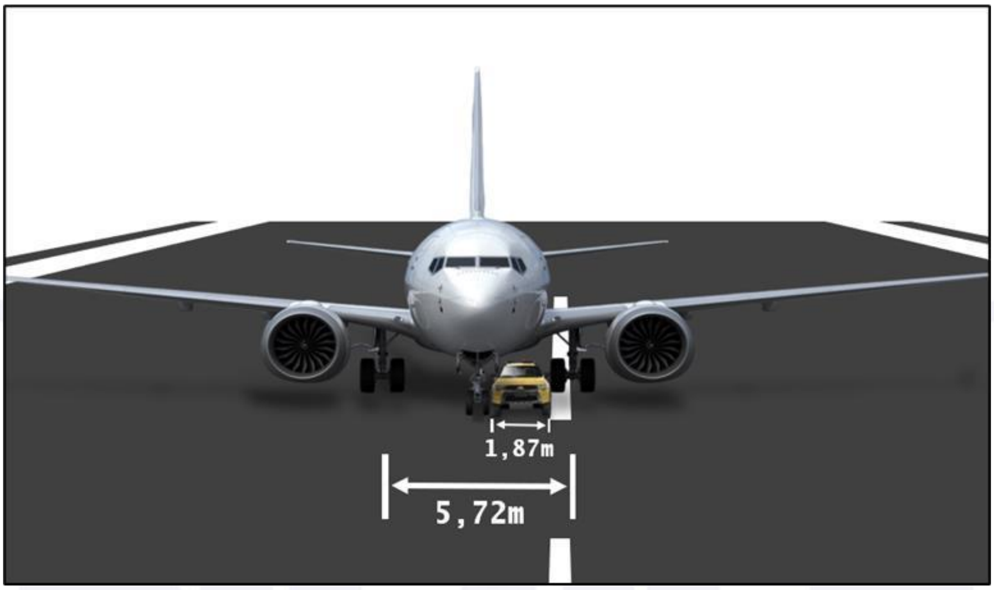

Figure 21 – Frontal view of the dynamics of the collision between the aircraft and the vehicle. The maintenance vehicle passed underneath the aircraft fuselage, between the nose landing gear and the left main landing gear.

The mapping of damage to the aircraft fairings indicated that the initial impact with the vehicle occurred at the junction of the left wing and the fuselage, subsequently extending along the underside of the fuselage and resulting in damage to zones 191 to 194.


Figure 22 – Mapping of damage to the lower fuselage fairings (zones 191 to 194).

The PF’s pedal input – 0.5 seconds before the collision – prevented a direct impact of the nose landing gear with the rear of the vehicle, significantly reducing damage to the aircraft and the severity of injuries to those involved. According to FDR data, the pilots spotted the vehicle at a distance of approximately 185 meters (Figures 23).

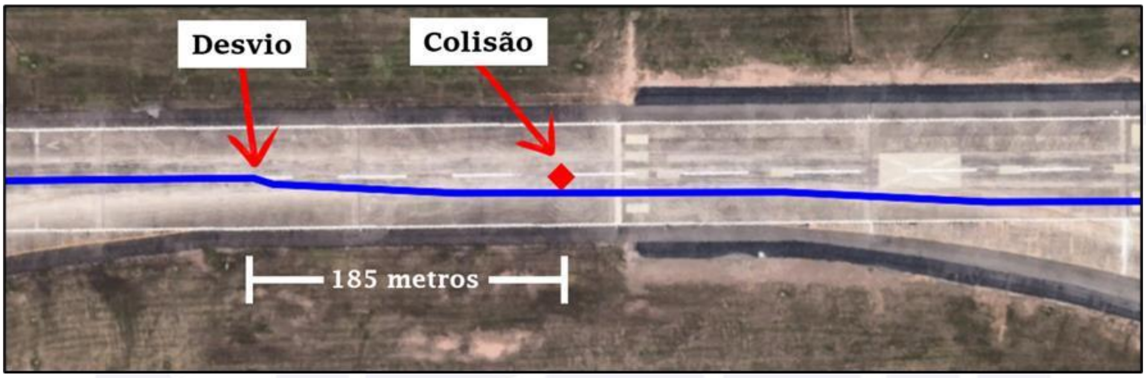

Figure 23 – Moment when the pilots sighted the vehicle and initiated a right turn, at a distance of 185 meters short of the collision point. At that moment, the aircraft had an indicated airspeed of 153 kt. The blue line indicates the approximate trajectory of the nose landing gear. Source: adapted from the *Google Earth*/FDR

Figure 24 shows the pedal input amplitude used in the maneuver, in accordance with data extracted from the FDR.

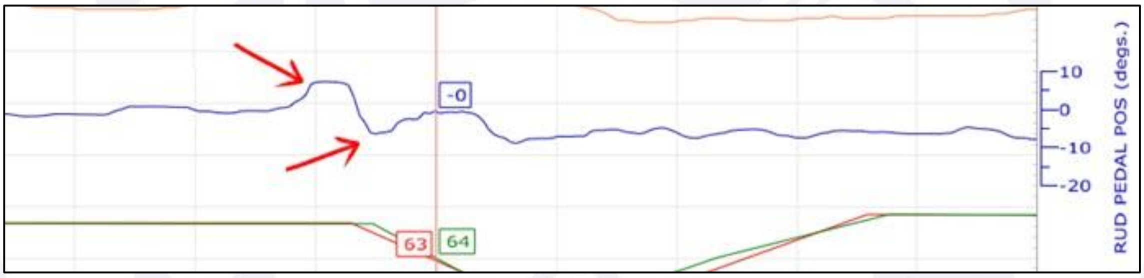

Figure 24 – Pedal input amplitude used by the PIC prior to impact with the vehicle. Source: FDR.

One of the vehicle’s occupants managed to get out before the impact. The other one lay down across the seats and became trapped in the wreckage due to deformation of the pickup truck cabin.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

NIL.

1.13.2. Ergonomic information.

With regard to the ergonomics of the control room, the SIPAER Investigation Committee found that the workstation used by the TWR Control and Ground Control operational positions was located below the appropriate line of sight for air traffic controllers, regardless of the individual physical characteristics of the professionals (Figures 25 to 27).

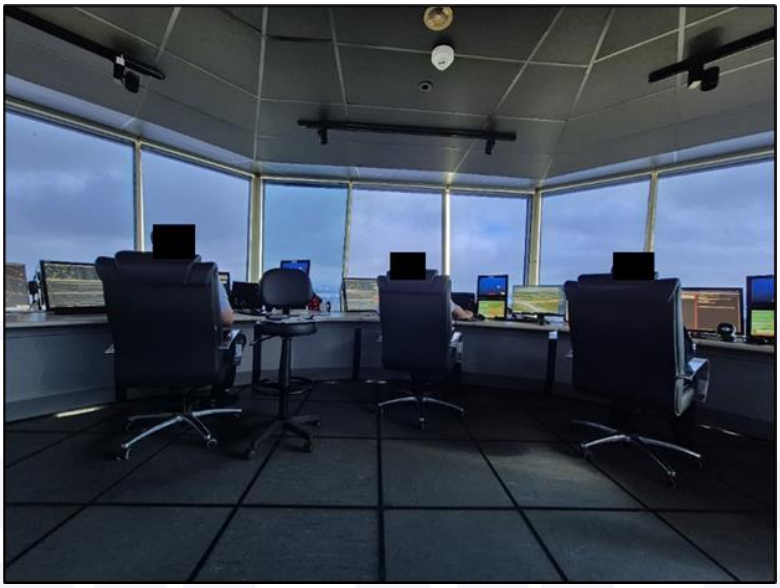

Figure 25 – Chairs used in the TWR-GL control room at the time of the occurrence.

Figure 26 – Chairs used in the TWR-GL control room at the time of the occurrence.

Figure 27 – Chairs used in the TWR-GL control room at the time of the occurrence.

The conditions observed at TWR-GL revealed an inadequate workspace layout, in noncompliance with current regulatory requirements and the operational demands of continuous visual surveillance - particularly those set forth in MCA 63-15 - *Human Factors Manual for Operational Safety Management in SISCEAB* – thereby compromising the effectiveness of direct supervision of the movement areas by the ATCOs.

1.13.3. Psychological aspects.

The ATCO occupying the operational TWR Control position for runways 10/28 was described by colleagues as an engaged, experienced, attentive, and confident professional.

According to his statement, he felt professionally fulfilled, enjoyed his duties, and maintained good relationship with both peers and supervisors. He also reported being well-rested for the shift, noting that his last day off had been two days prior. When asked about his workload, he expressed satisfaction with his duty schedule and with the way work was organized.

He mentioned that he had the knowledge and skill to perform in all operational positions of TWR-GL and that he usually worked as Supervisor. Regarding the position he held at the time of the occurrence – TWR Control runways 10/28 – he said he felt comfortable and accustomed to it, having worked in that position for a long time.

As for external influences, such as personal life events or emotional states, he reported that there were no such issues negatively affecting his performance.

At the time of the serious incident, the ATCO had been in the TWR Control position for runways 10/28 for approximately 10 minutes. According to his account, there was a drop in his level of attention due to the low volume of arrivals and departures at that moment and to the relaxed atmosphere prevailing in the Control Tower. He also mentioned the existence of some blind spots caused by vegetation, which made it difficult to see the vehicle on the runway, especially at night.[1]

Regarding the *Total Air Traffic Information Control* (TATIC) [1] system, the ATCO reported that he could not recall whether the screen was locked prior to authorizing the takeoff of aircraft PS-GPP, but after issuing the clearance, he remembered the vehicle and decided to check with the Supervisor whether it was still on the runway. Upon confirming the vehicle's presence on the runway, he became alarmed and did not consider the possibility of instructing aircraft PS-GPP to abort takeoff.

As for the ATCO who occupied the Supervisor position, he was described by colleagues as a reserved and focused professional, always attentive to operations to ensure compliance with regulations.

When the serious incident happened, he had been approximately two hours in the role of Supervisor. According to his account, he felt rested. He described the day as uneventful and marked by routine, both before and during his duty period.

According to available information, the Supervisor position was normally deactivated at 22:00 and reactivated at 06:00 (local time) on the following day. However, he reported that at the time of the occurrence, he was still in the Control Tower, filling out the logbook and monitoring via radio the inspection being performed by the lighting-maintenance vehicle on the runway, which had already been interrupted and resumed twice and, in his opinion, was taking longer than usual.

Based on his account, he felt that, if he had still been on duty as Supervisor, his situation awareness might have been higher and, upon perceiving the situation, he might have insisted on aborting the takeoff.

[1] The TATIC system enables air traffic management and control by providing real-time information for flow management, statistics, and fee calculation.

It is worth noting that all crewmembers of the aircraft and the drivers of the vehicle were interviewed by the Investigation Committee. However, no psychological aspects were identified that might have compromised their operational performance or contributed to the occurrence.

1.14. Fire.

There was no fire.

1.15. Survival aspects.

The activation of the SBGL Aerodrome Emergency Plan (PLEM) took place immediately after the TWR triggered the aeronautical emergency alarm, at 01:11:40 UTC.

According to information obtained by the Investigation Committee, all procedures established in the PLEM were carried out as prescribed and within the expected response time. The actions included firefighting, first aid, disembarkation of passengers and crew, isolation of the area for SIPAER investigation, and the measures necessary for the release of the runway for operations after the occurrence.

Footage from a security camera located near the United Airlines hangar in apron 6, although showing a delay of 3 minutes and 31seconds relative to the actual time, made it possible to identify the response time of the Aerodrome Rescue and Firefighting Service (SESCINC) vehicle to the emergency.

According to data extracted from the FDR, the aircraft came to a complete stop at 01:09:00 UTC, which corresponds to the time of 22:05:29 recorded by the security camera footage, as illustrated in Figures 28 and 29.

Figure 28 – Complete stop of aircraft PS-GPP after the collision, at 22:05:29 (camera time), corresponding to 01:09:00 UTC, according to the FDR.

Figure 29 – Moment of the aircraft's complete stop after the collision, at 01:09:00 UTC[2], according to FDR data.

The SESCINC vehicles began moving toward the occurrence site immediately after hearing the call for help made by one of the maintenance vehicle's occupants' at 01:10:13 UTC. They were subsequently dispatched by the TWR-GL emergency call at 01:11:40 UTC.

The team of the CCI-4 (Firefighting Vehicle) stationed at PACI-2 (Forward Firefighting Post) arrived at the aircraft's stop point at 01:11:50 UTC.

At the scene, firefighters identified incandescence in the right landing gear and, following the procedures outlined in the Aerodrome Firefighting Plan (PCINC), carried out controlled cooling of the component, and protected the fuselage using Fire Extinguishing Foam Liquid (LGE) [3] to prevent overheating and ensure the structural integrity of the aircraft.

At 01:15:00 UTC, firefighting teams CCI-1 and CCI-2 arrived at the aircraft location via taxiway N to support the operation. After the cooling process, the firefighters conducted a detailed inspection to verify possible fuel leaks, structural ruptures, or risks to the safety of occupants.

---

[2] UTC = GMT Time

[3] LGE is a concentrate that, when mixed with water and air, forms a foam used to fight fires, primarily those involving flammable liquids (Class B fires), such as fuels and petroleum derivatives.
The foam acts in three main ways:
* Smothering: creates a layer that prevents oxygen from coming into contact with the fuel.
* Cooling: the water in the foam helps lower the temperature of the burning material.
* Vapor suppression: prevents the release of flammable vapors, reducing the risk of reignition and fire spread.
At airports, LGE is widely used by firefighters in situations such as the one described in the Report, where there is a risk of fire involving aircraft due to fuel and lubricants.

After confirming the absence of additional risks, the firefighters established direct communication with the pilots through the inspection window and were informed that no internal abnormalities were present in the aircraft.

In light of this, the use of a platform ladder was chosen to enable the orderly disembarkation of passengers and allow for internal cabin verification, ensuring priority assistance to those who might have difficulty exiting the aircraft independently.

Controlled evacuation of the 109 passengers and crew began at 01:18:00 UTC, following established safety protocols. The aircraft occupants were escorted to the support buses previously positioned, under the coordination of the emergency-response team leader.

No injuries were reported among the aircraft occupants. However, an elderly female passenger, who used a colostomy bag, reported emotional distress due to the serious incident. The team provided appropriate support and transported the passenger on a spine board

The aircraft-evacuation operation was successfully completed at 01:38:00 UTC.

At 06:42:00 UTC, the vehicle involved in the serious incident was removed to PACI-2.

At 07:08:00 UTC, after the aircraft was chocked and all systems were shut down, the emergency status was lifted.

Runway 10/28 was cleared for operations at 14:50 UTC, after completion of runway pavement decontamination. However, it remained inoperative due to NOTAM E9627/24, which established preventive maintenance on the runway, scheduled to end at 20:00 UTC.]

1.16. Tests and research.

NIL.

1.17. Organizational and management information.

According to information gathered by the Investigation Committee, the organizational climate at TWR-GL was perceived by personnel as favorable. Likewise, the support provided by management was described as adequate.

The group of controllers consisted of professionals with extensive experience and, according to reports, demonstrated good cohesion, resulting in a collaborative and respectful work environment.

The physical conditions of TWR-GL's facilities were described as satisfactory; however, there were reports that vegetation in the vicinity created blind spots that hindered visibility of vehicles on runway 10/28, particularly at night.

The individual duty rosters of the controllers involved in the occurrence – covering the months of December 2024, January, and February 2025 – were analyzed, and it was found that the ATCOs' workload followed the limits established by the legislation in force. Interviews revealed no indications of nonconformities in this regard.

The organization of work at TWR-GL received praise; however, there were complaints that runway inspections often took place during peak aircraft-traffic periods, which increased the workload for controllers.

1.17.1 Operational Safety Management of the Air Navigation Service Provider (ANSP)

The Operational Safety Management Manual (SMM) of CRCEA-SE aimed to establish and guide the management of the Safety Management System (SMS) for the ANSPs under the authority of the Southeast Regional Airspace Control Center (CRCEA-SE).

According to item 1.2, the objective of the SMM was to define the minimum requirements related to the management, activities, responsibilities, and standardization of documents necessary for the functioning and continuous improvement of the SMS in the ANSPs under CRCEA-SE's oversight.

As outlined in section 1.3 (Scope), the Manual applied to CRCEA-SE and to all of its subordinate ANSPs.

The CRCEA-SE was an Air Navigation Service Provider Organization, which had several subordinate providers under its jurisdiction, all managed by the CRCEA-SE's Commander, who acted as the Accountable Executive (AE). These providers operated in a coordinated manner and were governed by a single SMM.

The CRCEA-SE's SMS applied to all subordinate ANSPs, in accordance with the guidelines established in the SMM, aiming at the continuous improvement of operational safety. Among the subordinate providers under the CRCEA-SE was the *Galeão* Airspace Control Detachment (DTCEA-GL), which included *Galeão* Control Tower (TWR-GL).

The most recent version of the SMM came into effect in February 6, 2024, following its approval through the CRCEA-SE's Ordinance No. 176/SIPACEA.

The amendment history of the previous SMM version showed that several updates had been made to the document, including the incorporation of the term SDCPS – Safety Data Collection and Processing Systems; update of the list of providers under the CRCEA-SE; interactions between the SMS and related systems; and the SMS structure, in accordance with the provisions of the Command of Aeronautics' Instruction (ICA) 81-2.

The items related to the safety policy and objectives, the management of safety risks, safety assurance, and safety promotion were also reviewed, along with the inclusion of the item concerning the collection, analysis, protection, sharing, and exchange of safety data and information.

In the Manual, the organization's Top Management reaffirmed its commitment to operational safety through the following actions:

> ...
>
> III –Maintain effective hazard identification and risk management processes, including those related to ATC fatigue, with the aim of eliminating or mitigating ANS provision risks to acceptable levels; as well as assessing residual risks and the effectiveness of the mitigation measures implemented.
>
> ...
>
> IX –Promote the continuous improvement of operational safety management processes, tools, and procedures, aiming to enhance compliance with ANS regulations and to raise the SMS maturity level of subordinate units.

In accordance with the requirements of DECEA, and the standards and recommended practices of the International Civil Aviation Organization (ICAO), the Safety Management System (SMS) was organized into four fundamental components, as described below:

1. Safety policy and objectives;
2. Safety risk management;
3. Safety assurance; and
4. Safety promotion.

With regard to safety risk management, the Safety Management Manual (SMM) established that ANSPs should maintain formal, explicit, and traceable processes for the continuous monitoring of operational safety in service provision, as well as establish procedures for the identification and systematic recording of hazards related to the provision of Air Navigation Services (ANS).

It was the responsibility of ANSPs to ensure that the risks associated with hazards identified during current operations were under control, in order to meet the established operational safety objectives. This process, known as Safety Risk Management (SRM), comprised the following steps:

a) hazard identification;
b) risk assessment;
c) risk classification;
d) risk mitigation; and
e) risk control.

The safety risk management process for current operations was to be applied whenever a hazard related to the provision of air navigation services was identified by any means.

Regarding hazard identification, ANSPs were required to develop and maintain formal and effective procedures and processes for collecting, recording, processing, and providing feedback on operational hazards during current operations, using both reactive and proactive methods for collecting operational safety data.

In accordance with the SMM, SIPACEA (Section for the Investigation and Prevention of Airspace Control Accidents and Incidents) was responsible for monitoring and supervising SRM processes by means of Operational Safety Visits, Operational Safety Reports, and other tracking and control tools.

Both internal and external sources of hazard identification were to be analyzed in accordance with standardized procedures established by specific regulations. The main sources included:

<u>Mandatory Reports</u>

ANSPs maintained clear regulations regarding the mandatory reporting of air traffic incidents, operational occurrences, technical anomalies, and failures in air navigation infrastructure that could affect the safety of ANS provision.

They were also required to establish formal, explicit, and traceable means for personnel to report occurrences within their area of responsibility during the performance of their duties.

The mandatory reporting tools used by ANSPs under the CRCEA-SE included: the Occurrence Logbook (LRO), the Occurrence Notification Form (FNO), and the Malfunction Report Form (RIF).

<u>Voluntary Reports</u>

ANSPs maintained specific regulations for voluntary reporting and encouraged their personnel to report any observed conditions that could compromise operational safety.

They were also required to ensure that professionals who voluntarily reported an air traffic incident, an operational safety-related occurrence, or a fatigue-related event would not be subject to disciplinary sanctions – except in cases of unlawful acts or intentional noncompliance with applicable regulations.

The voluntary reporting tools adopted included the PREVENT Report (RELPREV) and the Voluntary Fatigue Report (RVF).

<u>Operational Safety Inspections</u>

SIPACEA-SE conducted inspections at subordinate ANSPs with the purpose of identifying potential hazards in day-to-day operations. These Operational Safety Inspections (VSOs) were carried out as outlined in a specific NPA (Standard Operating Procedure - SOP).

Internal Operational Safety Inspections

ANSPs established internal procedures for conducting regular inspections of activities related to operational safety, in accordance with the specific NPA issued by SIPACEA-SE, aiming to identify potential hazards in the operations under their responsibility.

Review of Recorded Communications

ANSPs instituted internal procedures to listen to recorded communications from the Aeronautical Mobile Service (AMS) and Aeronautical Fixed Service (AFS) at randomly determined dates and times, to verify operational factors affecting the provision of air traffic services, in accordance with a specific NPA from SIPACEA-SE.

Operational Factors Survey (PFO)[4]

Area Control Centers (ACC), Approach Control Units (APP), and Control Towers (TWR) with annual movement exceeding 50,000 operations systematically conducted Operational Factors Surveys during normal operations, in order to assess the provision of air traffic services.

To this end, they established specific internal procedures in accordance with the NPA issued by SIPACEA-SE, ICA 63-32 (Operational Safety Surveys for Air Traffic Service Providers), and MCA 63-16 (Operational Safety Survey Manual for Air Traffic Service Providers).

Normal Operations Observation (OON)

OON was a hazard identification process conducted through real-time, direct observation of normal operations, allowing for the collection of objective data on factors influencing the safety of air traffic service provision.

ANSPs with annual movement equal to or less than 50,000 operations established internal procedures for conducting OON, in accordance with a specific NPA from SIPACEA-SE.

Other Sources of Hazard Identification

Other sources of hazard identification could also be used, provided they were available and considered relevant, such as PFH (Human Factors Profile) reports issued by DECEA, Airspace Control Investigation Reports (RICEA), ATS Assessments, fatigue-related investigations linked to air traffic incidents, analysis of planned operational duty rosters, and the Fatigue Database.

The SMM stated that air traffic occurrences and incidents could result from failures on the part of ANSPs, navigation infrastructure, aircraft, or a combination of these factors. For this reason, it was essential to establish and monitor relevant Operational Safety Objectives, aligned with the primary objective of DECEA: to maintain operational safety in the provision of ANS by reducing the number of air traffic incidents.

As a complement to DECEA 's strategic goals, specific objectives were defined and monitored according to the methodology established in ICA 63-38 – Safety Performance Indicators in the SISCEAB, as follows:

a) Reduce the number of air traffic incidents (applicable to all ANSPs);

[4] The PFOs aimed to analyze the performance of an ATS provider, focusing on identifying potential future issues by collecting information capable of indicating emerging risks from various sources. It was a predictive hazard identification process, conducted through real-time monitoring of normal operations, with the purpose of obtaining data that would enable an objective assessment of the operational factors involved in the provision of services. Regardless of regular inspections, the PFO provided relevant diagnoses of the operational routine, establishing itself as an effective mechanism for obtaining meaningful information about different aspects of ATS providers' performance.

b) **Reduce the number of runway incursion occurrences (applicable to ANSPs providing Control Tower and AFIS services);**
c) Reduce the number of TCAS Resolution Advisory events (applicable to all ANSPs).

Specific Objectives of CRCEA-SE

The operational safety objectives established by CRCEA-SE reflected essential aspects which, when achieved, demonstrated operational compliance with the standards and principles of the Safety Policy, ensuring the maintenance of the Acceptable Level of Safety Performance (ALoSP).

To support the primary objective of SISCEAB (Brazilian Airspace Control System), CRCEA-SE adopted the same specific objectives defined by DECEA, reinforcing its commitment to the reduction of air traffic incidents and, consequently, to the maintenance of operational safety in the provision of air navigation services (ANS), namely:

a) Reduce the number of air traffic incidents classified as critical and potential risk (combined total);
b) **Reduce the number of runway incursions;**
c) Reduce the number of TCAS Resolution Advisory (RA) events.

Continuous Improvement of the SMS

In the context of the continuous improvement of the Safety Management System (SMS), ANSPs developed and maintained formal processes to identify system performance deviations, assess the implications of such deviations for operations, and correct situations that resulted in performance standards falling below expectations.

These activities included, among others, the following actions:

a) Development of internal inspection processes to verify SMS compliance;
b) Monitoring of occurrences, errors, infractions, and/or violations of ANS regulations;
c) Conducting operational safety assessments;
d) Evaluating performance against the organization’s operational safety objectives; and
e) Trend analyses based on Operational Safety Performance Indicators (IDSO) and Operational Safety Data Models (MDSO).

Additionally, ANSPs carried out activities aimed at ensuring the correction of systemic deficiencies identified, in order to mitigate potential negative impacts on operational safety.

As part of the monitoring and continuous improvement cycle, the Regional Operational Safety Committee held semiannual meetings in which the Head of the Operations Center and the Commanders of the subordinate Units (DTCEAs) were summoned to report to the Regional Authority (RA). These meetings included presentations based on the main occurrences recorded during the period and the outlook for achieving the goals established for the current year.

1.18. Operational information.

At the time of the occurrence, three ATCOs were on duty in the Control Tower, and the following operational positions were grouped, as provided in the TWR-GL Operational Model:

- Ground Control and Traffic Clearance Delivery;
- TWR Control and TWR Assistant;
- Supervisor and Coordinator.

The ATCOs directly involved in the occurrence were the one assigned to the TWR Control position, with 17 years of qualification, 11 years in the role, and 10 minutes at the operational position, and the one assigned to the Supervisor position, with 23 years of qualification, 10 months in the role, and two hours at the operational position (Figure 30).

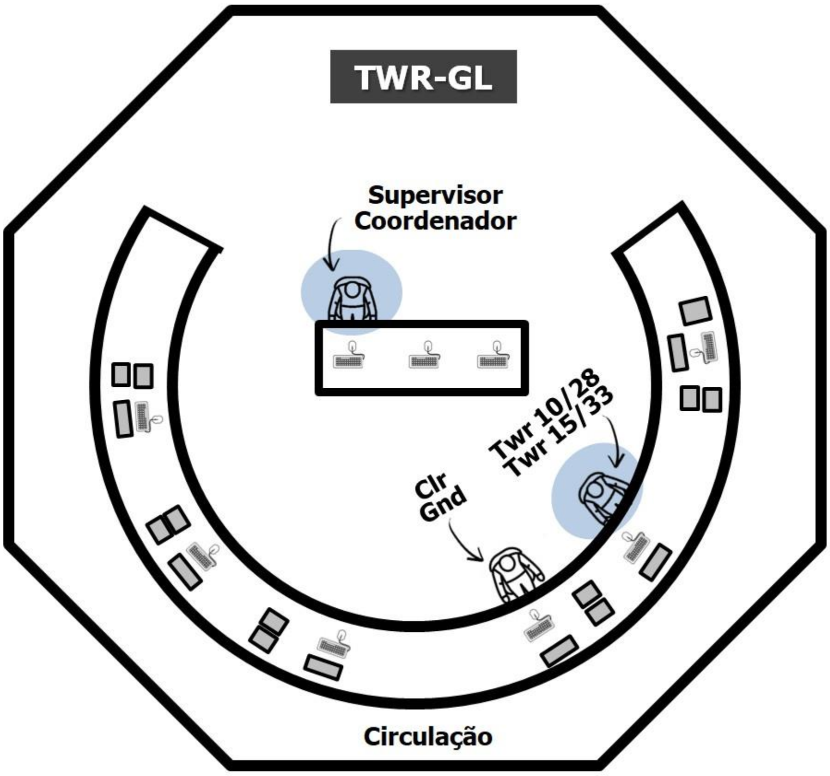

Figure 30 - Diagram of the operational positions occupied by the air traffic controllers in TWR-GL at the time of the runway incursion, with grouped positions. Highlighted in blue, the ATCOs directly involved in the occurrence.

No on-the-job training was being conducted at the time of the occurrence.

According to the TWR-GL Operational Model, item 6.4 "Activation and Deactivation of Operational Positions", after 21:45 local time, the Supervisor position could be deactivated, provided prior coordination had been made with the Team Chief and the *Rio de Janeiro*'s Flight Management Center (FMC-RJ), and provided that fewer than three control positions were active.

Although these requirements and procedures had been met, the Supervisor remained in the control room, coordinating the movement of a maintenance vehicle on runway 10/28. Therefore, both the Technical Opinion ATS 00004/TWR-GL/25 and the Technical Report ATS 001/ASEGCEA/25, prepared by DECEA, considered that the ATCO was still performing their functional duties at the time of the collision. This was also the understanding adopted by the SIPAER Investigation Committee.

At the time of the occurrence, authorizations for vehicle traffic on the maneuvering area were being issued by the Supervisor, using a handheld radio tuned to Group 7 frequency, in coordination with the ATCO assigned to the TWR Control position, as provided for in the TWR-GL Operational Model.

Based on the analysis of the audio and video records, it was found that at 01:03:18 UTC, the runway-lighting maintenance vehicle contacted TWR-GL, requesting authorization to enter runway 10, using the callsign "*Manutenção Balizamento*."

After coordinating the vehicle’s movement with the ATCO assigned to the TWR Control position, the Supervisor authorized the vehicle to enter the runway at 01:03:45 UTC, requesting that the runway be reported clear upon completion of the work.

Due to the entry of the maintenance vehicle onto the runway at 01:03:45 UTC, the ATCO at the TWR Control position initiated the TATIC screen locking procedure, as provided in item 6.7.3.9 of the TWR-GL Operational Model (Figures 31 and 32).

Figure 31 - Moment prior to the locking of the TATIC screen by the ATCO at the TWR Control position. The arrow indicates the unlocked screen.

Figure 32 - Moment after the locking of the TATIC screen by the ATCO at the TWR Control position. The arrow indicates the locked screen.

According to the TWR-GL Operational Model, this procedure aimed to mitigate runway incursion occurrences and was to be performed whenever there was an inspection, maintenance, or any other event restricting the runway’s use for takeoffs or landings.

Still according to the TWR-GL's Operational Model, the TATIC screen locking should remain activated until the vehicle exited, and the runway was subsequently cleared for normal operation. (Figure 33).

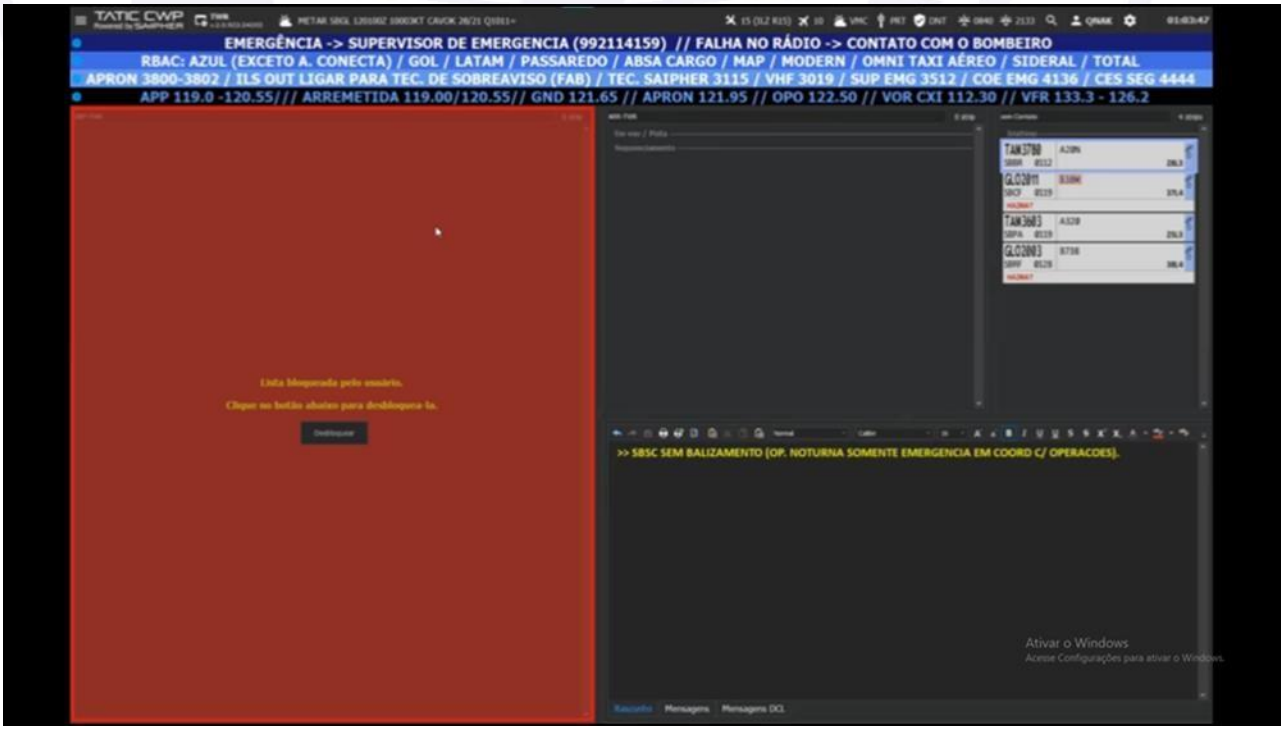

Figure 33 - TATIC screen locked after the command issued by the ATCO at the TWR Control position.

In the following four minutes, the ATCO at the TWR Control position engaged in non-operational conversations with the ATCO at the Ground Control position.

At 01:07:03 UTC, the ATCO at the TWR Control position unlocked the TATIC screen without verifying whether the vehicle had vacated the runway. Immediately afterward, the ATCO called aircraft PS-GPP, authorizing takeoff on runway 10, without visually scanning the runway.

Figures 34 and 35 show the ATCO unlocking the TATIC screen manually.

Figures 34 - Moment at which the TATIC screen was unlocked.

Figure 35 - Moment at which the TATIC screen was unlocked (zoomed view). On the left, the locked screen and, on the right, the same screen unlocked.

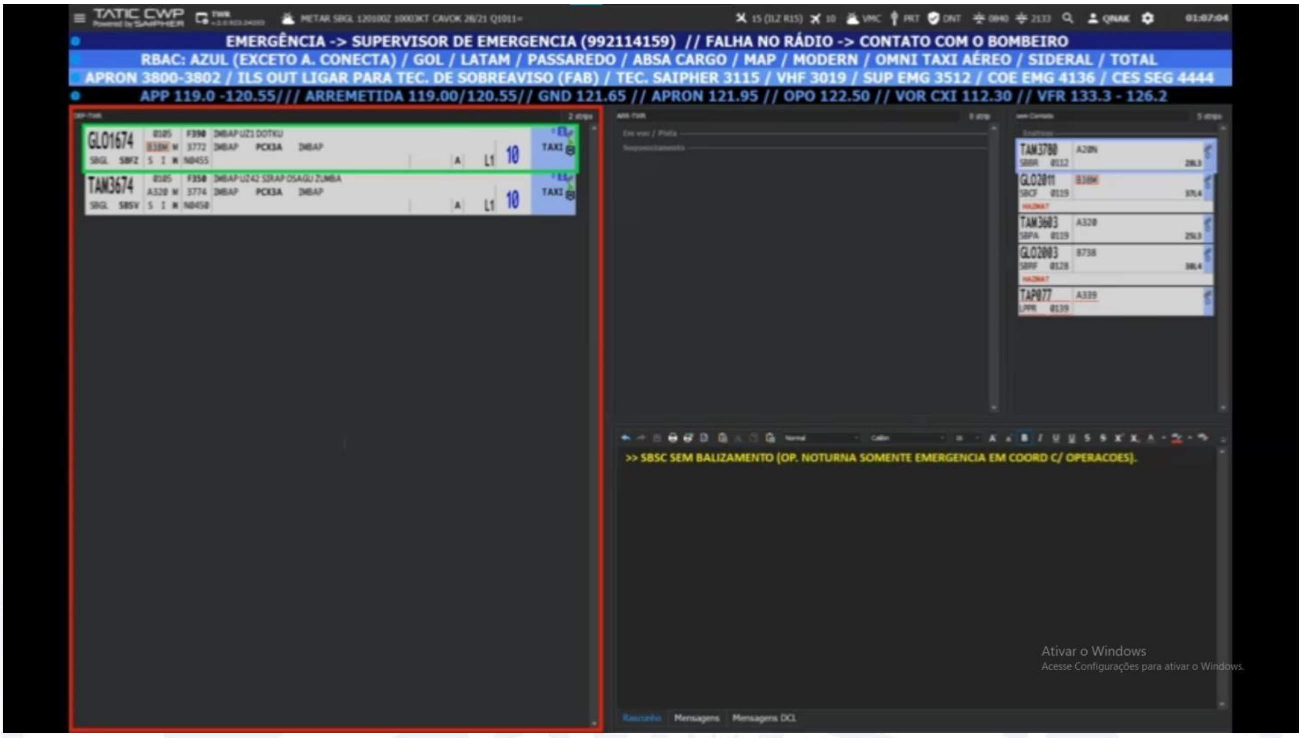

Figure 36 - TATIC screen unlocked after the command Issued by the ATCO at the TWR Control position.

At that moment, the Supervisor, distracted while handling a mobile phone, did not notice that the ATCO had failed to comply with the procedure set forth in the TWR-GL Operational Model (Figure 38).

On the occasion, TWR-GL had only two aircraft being controlled: *GOL* 1674 (PS-GPP), departing from runway 10, and TAM 3780, on the approach for landing on runway 15.

Figure 37 - Action performed by the Supervisor moments before the takeoff clearance was issued to the aircraft (view from the 360º camera, located on the ceiling of TWR-GL operations room).

At 01:07:17 UTC, aircraft TAM3780 called on final for landing on runway 15.

At 01:07:43 UTC, the ATCO at the TWR Control position cleared aircraft TAM3780 to land on runway

At 01:07:51 UTC, the ATCO at the TWR Control position turned to the Supervisor and asked whether the maintenance vehicle had been removed from the runway: "*Did you remove maintenance*?" (Figures 38 and 39).

Right away, the Supervisor replied: - *"No, no*!"

The ATCO at the TWR Control position reacted with surprise: *"Oh my God!"* However, he did not cancel aircraft PS-GPP's takeoff.

Figure 38 - Moment when the ATCO at the TWR Control position asked the Supervisor if the maintenance vehicle had been removed from the runway (view from the 360º camera, located on the ceiling of the TWR-GL operations room).

Figure 39 – Moment when the TWR controller asked the Supervisor if the maintenance vehicle had been removed from the runway. In the background, the aircraft can be seen while positioning for takeoff.

According to the data recorded by the FDR, aircraft PS-GPP began its takeoff roll at 01:07:54 UTC, three seconds after the ATCO recalled that the maintenance vehicle was still on the runway. At the exact moment the pilots applied engine power, the aircraft was 2,039 meters from the vehicle and 34 seconds from the estimated point of impact (Figures 40 and 41).

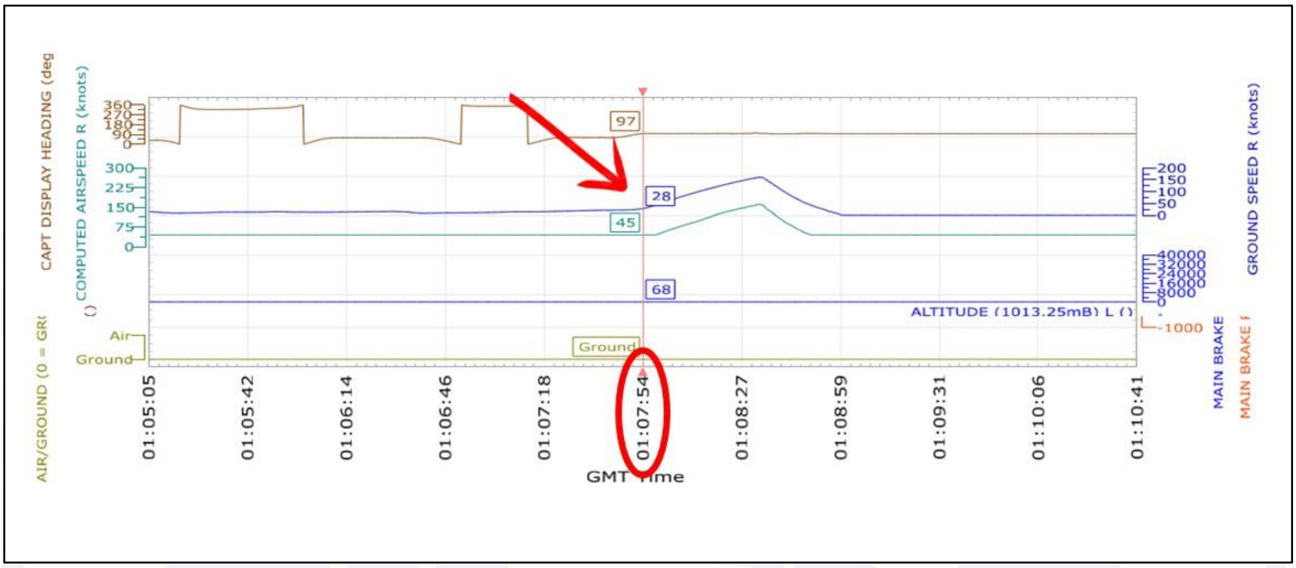

Figure 40 – Moment when the aircraft began the takeoff roll, according to data retrieved from the FDR.

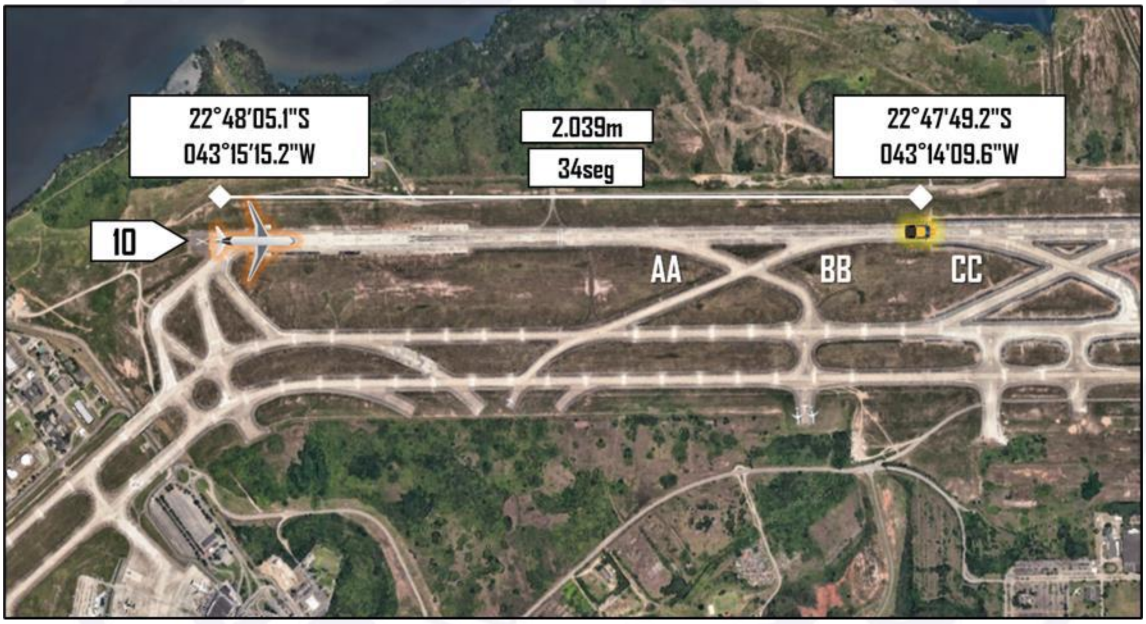

Figure 41 – Diagram showing the distance (2,039 meters) and time (34 seconds) to the collision at the moment the TWR controller questioned the Supervisor about the maintenance vehicle's presence on the runway (aircraft and vehicle not to scale for better visualization). Source: adapted from Google Earth.

At 01:07:59 UTC, aircraft TAM3674 called ready for departure at taxiway P, and was cleared to line up and hold.

At 01:08:00 UTC, the Supervisor made a call to the lighting-maintenance vehicle, requesting it to clear runway 10 ("*Manutenção balizamento, livre pista uno zero.* "). However, the ATCO did not check the vehicle's position, did not instruct an immediate vacation of the runway, and did not inform the personnel that an aircraft was initiating a takeoff on that runway.

Figure 42 – Moment when the Supervisor requested the maintenance vehicle to vacate the runway. In the background, it is possible to see that the aircraft PS-GPP had already begun its takeoff roll.

At that moment (01:08:00 UTC, according to FDR data), the aircraft's ground speed was 50 kt, which would still allow a Rejected Takeoff (RTO)[5] under low-energy conditions (Figure 43).

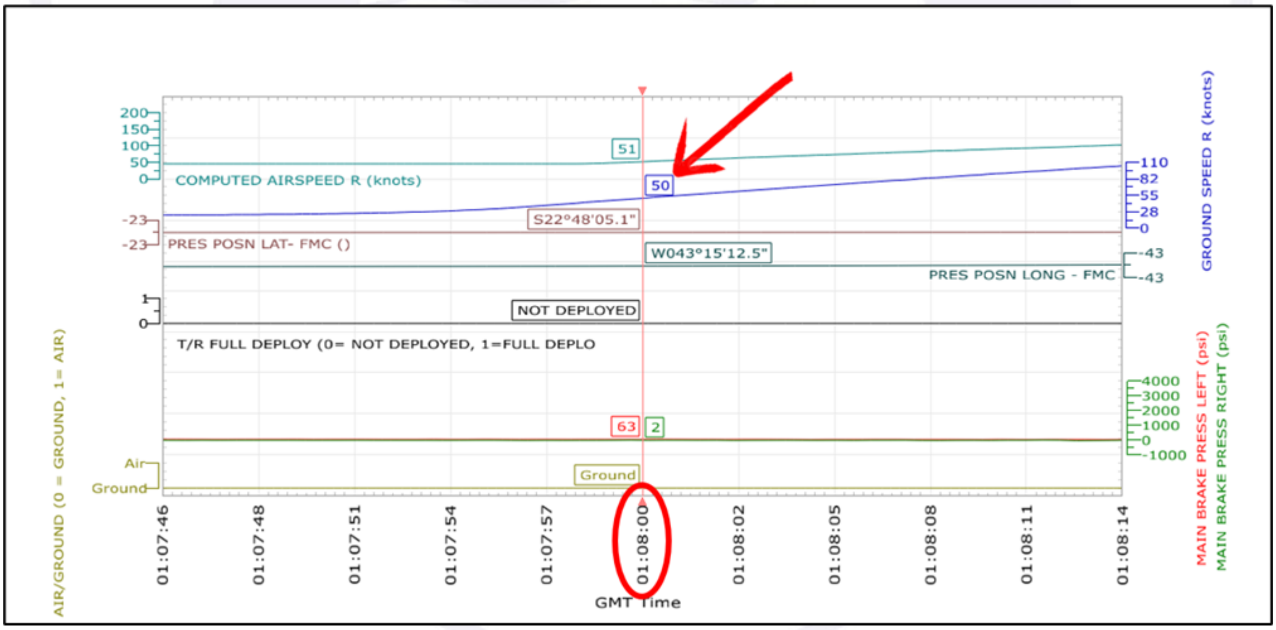

Figure 43 – Moment when the Supervisor requested that the maintenance vehicle vacate the runway, at 01:08:00 UTC). The arrow indicates the aircraft's speed of 50 kt.

[5] An RTO is the procedure in which pilots abort the takeoff due to an abnormality, such as warnings, technical failures, or runway obstructions. Low-speed RTOs have the following characteristics: the required braking distance is shorter since kinetic energy is proportional to the square of the speed; the decision tends to be quicker and the procedure can be performed more smoothly, not always requiring maximum braking; moreover, thermal stress on the brakes is reduced, which decreases the risk of overheating.

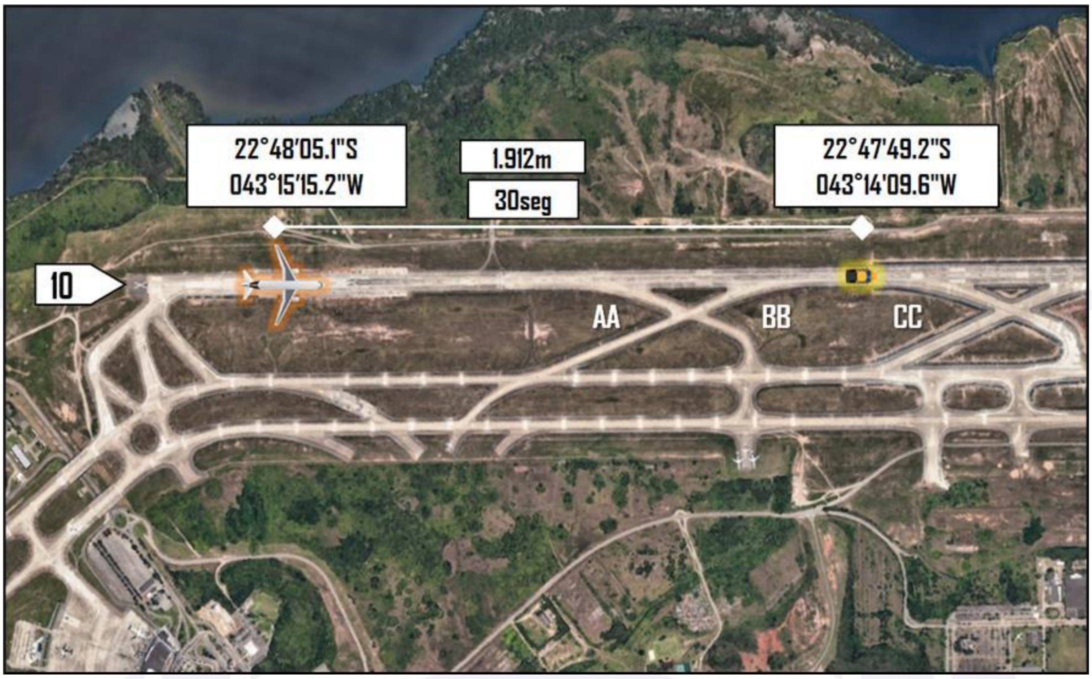

Figure 44 – Diagram showing the distance (1,912 meters) and time (30 seconds) for the collision at the moment the Supervisor requested that the vehicle vacate the runway, according to the FDR (aircraft and vehicle not to scale for better visualization).
Source: adapted from Google Earth.

Figure 45 – Controllers attempting to identify the maintenance vehicle's location on the runway during the takeoff roll of aircraft PS-GPP.

At 01:08:17 UTC, the lighting-maintenance vehicle reported it would vacate the runway via Taxiway CC.

At 01:08:32 UTC, the aircraft and the maintenance vehicle collided.

Figure 46 – Moment of impact between the aircraft and the vehicle.
The point of collision is highlighted on the right.

According to the data analyzed, the pilots sighted the vehicle about 0.5 second before impact, at an estimated distance of 185 meters, at which time the aircraft's indicated speed was approximately 153 knots.

In an attempt to avoid direct impact of the landing gear with the vehicle and a possible excursion off the right side of the runway, the pilots executed an evasive ground maneuver. They then contacted TWR-GL to report the occurrence.

Figure 47 – Moment of the collision between the aircraft and the vehicle, based on FDR data. At point 1, rudder input by the PIC is observed in an attempt to avoid direct impact of the nose gear with the vehicle; at point 2, power reduction; and at point 3, brake application.

At 01:08:57 UTC, aircraft PS-GPP called TWR-GL and reported having aborted takeoff due to the presence of a vehicle on the runway 10 centerline.

In the moments that followed, the controllers at the TWR Control and Ground Control positions exchanged information as they tried to understand the nature of the event. According to the information obtained, the Ground Control position controller stated that the aircraft had not been cleared for takeoff. In turn, the TWR Control position controller confirmed that he had issued the clearance. The Ground Control position controller then questioned whether it was not the aircraft that had been waiting at the holding point. The TWR Control position controller replied in the negative, clarifying that it was aircraft PS-GPP, which had already begun its takeoff roll.

During this period, the Supervisor remained at his workstation, operating the computer, without immediately assuming coordination of the emergency response.

At 01:09:14 UTC, aircraft PS-GPP reported the collision with the maintenance vehicle through the following message: “We aborted the takeoff, we hit a car in the middle of runway 10.”

TWR-GL asked whether the vehicle was still on the runway or vacating it via taxiway CC, and aircraft PS-GPP confirmed it was on the runway centerline. The pilot then reiterated the information on collision and requested assistance.

At 01:10:13 UTC, one of the maintenance-vehicle occupants contacted TWR-GL, informing about the collision and requesting closure of the runway 10, in addition to immediate support from the firefighters.

At 01:11:13 UTC, the Supervisor informed the team that he would activate the emergency call.

At 01:11:40 UTC, the emergency sound-alarm was triggered.

From that point on, the actions unfolded as described in section 1.15. – *Survival Aspects* (information regarding survivability and/or aircraft evacuation).

At 01:15:07 UTC and 01:35:05 UTC, respectively, the ATCOs occupying the TWR Control and Supervisor positions were relieved from duty, as provided for in ICA 63-7 – *Duties of SISCEAB Units Following an Aircraft Accident or Serious Incident*.

With respect to the actions taken by the ATCOs after the event, it was noted that, after the PS-GPP crew reported the collision, the Supervisor waited 2 minutes and 26 seconds before activating the emergency alarm.

Footage from the CCTV system also showed that, during the emergency’s progression, the Supervisor at one point left the radio unattended between the TWR Control and Ground Control stations, and took it back after a few seconds.

By means of the TWR-GL recorded images, one observed that none of the ATCOs was making use of headsets.

1.19. Additional information.

1.19.1 Runway Incursion (RI) Concept.

According to the International Civil Aviation Organization (ICAO)[6], runway incursion is defined as “any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft.”

[6] INTERNATIONAL CIVIL AVIATION ORGANIZATION. Manual on the prevention of runway incursions. Doc 9870 AN/463. 2. ed. Montreal: ICAO, 2020.

A “protected area” is defined as the region encompassing the runway, stopway, runway strip length, the area on both sides of the runway delimited by the distance established by RBAC No. 154 up to the runway holding point (RESA), and, when applicable, the clearway.

The term “incorrect presence” refers to the unsafe or unintended positioning or movement of an aircraft, vehicle, or person within the protected area, which may occur with or without clearance from the Aerodrome Control Tower (TWR).

1.19.2 Guidelines and Best Practices in ATS for Runway Incursion Prevention

With regard to the contributing factors observed in this serious aviation incident, Appendix E of the European Action Plan for the Prevention of Runway Incursions (EAPRI)[7], Version 3.0, presented the following guidelines and best practices for ANSPs and air traffic controllers, focusing on the prevention of runway incursions and the enhancement of operational safety.

> The most common runway incursion scenarios include:
>
> • Takeoff or landing on an already occupied runway;
>
> • Entry onto a runway for which another aircraft has already been cleared to take off or land;
>
> • Simultaneous takeoff or landing on intersecting runways;
>
> • Runway crossing after another aircraft has been cleared to take off or land.
>
> Several studies have focused on types of errors committed by controllers that may contribute to runway incursions. The findings converge on several key areas, with the most recurrent being related to:
>
> 1. MEMORY: Forgetting an aircraft, a runway closure, a vehicle on the runway, and/or a previously issued clearance;
>
> 2. COORDINATION: Inadequate coordination between controllers, transfer process issues, or deficient Traffic Resource Management (TRM);
>
> 3. SITUATIONAL AWARENESS: Misidentification of an aircraft or its position, or insufficient visual scanning;
>
> 4. COMMUNICATION: Incomplete, incorrect, ambiguous, or complex RTF (radiotelephony phraseology); inaccuracies in hearbacks; improper use of conditional clearances;
>
> 5. PLANNING AND DECISION-MAKING PROCESS: Incorrect ATC clearance, undue flexibility in applying procedures, provision of insufficient separation, or attempts to be excessively quick or efficient to the detriment of safety.
>
> All these key points are closely interrelated: forgetting something, unclear communication, underestimating the importance of a position transfer, or missing timely information can all undermine situational awareness.
>
> Therefore, many of the recommendations for air traffic controllers simultaneously address various aspects of operations and contribute to improved situational awareness, while also supporting correct decision-making by all parties involved in runway operations.
>
> ---
>
> **MEMORY**
>
> Memory can be defined as the ability to store, retain, and later recall information. It may involve both conscious and unconscious aspects.
>
> Aerodrome traffic control includes observing and reacting to events occurring in the maneuvering area, based on the interpretation of information acquired visually, presented at the workstation, or received via voice communication.

[7] EUROCONTROL. European action plan for the prevention of runway incursions. 3.0 ed. Brussels: EUROCONTROL, 2017. Available at: https://www.eurocontrol.int/publication/european-action-plan-prevention-runway-incursions-edition-3. Access on: 4 June 2025.

Memory plays an important role in this process due to the large volume of information received by the controller. Therefore, it is essential to manage this data so that it is not lost, forgotten, or overlooked.

Techniques, procedures, and disciplined use of memory aids can assist controllers in this task.

BEST PRACTICES

a. Runway occupancy detection

Air Navigation Service Providers (ANSPs) should provide memory aids, surveillance systems, and integrated solutions to detect and alert controllers when a runway is occupied.

Controllers should strictly follow local procedures related to the recording and display of runway occupancy information (whether through paper/electronic flight strips or other established methods, such as “blanking” anemometers/wind indicators).

The effectiveness of any of these measures strictly depends on operational procedures and, evidently, on the controller’s strict adherence to them. If, for any reason, controllers choose to delay the use of available aids or rely solely on memory, the chances of forgetting increase significantly.

Electronic Flight Strips (EFS) can help mitigate this problem by automatically activating the runway occupied status whenever, for example, a vehicle strip is moved to the corresponding runway position. The Flight Progress Board (FPB) should be designed to have only ONE position to place aircraft and vehicles when cleared “on the runway” (unlike some EFS boards that have separate positions for takeoff and landing on the same runway)

Figure 2: Example of a Vehicle Progress Strip

SITUATIONAL AWARENESS

For a controller, situational awareness primarily means acquiring and maintaining a mental picture of the traffic situation, taking into account all progressions or unexpected changes in the scenario. It also involves projecting that mental picture into the immediate future and may generate an expectation of what will happen next.

The controller's working environment and procedures should be designed to support the maintenance of situation awareness, bearing in mind that ATC procedures and controller behavior also influence the situational awareness of pilots and drivers.

BEST PRACTICES

a. Promoting a sterile control room concept

Interruptions (e.g., phone calls, non-standard events, and communications) and distractions (e.g., loud conversations, background noise, presence of non-operational personnel, smartphones, etc.) do occur. Some cannot be avoided and must therefore be managed by controllers. Others can be minimized or eliminated through training, the adoption of effective procedures, discipline, and the application of good judgment. If the number of interruptions and distractions is not minimized, or the impact of residual ones is not managed, safety may be affected. In accordance with TRM principles, air traffic controllers who feel they are being distracted by non-operational factors should feel free to express their concern.

---

c. Visual recognition of hot spots

In some control tower rooms, photos of the maneuvering area and/or hot spots (taken from different heights or perspectives) are displayed near the controller’s workstation and/or included in local Operational Manuals. This information can assist air traffic controllers in improving their situational awareness by visualizing what a lost pilot or driver might be seeing.

...

e. Visual scanning techniques

In more than half of the Sudden High-Energy Runway Conflict (SHERC) events analyzed in the EUROCONTROL Operational Safety Study, ATC did not visually detect the potential conflict before the runway incursion occurred: a systematic and proper visual scan of the entire runway and approach area, in both directions, may be one of the most effective safety barriers to prevent such events.

Anyone can “look,” but scanning is more than just looking. Scanning is the skill of seeing by looking methodically.

Quickly glancing outward without pausing to focus on anything has limited value, just as staring at a single point for extended periods is also ineffective. Scanning is not limited to outside observation, but should also include a structured search within the visual control room – through supporting systems such as weather and surveillance displays, EFS, etc. Learning how to scan effectively, knowing where and how to focus the search, requires training and the constant division of attention with other controller tasks.

f. Continuous monitoring of aerodrome operations ("heads up" / "heads down")[8]

Recommendation 1.5.13c states “ANSPs should develop procedures to ensure that, as far as possible, controllers remain ‘heads up’ for continuous control of aerodrome operations.” Although this implies a predominantly “eyes-out” control style, in the context of modern ATC Visual Control Rooms (VCRs) and the increasing availability of supporting technology, the recommendation also acknowledges that controllers will inevitably spend some time “heads down.” A structured and methodical scanning technique will help controllers integrate “heads down” tasks with the need to maintain a “heads up” posture; the combination results in continuous control of aerodrome operations.

ANSPs should therefore regularly reinforce the critical importance of visual scanning in aerodrome control (both inside and outside the control room) and train controllers in techniques that help develop and maintain this skill.

g. Vehicle management on the maneuvering area

ICAO Doc 4444 PANS-ATM, § 7.12.6, prescribes the recording of vehicle movements during low visibility operations. ANSPs should consider implementing this provision under all visibility conditions and managing vehicles on the maneuvering area using, for example, EFS – just as with aircraft – in order to enhance situational awareness and detect potential conflicts.

...

TRAINING

Runway safety issues should be included in ATC team briefing or debriefing sessions that may occasionally be conducted by the ANSP as part of a learning process. These should address not only the scenarios that led to actual runway events but also other situations that nearly resulted in a runway incursion.

Air traffic controller training, from the initial stages through to refresher courses, should include at least the following topics:

1. Contributing factors to runway incursions;

2. How to prevent runway incursions;

3. Lessons learned (e.g., through case studies of runway incursions that occurred at the controller’s own aerodrome or elsewhere);

4. Visual scanning techniques (outside and inside the visual control room).

ATC Lines of Sight

[8] Note: The expressions "heads up" and "heads down" are well-established in the international aeronautical context and, in fact, have no direct equivalents in Portuguese that convey, with the same precision and economy of language, the controller’s visual and attentional posture. These expressions simultaneously carry a physical dimension (position of the head/gaze) and a cognitive one (attention focused on the external environment or internal systems).

> Despite the introduction of new technologies and features that sometimes encourage a “heads-down” posture, aerodrome control still requires controllers to maintain a “heads-up, eyes-out” posture, observing aerodrome operations directly whenever possible. This continuous visual surveillance is essential to operational safety, though it becomes impractical under low visibility conditions, in which technology can support the control of traffic on runways and adjacent areas.
>
> Obstruction or impairment of controller lines of sight – particularly with regard to runway thresholds, intersections, crossings, hot spots, and approach areas – can undermine this fundamental principle of visual control.
>
> ANSPs, in collaboration with aerodrome operators, should conduct regular assessments of visibility lines from the Visual Control Room (VCR), identifying any visual restrictions that may limit effective runway oversight. Known blind spots should be represented on aerodrome charts and on hot spot maps published in the AIP. Tools such as A-SMGCS *(Advanced Surface Movement Guidance and Control System)*, cameras, and other sensors (similar to those used in remote tower operations) may be employed to mitigate areas of low visibility. Temporary visibility restrictions – such as those caused by works or temporary structures – should be addressed with the same level of attention as permanent limitations.
>
> As long-term solutions, ANSPs may consider revising operational procedures, adopting new surveillance technologies, or physically relocating the control tower, the VCR, or controller workstations (CWP), always seeking the best possible alternative within the physical and operational constraints of the aerodrome.

With regard to best practices related to communications on the maneuvering area, *Appendix A – Communications Guidance* of the same Plan (EAPRI) included the following considerations:

> RUNWAY FREQUENCY
>
> It is recommended that all communications related to runway operations (landings, takeoffs, aircraft and vehicle crossings, runway inspections, etc.) be conducted on the VHF frequency assigned to that runway; this helps maintain high levels of situational awareness.
>
> To accommodate vehicles equipped only with UHF radios, frequency coupling should be used to ensure that all UHF communications associated with runway operations are simultaneously transmitted on the corresponding VHF frequency (and vice versa). When using RTF frequency coupling, controllers (and drivers) should be aware of truncated transmissions, where the beginning or end of the message may not be transmitted/received.
>
> Concerns about runway frequency congestion due to VHF use by drivers can be mitigated by treating each use of the runway as a planned traffic movement, reserving detailed discussions – such as FOD descriptions – for another frequency.
>
> Some aerodromes (such as Brussels Airport) have gone beyond the principles described above and implemented the concept known as “Triple One”: One Runway, One Frequency, One Language (English), as a means to further improve communications and situational awareness in all runway operations.

1.19.3 Technologies Aimed at Preventing Runway Incursions

In addition to adopting operational guidelines, best practices, and ongoing training for operators, the international aviation community has developed technological tools to mitigate the risks posed by runway incursions: *Runway Status Lights* (RWSL), *Airport Surface Detection Equipment* (ASDE), *Airport Movement Area Safety System* (AMASS), *ASDE Taxiway Arrival Prediction* (ATAP), and *Final Approach Runway Occupancy Signal* (FAROS).

In the national context, a low-cost solution implemented by the Control Tower of *Brasília* International Airport (TWR-BR) significantly improved ATCOs’ situational awareness during vehicle entries onto runways.

This preventive measure consisted not only of locking the TATIC system screen but also of creating a functional strip for the vehicle entering the protected area, in addition to activating a red warning light on the console of the ATCO responsible for the TWR Control position. In practice, this represented the implementation of two additional layers of safety to the procedure used by TWR-GL.

The procedures established by TWR-BR for conducting runway inspections at *Brasília* International Airport, as provided in the Operational Letter of Agreement signed between TWR-BR, APP-BR, and INFRAMERICA, were as follows:

> 2.1.3 TWR-BR DUTIES
>
> Upon receiving, from INFRAMERICA inspectors (OSCAR UNO, E.P.), the request to conduct a runway inspection, the TWR ATCOs shall:
>
> a) Inform APP-BR when there is any change in the scheduled runway inspection times established in subitems ‘a)', 'b)', and 'c)' of item 2.1.1.1;
>
> b) Create a functional strip for the INFRAMERICA vehicle (OSCAR UNO, E.P.) at position TWR North or TWR South;
>
> NOTE: Before the runway inspection begins, the functional strip shall be created in TATIC TWR and, upon completion, archived for traceability purposes.
>
> c) Lock the strip list via the title bar of the TATIC TWR screen (see Annex B);
>
> d) Switch on the red LED lamp on the operational console SPVS, TWR North or TWR South (see Annex B);
>
> e) Authorize the INFRAMERICA vehicle (OSCAR UNO, E.P.) to conduct a continuous and uninterrupted runway inspection, except in the cases provided in subitems 'h)' and 'i)' of item 2.1.3;
>
> f) Notify APP-BR of the beginning and end of the runway inspection;
>
> g) Keep aircraft informed of the reason for takeoff delays when the runway in use is under inspection;
>
> NOTE: Aircraft at the holding point shall not be cleared to line up on the runway while the inspection is being carried out.

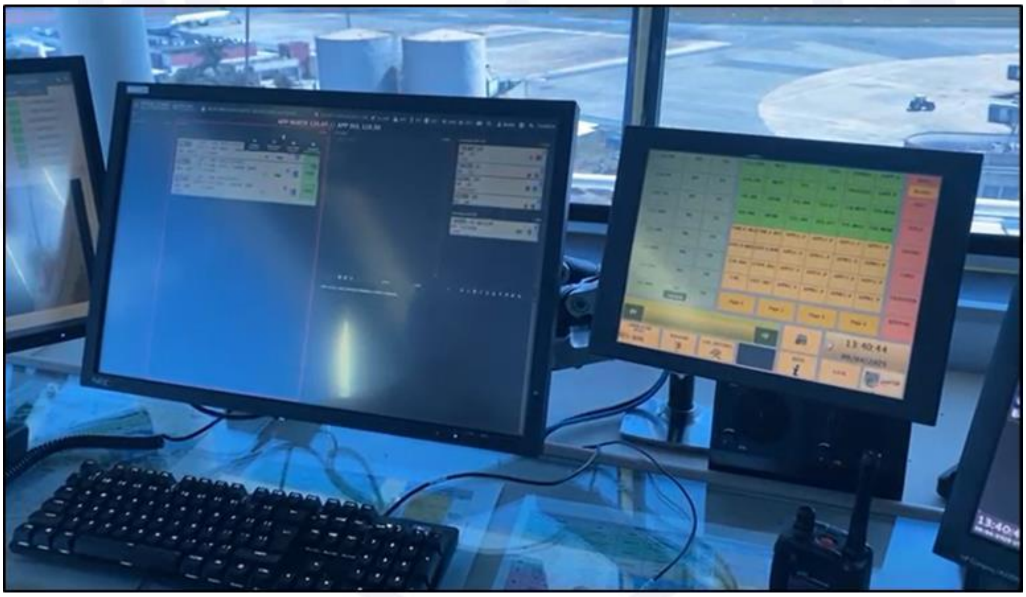

Figure 48 – Overview of the TATIC screen.

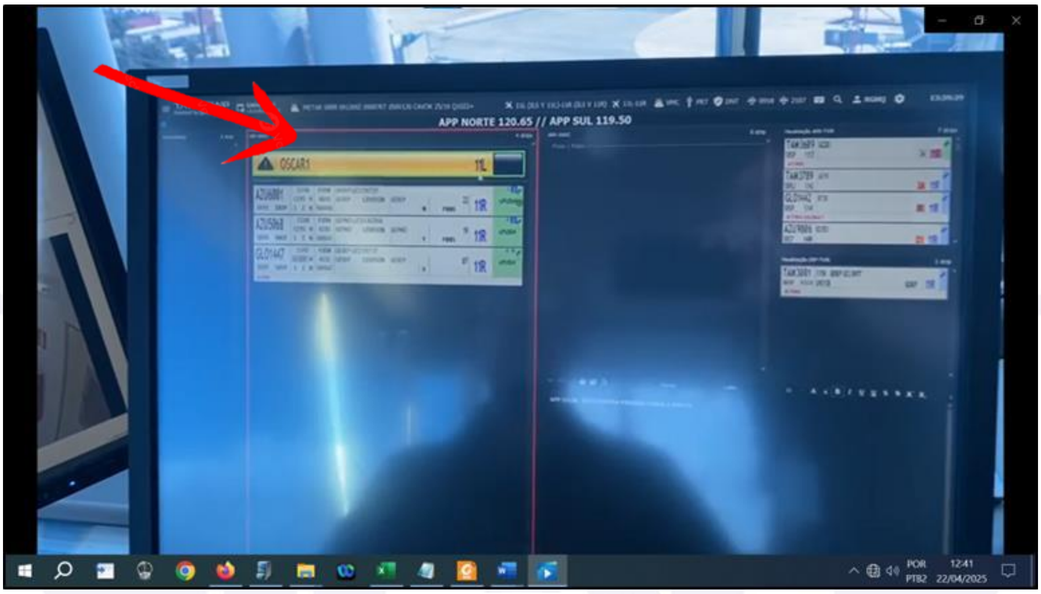

Figure 49 - Creation of the vehicle's functional strip.

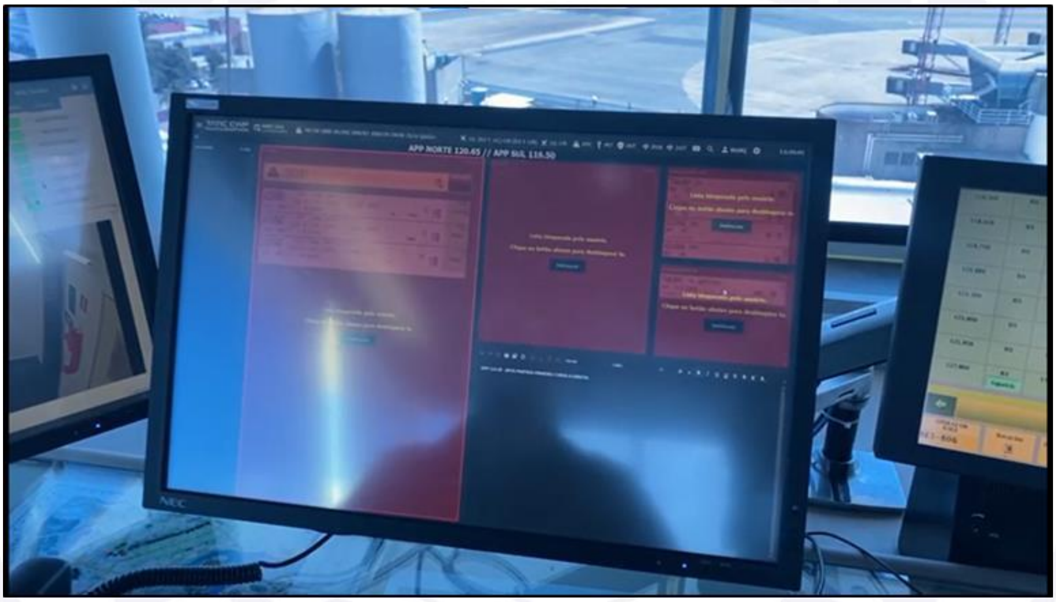

Figure 50 - Locking of the TATIC screens.

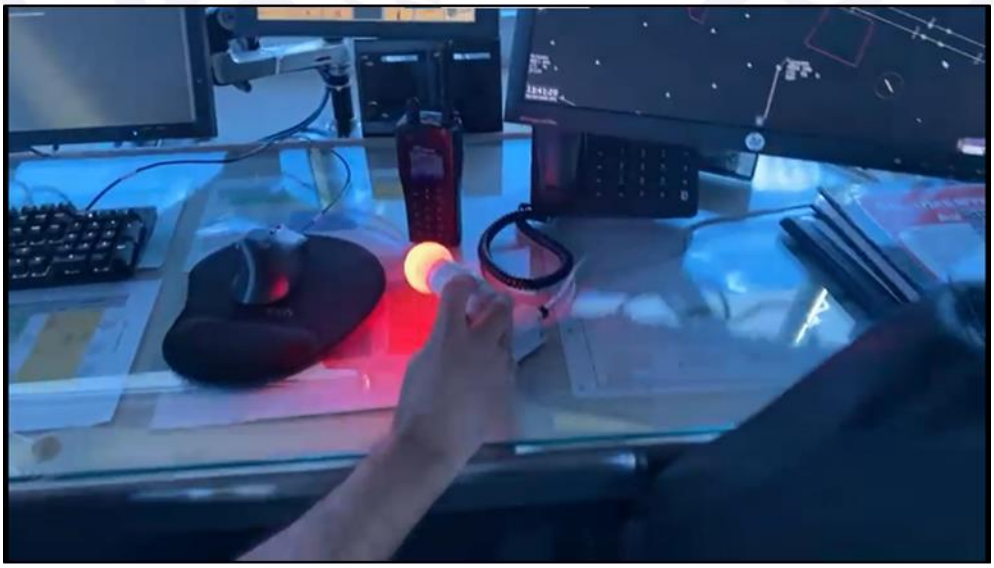

Figure 51 - Activation of the red LED light on the operational console.

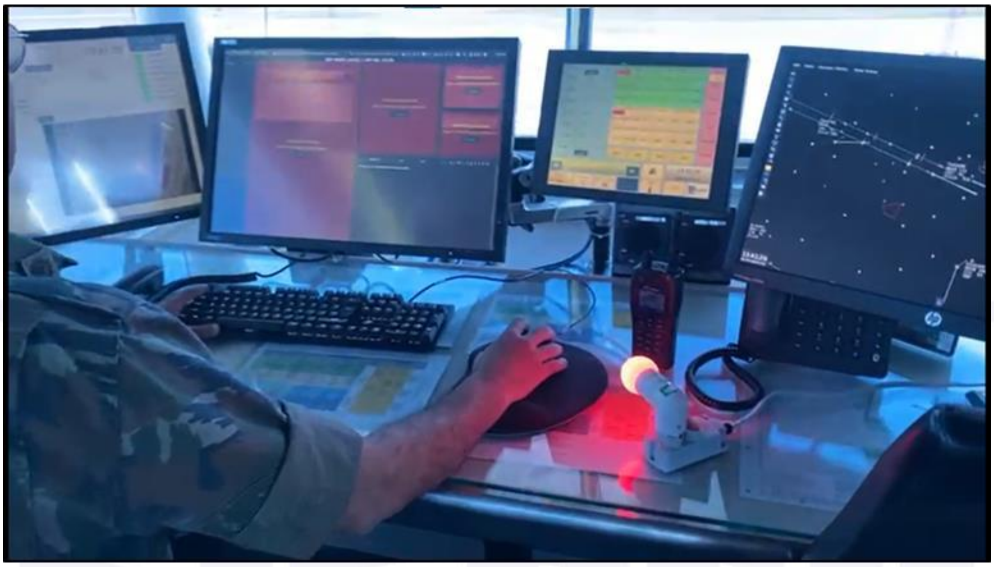

Figure 52 – General view of the operational console after execution of the procedure.

1.19.4 *Galeão* Aerodrome Control Tower (TWR-GL).

TWR-GL was located at an equidistant position between runways 10/28 and 15/33, featuring a height of 56 m and a cabin area of 56.68 m² (Figure 53).

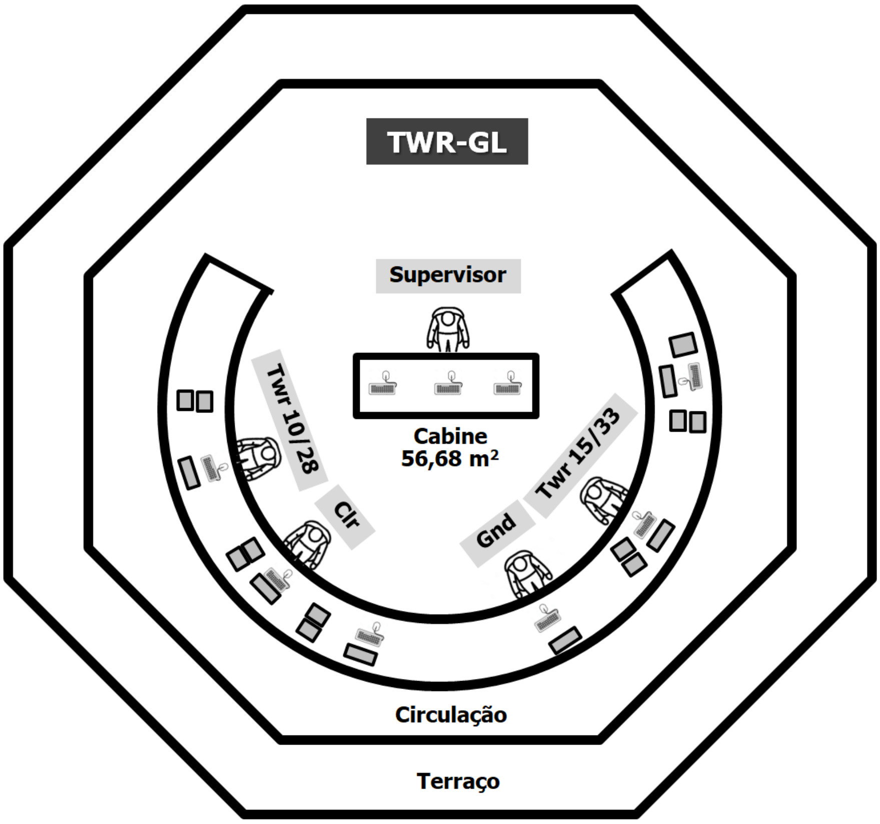

Figure 53 – Schematic overview of the operational environment.
Source: adapted from the TWR-GL Manual/2023.

TWR-GL provided air traffic control services within its area of responsibility, defined by the Airport Maneuvering Area and its surroundings, encompassing the traffic circuits of RWY 10/28 and RWY 15/33, as established in ICA 100-37:

a) aerodrome control services;
b) flight information service; and
c) alerting service.

According to its Operational Model, TWR-GL comprised the following operational positions:

1. Supervisor
2. Coordinator
3. TWR Control 10/28
4. TWR Control 15/33
5. TWR Assistant 10/28
6. TWR Assistant 15/33
7. Ground Control
8. Clearance Delivery
9. Clearance Delivery Assistant

ATCOs qualified to operate in TWR-GL could, at any time, occupy the positions of Coordinator, Tower Control, Tower Assistant, Ground Control, Clearance Delivery, or Clearance Assistant, and were required to be familiar with all the different types of equipment and resources available for the performance of their duties.

No ATCO was allowed to assume any operational position unless physically and psychologically fit to perform the assigned duties, and only after becoming aware of the operational briefing related to their duty shift.

ATCOs were required to inform the Supervisor or the Team Leader if they were unfit, physically and/or psychologically, to assume duty.

Duty shifts could only be exchanged if they complied with the criteria set forth in applicable regulations.

TWR-GL operational positions were to be staffed by ATCOs in accordance with this Operational Model and current regulations. If an ATCO in an operational position needed to be absent, even temporarily, a replacement had to be requested, and a proper handover performed, as detailed in Annex C of the MOp.

The use of mobile phones by ATCOs was strictly prohibited within the operational environment, in accordance with the provisions of the ICA 200-17 - *Utilization of mobile devices in the COMAER*.

No ATCO was permitted to engage in any activity at an operational position that was not directly related to air traffic control duties.

1.19.5 TWR-GL Operational Model (MOp)

On the date of the accident, the TWR-GL Operational Model in force was dated March 13, 2023.

The MOp had both instructional and regulatory nature, and was drafted by DTCEA-GL, in compliance with CIRCEA 100-57 – *Operational Model and ATC Unit Manual*. Its purpose was to provide TWR-GL with a document capable of enhancing and standardizing operational procedures, which detailed the actions related to air traffic control activities.

The subjects covered in this Model were intended to present the local particularities of operations within the areas under TWR-GL jurisdiction. The rules and procedures established in the Operational Model did not exempt compliance with other regulations in force. Situations not foreseen in the document were to be submitted to the TWR-GL Chief for assessment.

It was the responsibility of the TWR-GL Chief to update the MOp whenever necessary. If no updates were required, the Model would remain valid for two years from the date of its approval.

Supervisors and instructors were to oversee strict compliance with the rules contained therein.

The procedures described – mandatory in nature – were to be applied by all ATCOs operating at the aerodrome and in the airspace under jurisdiction of TWR-GL.

The TWR-GL Operational Model – items 4.2 *Operational Duties*, 6.2.5 *Control of Personnel/Vehicles in the Maneuvering Area*, 6.7.3 *Recommendations for Runway Incursion Prevention*, 6.10 *Use of Headsets* - contained the following guidelines:

> 4.2 OPERATIONAL DUTIES
>
> 4.2.1 DUTIES OF THE SUPERVISOR POSITION
>
> ...
>
> n) Supervise the activities of TWR-GL's operational positions, aiming for integrated and efficient operations;
>
> ...
>
> p) Assume, or designate another ATCO to assume, communications with vehicles operating in the maneuvering area, via Group 7, in the absence or deactivation of the Coordinator position;
>
> ...
>
> z) Supervise the team, ensuring compliance with this Operational Model and other applicable regulations;
>
> ...
>
> bb) Prohibit the use of electronic devices within the TWR-GL's operational environment (video cameras, photo cameras, radios, televisions, cell phones, laptops, tablets, etc.), in accordance with ICA 200-17;
>
> ...
>
> 6.2.5 CONTROL OF PERSONNEL/VEHICLES IN THE MANEUVRING AREA
>
> The issuance of air traffic clearances in the maneuvering area for personnel/vehicles shall always be conducted via radio transmitters on Group 7 or Group 6 (in case of emergency), and shall be carried out by the Supervisor, Coordinator, or GND operator.
>
> ...
>
> 6.7.3 RECOMMENDATIONS FOR PREVENTION OF RUNWAY INCURSIONS
>
> 6.7.3.1 Strategy
>
> Analyses of runway incursion occurrences have demonstrated the need to disseminate procedures to mitigate such events. As a preventive measure, the following procedures must be adopted in TWR-GL's operations:
>
> ...
>
> 6.7.3.5 information on the situation
>
> During the duty shift, the Team Supervisor shall delegate to the Coordinator the task of centralizing all relevant information for the team. This approach reduces the number of interlocutors, enhances situational awareness, disciplines unit operations, and minimizes the likelihood of errors during shift handovers.
>
> 6.7.3.6 Noise Level
>
> 6.7.3.6.1 A high noise level increases ATCO distraction (reducing situational awareness), hampers comprehension of ATS messages, and increases the number of repeated clearances.
>
> 6.7.3.6.2 To reduce noise, ATCOs manning the CLRD-GL, GNDC-GL, and TWR CONTROL operational positions shall use headsets while these positions are active. (ICA 100-31 and ICA 81-4)
>
> 6.7.3.7 Runway Visual Scanning

> The ATCO at the TWR-GL Control position must perform a visual scan of the runway before issuing any crossing, lineup, landing, or takeoff clearance. This procedure ensures the controller confirms that the runway is indeed clear.
>
> ...
>
> 6.7.3.9 Lock Screen with TATIC Display
>
> 6.7.3.9.1 To mitigate runway incursion occurrences, whenever there is an inspection, maintenance activity, or any other event that imposes restrictions on runway use for takeoff or landing, the TWR Control Assistant shall lock the TATIC window using the "red" display setting corresponding to the closed system.
>
> ...
>
> 6.10 USE OF HEADSETS
>
> To reduce ambient noise, ATCOs assigned to the CLRD-GL, GNDC-GL, and TWR CONTROL operational positions shall use headsets while such positions are active, as provided in item 4.2.5.2 of ICA 81-4 and item 3.11.1 of ICA 100-31.
>
> ...

1.19.6 ICA 81-4 - *Program for the Prevention of Runway Incursion Occurrences in the Provision of Air Traffic Services.*

ICA 81-4, dated Aug 5, 2021, aimed to establish the procedures to be adopted by Air Navigation Service Providers (ANSPs) for the prevention and management of runway incursion occurrences at Brazilian aerodromes. It constitutes the primary document on the subject within the SISCEAB. In item 4 (*Recommendations for the Prevention of Runway Incursion Occurrences in the Provision of ATS*), the Instruction included the following guidelines:

> 4 RECOMMENDATIONS FOR THE PREVENTION OF RUNWAY INCURSION OCCURRENCES IN THE PROVISION OF ATS
>
> 4.1 STRATEGY FOR THE PREVENTION OF RUNWAY INCURSIONS IN THE PROVISION OF ATS
>
> 4.2.6 RUNWAY VISUAL MONITORING
>
> 4.2.6.1 In general, it was found that some aerodrome tower controllers look at the aircraft when issuing clearances, without performing a visual scan of the runway before authorizing takeoff or landing. This behavior is based on the assumption that the runway is clear simply because no prior clearance was issued for an aircraft or vehicle to enter it. However, there are recorded incidents caused by the presence of unauthorized vehicles or aircraft on the runway in use.
>
> 4.2.6.2 Therefore, to avoid recurrence of such incidents, controllers must be trained on the necessity of visually checking the runways to ensure they are free of obstructions before issuing clearances for crossing, landing, takeoff, or lineup.

1.19.7 ICA 63-7 - ICA 63-7 *– SISCEAB Units' Duties Following the Occurrence of an Aircraft Accident or Serious Incident*

ICA 63-7 (dated March 5, 2018), under item 3.5.4.8, established the following as one of the responsibilities of ANSPs:

> 3.5.4.8 Promptly arrange for the replacement of operators directly involved in the aircraft accident or serious incident.

1.19.8 MCA 63-15 - *Manual of Human Factors in the Management of Operational Safety within SISCEAB*

MCA 63-15, dated September 10, 2012, provided the following guidelines in its Sections 4.8.4 *Consoles*, 4.8.6 *Control Towers* (TWR), and 4.8.8 *Anthropometry*:

> 4.8.4 CONSOLES
>
> 4.8.4.1 The ATCO workspaces are grouped into consoles according to the functions and tasks of each team member. The design of the consoles includes the

environment in which they are embedded, as well as software and hardware characteristics.

4.8.4.2 Due to the division of tasks within control units, the controller's console contains two operational positions (controller and assistant). In addition, there are the supervisor's console and the team leader's console (when applicable), each with specifications related to their functions. Certain requirements must be observed in the design of consoles:

...

h) No console should obstruct any controller's view of essential information.

...

4.8.6 CONTROL TOWERS (TWR)

4.8.6.1 In the control tower environment, all ATCOs must have unrestricted visual access to the information required for operations.

4.8.6.2 There must be no visual obstructions of any kind, whether caused by other controllers, equipment inside the tower, fixed or mobile structures within the tower itself, or other airport buildings. ATCOs must be able to see, from their workstation, all takeoffs, final approaches, the full length of all runways – regardless of number or direction – taxiways, and the apron below the TWR. The tower workspace must:

a) be designed to promote an easy and unambiguous flow of information; and

b) facilitate the transfer of operational information and the handover of responsibility over aircraft.

4.8.8 ANTHROPOMETRY

4.8.8.1 Anthropometry measures the reach and distribution of standardized human body dimensions, taking into account the individual's integration into their work environment. Certain aspects related to the different body sizes of ATCOs will require workspace adjustments so that all professionals are accommodated. Accordingly:

a) Either the console may be adjustable (e.g., allowing the desk surface to move up and down), or the seat height may be adjustable (chairs with adjustable seat, backrest, and armrests), or both may be adjustable.

b) The chair must be wide, sturdy, and adjustable, considering the various body sizes of controllers. It should provide proper back support and include adequate cushioning and upholstery for continuous occupancy.

c) The desk should be narrow at the front to ensure sufficient space for each seated controller's thighs.

d) There must be ample space beneath the console to allow the controller to stretch their legs while seated.

e) The seat must be easy to move, with sturdy wheels that do not snag on the floor.

f) Armrests on chairs are recommended and must be adjustable. They should allow for the recommended spacing between adjacent chairs so that each controller can enter or leave the workstation without disturbing neighboring colleagues.

g) A minimum recommended distance of 750 millimeters between chairs should be maintained, especially when seats have armrests, taking into account continuous occupancy.

1.19.9 ICA 100-31 - *Air Traffic Service Requirements*

ICA 100-31, dated October 31, 2024, in Section XI – *Use of Headsets in ATC Units*, articles 50 and 51, established the following:

Section XI

Use of Headsets in ATC Units

Art. 50. The Chief of the ATC Unit shall:

I - mandate the use of headsets and establish the parameters for their employment, including such information in the operational model of the respective unit; and

II - provide headsets for each air traffic controller and maintain a reserve stock at the unit for replacement when needed.

Art. 51. The use of headsets may not be mandatory in the following cases:

I - when there is a technical impossibility in the ATC Unit; or

II - when the operational characteristics of the ATC Unit are such that the use of a headset does not add value to the performance of the unit's activities.

§ 1º In any of the cases described in items I and II above, an Operational Safety Assessment is required to demonstrate that operations can be conducted safely without the use of said equipment.

§ 2º If, by any chance, the Operational Safety Assessment indicates the need for headsets, even in the cases described in items I or II above, the installation of the equipment shall be arranged, and the provisions of Art. 50 shall be complied with.

1.19.10 ICA 100-37 - *Air Traffic Services.*

ICA 100-37, dated November 4, 2024, in Section XXIV – *Designation of Hot Spots* and Annex VII – *Definitions*, presented the following considerations on Hot Spots:

Section XXIV Designation of Hot Spots

Art. 675. Whenever necessary, one or more locations within the movement area of the aerodrome shall be designated as critical points.

Sole paragraph. Further information on the subject may be found in specific DECEA regulations.

ANNEX VII - *DEFINITIONS*

CXX – *Hot Spot*: A location within the aerodrome movement area that poses a potential and historical risk of collision or runway incursion, and where pilots and vehicle drivers must exercise increased attention.

1.19.11 ICA 96-1 - *Aeronautical Charts.*

ICA 96-1, dated April 7, 2025, presented the following considerations on *Hot Spots* in its Subsection II – *Concepts*:

Subsection II – Concepts

LXIV - "Hot Spot" Critical Point: A hot spot is a location within the movement area with a history of incidents or that presents a potential risk of collision or runway incursion. For this reason, such locations require increased attention from pilots and drivers. They are generally the result of a complex or confusing intersection between taxiways, or between a taxiway and a runway.

1.19.12 CIRCEA 100-86 – *Aeronautical Phraseology*

CIRCEA 100-86, dated November 13, 2020, included, in item 6.3.5, the phraseology for communications between the TWR and vehicles operating on the Movement Area (PPD):

6.3.5 If a vehicle is on a runway, it may be instructed to vacate it when an aircraft is expected to land or take off, or when an aircraft is taxiing on the runway and the vehicle poses a hazard to its operation.

Vehicle	Aerodrome Control
	“TRUCK 1, DOLON TOWER.”
“DOLON TOWER, TRUCK 1.”	“TRUCK 1, VACATE RUNWAY 17L VIA TAXIWAY BRAVO TO THE RIGHT, REPORT RUNWAY VACATED.”
“TRUCK 1, WILL VACATE RUNWAY 17L VIA TAXIWAY BRAVO TO THE RIGHT, WILL REPORT RUNWAY VACATED.”	
“TRUCK 1, RUNWAY 17L VACATED.”	“TRUCK 1, DOLON TOWER, ROGER.”

1.19.13 ABNT NBR 8919 Standard - *Aircraft - Ground Support Equipment - Signaling*

The 4th edition of the ABNT NBR 8919 Standard, dated February 29, 2016, contained the following guidelines for vehicles intended to provide services within the aircraft movement area, under Section 4 – *Requirements*:

4 Requirements

4.1 Classification

Vehicles and equipment used to support services at the airport or for aircraft and emergency operations in areas not intended for public traffic must be painted and equipped with lighting in a distinct manner, so they can be quickly identified. For this purpose, they are divided into four classes:

a) ambulances;

b) rescue and firefighting vehicles;

c) service vehicles operating in the aircraft movement area;

d) aircraft ground support vehicles and equipment (including ambulifts) and service vehicles operating on aprons.

4.4 Lighting

4.4.1 Self-propelled vehicles listed in 4.1, in addition to standard marker lights, taillights, and headlights as required by current legislation, must be equipped with warning lights in order to operate at night or under low-visibility conditions on aprons and aircraft movement areas:

a) ambulance, rescue, and firefighting vehicles: flashing red beacon or red and white strobe lights;

b) ground support and service vehicles and equipment (including ambulifts) at the airport and aircraft support: flashing beacon or amber strobe lights;

4.4.2 Towable equipment or units installed on chassis and fitted with emergency and/or warning lights for occasional use may follow the standard color and placement designed by the manufacturer.

4.4.3 Flashing beacons and strobe lights must be mounted at the highest point of each vehicle and ground support equipment, and must have:

a) 360° azimuthal coverage;

b) effective luminous intensity on the horizontal plane between 40 cd and 400 cd;

c) approximately 60 to 90 flashes per minute.

1.19.14 Recent history of runway incursions at SBGL

According to the Runway Incursion Data Spreadsheet prepared by DTCEA-GL, four runway incursion events occurred during the second half of 2024.

For each of these events, an internal investigation was conducted within DECEA. It is worth noting that these investigations do not constitute SIPAER investigations conducted by CENIPA.

The conclusions of the internal investigations conducted by DECEA are described below:

Event 1	
Date – Time	11/JULY/2024 - 11:20 (UTC)
Description	The Wildlife Management team was authorized to enter RWY 15 to conduct monitoring. However, the team had to vacate the runway immediately via the grass area upon spotting an aircraft on final approach for landing, without having received any prior warning from the ATCO responsible for granting the RWY 15 entry clearance.
Classification	C
Preventive Measures Adopted	Meeting between the Head of *ANSP* and those involved; Meeting among the heads of *ANSP*, *SO*, *SIATO*, *ASSIPACEA*, *PSYCHOLOGY* and *CMT*; Initiation of an operational board for the ATCO involved and suspension of their Supervisor and Instructor ratings; and Instruction provided to the ATCOs involved.

The Technical Report 00018/TWR-GL/24, dated August 15, 2024, presented the following conclusions regarding Event 1:

<u>Occurrence Analysis</u>

At the time of the incident, there were two aircraft being controlled.

The following ATCOs were assigned to operational functions during the runway incursion:

- Supervisor: with 25 years certified in the role, 13 years of experience at the unit, and 1 hour in the operational position;
- ATCO: with 15 years certified in the role, 6 years of experience at the unit, and one hour in the operational position;
- ATCO: with 15 years certified in the role, 3 years of experience at the unit, and one hour in the operational position.

There were no trainees assigned to operational positions.

Analysis of the records showed that there was a handover of an operational position without proper logging of the service transfer between the GND-GL ATCO and the Supervisor, which resulted in accumulation of functions.

It was also verified that GND-GL authorized the Wildlife Management team to enter RWY 15 while aircraft TTL 9905 was already cleared to land, without proper coordination with TWR-GL, which prevented the runway from being locked in the TATIC system.

Based on the findings, it was concluded that a TWR-GL's operational failure occurred by authorizing a vehicle to enter an active runway, despite previous clearance granted to an aircraft for landing.

<u>Contributing Factors</u>

Application of regulations: non-compliance with items 6.7.3.7 and 6.7.3.9 of the TWR-GL Operational Model, which deal, respectively, with requirement of *Runway Visualization* (visual scan of the runway) and verification of the Lock Screen with TATIC Display before issuing operational clearances.

Position Handover: non-compliance with item 4.1 of the Operational Model, *related to service handover between controllers,* compromising continuity and situational awareness of the operational positions.

Other: it was determined that there was a low level of situational awareness during the shift, a factor that directly contributed to the failure to identify the presence of the vehicle on the runway.

Application of regulations: in addition, noncompliance with ICA 100-37, item 3.9.7.6, which addresses requirement of readback/hearback of clearances and information related to operational safety, a critical measure for maintaining situational awareness and active monitoring.

<u>Corrective actions</u>

1) Instruction was provided to the ATCOs involved regarding items 6.7.3.7 and 6.7.3.9 of the MOp, which addressed, respectively, Runway Visualization (visual scanning of the runway) and the Lock Screen with TATIC Display. Instruction was also conducted, with support from the Psychology Section, addressing aspects related to situational awareness in the workplace environment.
2) Instruction was provided to the ATCOs involved on item 4.1 of the MOp, regarding Operational Position, with emphasis on shift handover procedures.
3) Instruction was provided to the ATCOs involved on item 3.9.7.6 of ICA 100-37, concerning the readback/hearback of clearances and safety-related information.

Event 2	
Date - Time	18/SEPT/2024 - 15:07 (UTC)
Description	Aircraft JAT761 entered runway 15 threshold without TWR-GL authorization. Aircraft GLO1656, which was on final approach with landing clearance, had its approach discontinued by the controller.
Classification	C
Preventive Measures Adopted	Instruction to the ATCOs involved on readback/hearback procedures, visual scanning of the runway, and phraseology.

The Technical Report 00025/TWR-GL/24, dated October 14, 2024, presented the following conclusions regarding Event 2:

<u>Occurrence Analysis</u>

At the time of the occurrence, the control unit was handling three aircraft.

The ATCO involved in the runway incursion had 11 years of certification in the function, 8 years of experience at the unit, and 34 minutes in the operational position.

The analysis of the audio and video recordings revealed that TWR-GL committed a phraseology error when instructing JAT761 by omitting the preposition “*of*” in the standard expression “hold short *of* RWY 15,” as prescribed in MCA 100-16 (Air Traffic Phraseology Manual). This omission led the pilot to incorrectly acknowledge the instruction as “*hold short* ***on*** *RWY 15*,” which resulted in unauthorized alignment on the runway.

Furthermore, TWR-GL did not perform a visual scan of the runway before clearing GLO1656 to land and did not notice the discrepancy in the readback performed by the pilot of JAT761. When JAT761 established contact, the TWR noticed that the aircraft was improperly aligned on the runway, a fact that had already required GLO1656 to go around.

It was concluded that the incident occurred due to the improper use of standard phraseology, failure to verify the pilot's readback, and lack of visual scanning of the runway. To prevent recurrence of similar events, refresher training on phraseology was recommended, with emphasis on runway visualization protocols prior to issuing clearances and greater attention to pilot readbacks.

Contributing factors

Skill: the runway in use was not visually scanned by the ATCO before issuing the landing clearance.

Phraseology: the ATCO involved made incorrect use of the expression “hold short of”, in noncompliance with the established standard phraseology.

Compliance with regulations: the ATCO involved failed to monitor the pilot’s readback properly, as established in the regulations in force.

Corrective Actions

1) Instruction was provided to the ATCO involved in the occurrence at hand, aiming to review item 6.7.3.7 of the MOp (Runway Scanning), which addressed the requirement for the controller at the TWR position to perform a visual scan of the runway before issuing any clearance for crossing, line-up, landing, or takeoff.
2) Instruction was provided to the ATCO involved in the occurrence in question, focusing on the review of item 4.4.1.5.2 (d) of MCA 100-16, which addressed the English phraseology applicable to advising an aircraft to remain clear of the runway.
3) Instruction was provided to the ATCO involved in the occurrence at hand, covering item 3.9.7.3 of ICA 100-37, which established the requirement for the controller to listen to the readback in order to ensure that the clearance or instruction was correctly received by the pilot-in-command, taking immediate action to correct any discrepancy eventually observed.

Event 3	
Date – Time	15/OCT/2024 - 07:36 (UTC)
Description	Aircraft SID9303 called for entry via TWY J and was instructed to proceed to the displaced holding point of RWY 33. When the aircraft on final was approximately 2 NM from threshold 15, it was observed that aircraft SID9303 was already on the runway. Subsequently, aircraft PS-DLC was instructed to go around.
Classification	C
Preventive Measures Adopted	The occurrence was entered into SIGCEA system for further investigation; a briefing was prepared for the personnel on guidelines and best practices to avoid runway incursions (RI); a guided review session of the event was scheduled with those involved.

Technical Report 00032/TWR-GL/24, dated November 2, 2024, presented the following conclusions regarding Event 3:

Occurrence Analysis

At the time of the occurrence, the operational positions CLR, GND, and TWR were combined, with a total of two aircraft under control.

The occurrence involved: the controller, with two years of certification, two years of experience in the role, and six minutes in the operational position; and the Coordinator, with 12 years of certification, seven years of experience in the role, and six minutes in the operational position.

There was no trainee on duty at the time of the occurrence.

The analysis of audio and video recordings demonstrated an interpretation error of messages, resulting from the failure to use simple, clear, and concise language when issuing clearances to SID9303 traffic.

Additionally, a failure was identified in listening to the aircraft's readback, which prevented the ATCO from confirming whether the instruction had been correctly understood by the pilot-in-command. This failure hindered the adoption of immediate corrective actions regarding the discrepancy presented in the readback, considering that at all times the aircraft was indicating its intention to enter runway 33.

It was also verified that, as the event occurred during nighttime, runway visibility was impaired, even with the assistance of the cameras available at the TWR-GL facility. This limitation compromised the effectiveness of the visual scan required to ensure that the runway was effectively clear for the landing of aircraft PS-DLC.

Contributing Factors

Compliance with regulations: in contrast with the applicable regulations, the ATCO failed to properly monitor the aircraft transmissions, which consistently indicated the intention to enter RWY 33.

Phraseology: The ATCO did not employ simple, clear, and concise language when issuing instructions related to SID9303, compromising standardization and the comprehension of transmitted messages.

Corrective Actions

1. Instruction was provided to the personnel involved on the importance of the correct use of phraseology as an essential tool to prevent interpretation errors in air traffic control communications, based on the relevant items of MCA 100-16.
2. Instruction was provided to the personnel involved regarding item 3.9.7.3 of ICA 100-37, which establishes that "the controller shall listen to the readback to ensure that the clearance or instruction was correctly received by the pilot-in-command and shall take immediate action to correct any discrepancies revealed in the readback."
3. Instruction was provided to the personnel involved regarding item 4.2.6 of ICA 81-4 and item 6.7.3.7 of the MOp, which address the importance of conducting a visual check of runways (visual scan) before issuing clearances for crossing, landing, takeoff, or line-up.
4. The TWR-GL staff received specific training on runway incursions, as established in Official Letter No. 1514/ASSIPACEA-GL. The session was conducted by CRCEA-SE. It presented guidelines and best practices for the prevention of runway incursions, based on regulations ICA 81-4, MCA 100-16 and ICA 100-37. The main objective was to reinforce the importance of adopting measures that contribute to mitigating operational risks and standardizing procedures, in accordance with international aviation safety standards. The session emphasized the mandatory use of standard phraseology and runway visual scanning before authorizing any operation, as established in item 6.7.3.7 of the TWR-GL MOp. Previous incidents involving unauthorized vehicles or aircraft on the runway were discussed as examples of the consequences of noncompliance with these procedures. Practical

recommendations aimed at ATCOs were also addressed, with emphasis on the need to perform a visual check of the runway before each clearance.

Event 4	
Date – Time	11/DEC/2024 - 07:36 (UTC)
Description	Aircraft SKU621 was instructed to hold at the holding point of RWY 15 but entered the runway without clearance. As a result, aircraft GLO2023, which was approximately 3 NM from the threshold, was instructed to go around.
Classification	C
Preventive Measures Adopted	Training was provided to the ATCOs involved in the present occurrence, in order to review article 97 of ICA 100-37, which addresses the readback of clearances and information related to operational safety.

The Technical Report 00038/TWR-GL/24, dated December 30, 2024, presented the following conclusions on Event 4:

Occurrence Analysis

Involved in the occurrence were the ATCO occupying the TWR Control operational position, with 15 years of certification in the role, 10 years of experience at the control unit, and 1 hour in the operational position; and the ATCO serving as Supervisor, with 19 years of certification in the role, 2 years of experience at the control unit, and 2 hours in the operational position.

According to video and audio recordings, the following sequence of events was observed:

At 13:53:12 UTC, aircraft GLO 2023 contacted TWR-GL, established on the ILS Z for RWY 15. TWR-GL instructed the aircraft to continue the approach and wait for RWY 15 to be clear.

At 13:53:42 UTC, aircraft SKY 621 contacted TWR-GL at the holding point of RWY 15. The TWR instructed the aircraft to hold at the holding point of RWY 15. The pilot read back the instruction incorrectly, but was not corrected by the ATCO.

At 13:54:47 UTC, aircraft GLO 2023 asked TWR-GL if they were cleared to land on RWY 15. The TWR instructed the aircraft to wait for RWY 15 to be clear.

At 13:55:27 UTC, TWR-GL instructed aircraft GLO 2023 to go around due to the unauthorized line-up of aircraft SKY 621 on RWY 15.

Based on the above, it was verified that aircraft SKY 621 lined up on RWY 15 without having received clearance from TWR-GL. However, the pilot's inaccurate readback was not corrected, as illustrated below:

TWR-GL: *SKY 621, maintain hold point RWY 15.*

SKY 621: *Maintain hold... RWY 15.*

Contributing factors

Compliance with regulations: Aircraft SKY 621 lined up on RWY 15 without having received clearance from TWR-GL. Nevertheless, the ATCO did not correct the pilot's readback, in noncompliance with the established procedures.

Corrective Actions

1) Instruction was provided to the ATCOs involved in the occurrence at hand, aiming to review Article 97 of ICA 100-37, which addressed the readback of clearances and information related to operational safety.

1.19.16 Lessons Learned from Runway Incursion Investigations conducted by CENIPA.

CENIPA's investigation of the last three runway incursion occurrences in SBBR (*Presidente Juscelino Kubitschek* Aerodrome), SBSP (*Congonhas* - *Deputado Freitas Nobre* - Aerodrome) and SBCT (*Curitiba* - *Afonso Pena* - Aerodrome), involving, respectively, a commercial aircraft and a military aircraft, two commercial aircraft, and a commercial aircraft and a maintenance vehicle, led, in summary, to the following findings:

Final Report	Date	Location
IG-065/CENIPA/2018	10APR2018	SBBR

In this runway incursion, aircraft PR-GTN departed from SBBR (*Presidente Juscelino Kubitschek* Intl Airport, *Brasília*, Federal District) bound for SBSL (*Marechal Cunha Machado* Airport, *São Luís*, state of *Maranhão*), at approximately 00:30 UTC, on a scheduled passenger transport flight, with 160 POB (6 crew, 154 passengers).

Aircraft FAB 2345 (Brazilian Air Force) had departed from SBSC (Aerodrome of *Santa Cruz*, *Rio de Janeiro*, state of *Rio de Janeiro*) en route to SBBR, on a personnel transport flight, with 08 POB (3 crew, 5 passengers).

During the Boeing 737's takeoff roll at SBBR, the Brazilian Air Force aircraft, which had just landed, was seen still on the runway.

Aircraft PR-GTN took off, passing just a few meters above the military aircraft.

Neither aircraft sustained any damage, and no occupants were injured.

The SIPAER Investigation Committee in charge of this serious incident did not have access to recordings from the internal cameras of TWR-BR. Therefore, it was not possible to determine what the ATCOs responsible for the TWR and Supervisor positions were doing at the time of the occurrence.

The ATS-related contributing factors playing a role in the abovementioned runway incursion were:

- Attention – a contributor.

The attention of the Tower controller was impaired by the context experienced in his daily work routine, in which, due to existing physical obstacles, there was an expectation that aircraft would comply with the instructions given, even though he was unable to visually monitor them from his position, as occurred in this case.

The fact that the Tower controller did not realize that the aircraft FAB2345, after readback indicating that it would vacate the runway via TWY "G", did not do so, demonstrated that his focus of attention was not properly directed to the situation.

The Ground controller also did not identify that the referred aircraft, upon first contact on his frequency, was still on the active runway.

- Control Skill (ATS) – a contributor.

There was no proficiency in the execution of ATS procedures, such as the visual scan of the runway and the use of phraseology, which would have exhausted the means to identify the presence of an aircraft on the runway at the time of authorizing the takeoff of another.

Final Report	Date	Location
IG-144/CENIPA/2020	03DEC2020	SBSP

In this runway incursion, at approximately 13:35 UTC, aircraft PR-AUJ took off from SBRJ (*Rio de Janeiro,* RJ) bound for SBSP (*São Paulo*, SP), on a scheduled passenger transport flight, with 73 POB (5 crew, 68 passengers).

Aircraft PR-GUD was departing from SBSP bound for SBSV (*Luís Eduardo Magalhães* Airport, *Salvador*, state of *Bahia*), also on a scheduled passenger transport flight, with 169 POB (6 crew, 163 passengers).

While aircraft PR-GUD was holding on the threshold of runway 35L, awaiting clearance for takeoff roll, TWR-SP cleared aircraft PR-AUJ to land on the same runway. After aircraft PR-GUD reported still being on the runway, TWR-SP instructed aircraft PR-AUJ to go around.

Aircraft PR-AUJ performed a go-around, overflying aircraft PR-GUD at a distance of approximately of 22 meters. The aircraft were not damaged, and no occupants were injured.

The SIPAER Investigation Committee that investigated this serious incident did not have access to the internal TWR-SP camera recordings. Therefore, it was not possible to determine what the ATCOs responsible for the TWR and Supervisor positions were doing at the time of the occurrence.

The contributing factors related to ATS that led to the runway incursion were:

- Attention – a contributor.

The ATCO did not perceive the developing scenario and cleared aircraft PR-AUJ to land on runway 35L, which was still occupied by another aircraft. This lapse of attention led to the worsening of a situation in which aircraft were approaching below the prescribed minimums.

- Attitude – a contributor.

The ATCO did not carry out a visual scan of the runway, as established in ICA 63-21 – *Runway Incursion Prevention Program in ATS*. Had this procedure been followed, the ATCO would have seen that aircraft PR-GUD was still on threshold 35L and would not have cleared aircraft PR-AUJ to land.

At the time of the occurrence, the Supervisor was not paying attention to the tasks being performed by the on-duty controllers, as he was filling out the occurrence logbook.

- Perception – a contributor

When asked about the reasons for not intervening, the Supervisor reported that, at the moment of the runway incursion, he was filling out the occurrence logbook. This situation led to a reduction in the ATCO's situational awareness, impairing the perception of the developing RI scenario.

- Supervision (ATS) – a contributor.

There was no adequate monitoring of the ATCO's actions at the TWR position by the Supervisor, which could have enabled a timely correction to prevent the runway incursion.

Final Report	Date	Location
IG-123/CENIPA/2024	24JULY2024	SBCT

In this runway incursion, aircraft PR-TTO departed from SBCT (*Afonso Pena* Airport, *Curitiba*, state of *Paraná*) bound for SBGR (*Guarulhos - Governador André Franco Montoro*

– Airport, *São Paulo*, state of *São Paulo*) on a scheduled public air transport flight, with 4 crew members on board.

During takeoff from runway 15, shortly after rotation, the aircraft crossed paths with a vehicle that had entered the runway via threshold 33. The vehicle was towing a light tower for the ongoing runway widening and leveling works.

The aircraft's right wing passed approximately 6 meters from the light tower (Figure 54). There was no damage to the aircraft or the vehicle, and no injuries to their occupants.

Figure 54 – Runway incursion at SBCT (*Afonso Pena* Airport) on July 24, 2024.

The SIPAER Investigation Committee that investigated this occurrence had access to the internal TWR-CT camera recordings. However, it was not possible to verify what the ATCO was doing at the time of the serious incident, as the equipment was configured to activate recording mode only upon detecting motion in the monitored area. No recording was available between 03:16:02 UTC and 03:18:07 UTC, the period during which the runway incursion occurred.

From the analysis of the last frame recorded before the event, at 03:16:01 UTC, and the first frame recorded after the event, at 03:18:08 UTC, it was possible to infer that the ATCO involved in the occurrence was inside the TWR and at his operational position during the runway incursion, but remained motionless, engaged in an activity other than monitoring operations, as prescribed in ICA 100-37 (Figure 55).

Figure 55 – On the left, last frame recorded before the event, at 03:16:01 UTC.
On the right, zoomed-in and enhanced image.

The ATS-related contributing factors that led to the runway incursion were:

- Attention – a contributor

After authorizing aircraft PR-TTO for takeoff, the air traffic controller – due to inattention, distraction, or fixation on another activity – did not follow the development of operations and, consequently, failed to notice the entry and continued presence of the incursing vehicle on the runway for over a minute. This prevented the adoption of appropriate corrective measures.

- Attitude – a contributor

The controller reported having conducted a visual scan of the runway, as prescribed in ICA 63-21. However, it was determined that the scan was ineffective, since at the time of takeoff clearance, the incursing vehicle was already a few meters from the runway. By failing to maintain continuous vigilance over all flight operations at and near the aerodrome, including vehicle monitoring in the movement area, the ATCO demonstrated an inadequate posture of disregard for operations and procedures. As a result, the vehicle's entry onto the runway went unnoticed, preventing the coordination of corrective actions necessary to avoid the incursion.

1.19.17 *Reason's* Organizational Accident Model.[9]

The Organizational Accident Model, developed by James Reason in the 1990s, is one of the most influential approaches for understanding how accidents occur in complex systems such as aviation. Also known as the Swiss Cheese Model, it posits that catastrophic failures rarely result from a single isolated error. Instead, they are the outcome of the interaction among multiple failures – both human and organizational – that, when inadvertently aligned, open a path for an adverse event to take place.

The model distinguishes between two main types of failures: active and latent. Active failures are actions or omissions committed by frontline personnel directly involved in operations, such as pilots, air traffic controllers, or maintenance technicians. These failures have immediate and visible effects and are often associated with execution errors, faulty decisions, or procedural violations – frequently influenced by factors such as fatigue,

[9] REASON, J. Managing the risks of organizational accidents. Aldershot: Ashgate, 1997.

workload, distractions, stress, or cognitive limitations. Examples include selecting the wrong autopilot mode, omitting a checklist item, or issuing an incorrect control instruction.

Latent failures, on the other hand, are pre-existing structural weaknesses within the system, often stemming from managerial decisions, design flaws, inadequate regulations, or permissive institutional policies. These remain hidden for extended periods and are not attributed to specific individuals, but rather to systemic deficiencies—such as ineffective training, reactive safety culture, weak oversight, poor resource allocation, poorly designed procedures, or organizational pressures that prioritize operational efficiency over safety. While latent failures do not directly cause an accident, they create a context in which active failures may lead to severe consequences.

The Swiss cheese metaphor helps visualize this concept: each slice represents a system defense barrier – such as standards, equipment, training, or procedures – and the holes symbolize its vulnerabilities. When these gaps align across all layers, they form a clear path for the accident to occur. Thus, safety does not depend solely on the existence of defenses, but on their robustness and mutual complementarity (Figure 56).

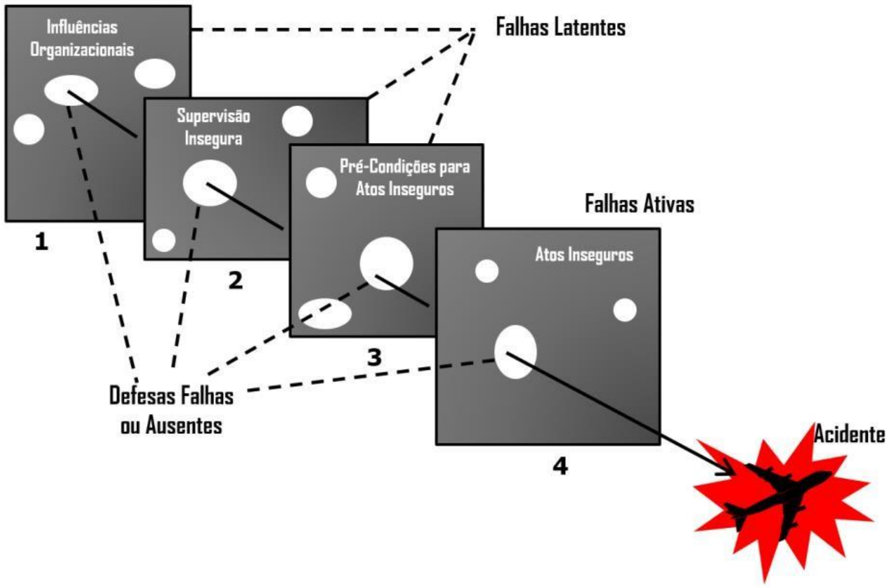

Figure 56 – *James Reason*'s Organizational Accident Model.
Source: Adapted from *Reason* (1997).

Reason's model identifies four main levels where failures may occur: (1) Latent organizational conditions, such as poorly structured policies or a negligent safety culture; (2) Supervisory failures, such as failure to identify risks or ineffective enforcement of standards; (3) Deficiencies in control barriers, such as inadequate signage or inefficient alert systems; and (4) Faulty actions by frontline operators. This structure allows for understanding the accident as a product of interacting layers of vulnerability rather than as the isolated error of a single individual.

This systemic view has broad application in accident investigation and prevention, enabling investigators to go beyond the mere attribution of blame to human error. By focusing on underlying causes, the model supports the identification of organizational weaknesses, process redesign, and the reinforcement of existing defenses – fostering a culture that proactively prioritizes safety.

Mitigating these risks requires complementary strategies. To reduce active failures, it is essential to invest in effective training, robust checklists, early warning systems, ergonomic improvements, and continuous supervision. To address latent conditions, the implementation of Safety Management Systems (SMS), systematic risk assessments, and the development of an institutional culture that values early identification of vulnerabilities and organizational learning are necessary.

In summary, *James Reason*'s Organizational Accident Model provides a realistic and comprehensive lens through which to understand how multiple failures interact within complex systems. It emphasizes that operational safety depends on constant vigilance over vulnerabilities – both in day-to-day operations and in organizational structures – on the strengthening of institutional defenses, and on fostering a culture that recognizes, addresses, and learns from failures before they align and lead to irreversible outcomes.

1.19.18 *James Reason*'s Human Error Classification Model.[10]

The Human Error Classification Model, proposed by James Reason in 1990, is an essential tool for understanding the different types of mistakes committed by individuals within organizational environments. This model was developed with the goal of providing a conceptual foundation for the analysis of incidents and accidents, allowing not only for the identification of the nature of human failures, but also for the proposal of effective strategies for preventing them (Figure 57).

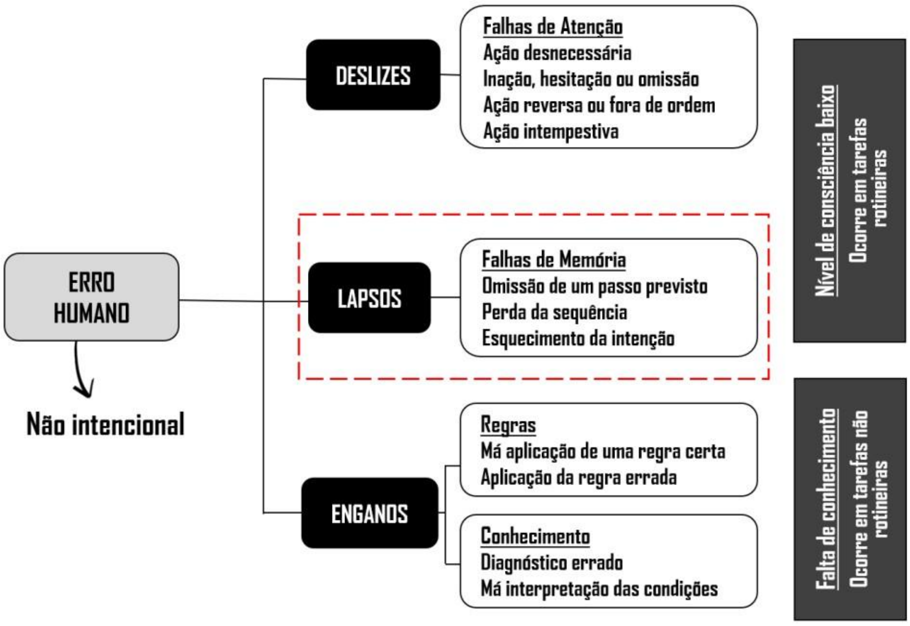

Figure 57 – James Reason's Human Error Classification Model. In this figure, violations are not depicted.
Source: Adapted from *Reason* (1990).

Reason classifies human failures into three main categories: execution errors (slips and lapses), planning or decision errors (mistakes), and violations.

Execution errors occur when the action carried out does not correspond to the individual's intention. Within this category, slips are motor or perceptual failures, such as pressing the wrong button or selecting the incorrect radio frequency, while lapses are related to memory, such as forgetting to complete a critical step during a procedure. These errors are common in routine and automated tasks, especially under conditions of fatigue, distraction, or cognitive overload.

Planning errors, known as mistakes, involve devising an inadequate plan to achieve a goal. These are further subdivided into rule-based mistakes, when an incorrect rule or procedure is applied to a given context, and knowledge-based mistakes, which occur when the individual lacks sufficient knowledge about the situation or misinterprets the available

[10] REASON, J. Human error. Cambridge: Cambridge University Press, 1990.

information. Unlike slips and lapses, mistakes are associated with reasoning and decision-making and are more likely to occur in new and complex situations.

The third category, violations, refers to the deliberate non-compliance with rules, procedures, or regulations. Reason emphasizes that not all violations stem from bad faith. They can be routine violations, when deviations become habitual practices; situational violations, when they result from adaptations to operational conditions; or exceptional violations, which arise in unforeseen or emergency situations. Often, violations reflect organizational factors such as performance pressure, unrealistic rules, or a culture that tolerates or overlooks deviations.

The great contribution of Reason's Human Error Classification model lies in its ability to clearly distinguish between different types of failures, enabling more effective preventive actions.

For slips and lapses, the response involves improving the work environment, using support systems such as *checklists* and alarms, reducing distractions, and enhancing monitoring and control processes.

For mistakes, preventive measures include qualification, training, better decision support, and procedure reviews.

In the case of violations, it is essential to address organizational culture, ensure effective supervision, understand the reasons behind non-compliance, and foster an environment that encourages rule adherence.

This model plays a fundamental role in building a mature safety culture and promoting a just culture regarding human error. It recognizes that many failures are not the result of negligence or misconduct, but rather systemic vulnerabilities. It provides a conceptual foundation for the development of Safety Management Systems (SMS), supporting the critical analysis of human and organizational factors contributing to undesired events. By adopting this understanding, organizations can move forward in accident prevention, strengthen their defenses, and promote more resilient and safer operations.

1.19.19 Mica Endsley's Model of Situational Awareness in Dynamic Environments.[11]

The Model of Situational Awareness in Dynamic Environments, developed by *Mica Endsley* in 1995, constitutes a foundational theoretical framework for understanding how operators in high-complexity settings – such as air traffic control – perceive, interpret, and anticipate what is happening around them. In environments where information changes rapidly, decisions must be made under pressure, and multiple variables interact simultaneously, situational awareness becomes a decisive factor for ensuring safety.

Endsley defines situational awareness as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future." This definition emphasizes that situational awareness is not merely about knowing what is happening, but also understanding the impact of what is perceived and, more importantly, anticipating possible outcomes. The proposed model is structured into three progressive and interdependent levels: perception, comprehension, and projection (Figure 58).

[11] ENDSLEY, M. R. Toward a theory of situation awareness in dynamic systems. Human Factors, v. 37, n. 1, p. 32-64, 1995.

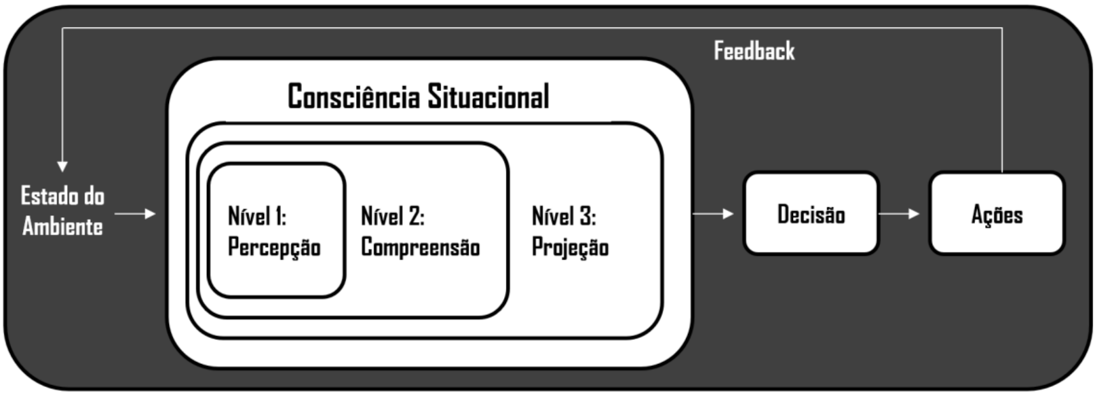

Figure 58 – Mica Endsley's Model of Situational Awareness in Dynamic Environments.
Source: Adapted from Endsley (1995).

Level 1 – Perception of Elements in the Environment represents the foundation of the process. At this stage, the operator detects and registers the available data, such as positions, states, events, and relevant objects. In the air traffic control context, this includes, for example, recognizing aircraft positions, altitudes, speeds, the presence of obstacles, or adverse weather conditions. The effectiveness of this level depends on the operator's ability to perceive the right stimuli amid a high volume of available information, which can be affected by fatigue, distraction, or poorly designed interfaces.

Level 2 – Comprehension of the Current Situation refers to the integrated interpretation of the perceived information. The operator connects the data, understands causal relationships, and infers what is actually occurring. Using the same example, the controller perceives that two aircraft are converging at the same altitude and interprets this as a potential loss of separation. Here, experience and training play a key role in transforming data into meaningful knowledge.

Level 3 – Projection of Future Status is the most advanced stage, in which the operator uses their understanding of the current scenario to predict its future development. Anticipating consequences allows for proactive actions, preventing errors and reducing risk exposure. In the controller's case, this means foreseeing that, without intervention, an in-flight collision will occur, and thus promptly issuing the appropriate corrective instructions.

The importance of Endsley's model lies in its ability to explain why erroneous decisions are made even by experienced professionals. Operational failures often do not stem from ignorance or negligence, but rather from gaps in the development of situational awareness at any of the three levels. Therefore, maintaining robust situational awareness is essential for safe and efficient operations.

Several factors influence the effectiveness with which situational awareness is built and maintained. These include individual operator characteristics (knowledge, training, fatigue, and cognitive load), the complexity and urgency of tasks, the reliability of support tools (interfaces, alerts, and displays), and the quality of team communication.

Failures in situational awareness are present in a large number of accidents within complex systems. Whether due to the failure to perceive relevant signals, the misinterpretation of perceived information, or the inability to predict the unfolding of events, such failures impair decision-making and the execution of corrective actions.

For this reason, organizational strategies aimed at promoting situational awareness – such as human-centered design, the elimination of distractions, decision-making training under pressure, and the use of cognitive support tools – are crucial for effective safety management.

In summary, Endsley's Model of Situational Awareness provides a solid theoretical structure for understanding how operators process information in high-demand cognitive environments. It highlights that safety and effectiveness depend not only on task execution, but also on the continuous ability to perceive, comprehend, and anticipate events. Strengthening situational awareness is therefore one of the fundamental pillars in preventing failures in Air Traffic Services (ATS).

1.19.20 Just Culture and Cognitive Resilience

Just Culture is a central concept in promoting organizational safety, particularly in sectors that involve high-risk operations and activities. Developed and widely disseminated by Sidney Dekker (2007)[12], the concept proposes an ethical and balanced approach to operational errors, distinguishing between human failures and reckless or intentional misconduct.

According to Dekker, a Just Culture is "a work environment where professionals are encouraged to report errors, near misses, and other safety issues without fear of punishment, provided their actions do not involve gross negligence or deliberate recklessness." In other words, it is an organizational philosophy that seeks to promote learning from failures – without renouncing accountability, but applying it in a fair and contextualized manner.

One of the core principles of this philosophy is the recognition of human fallibility. It is based on the understanding that error is inevitable in complex systems and, therefore, should be seen as a learning opportunity, not as grounds for punishment. When accountability is necessary, it should be fair and take into account the intentions of those involved, the conditions under which they acted, and the information available at the time. Furthermore, a Just Culture shifts the focus of incident analysis away from the individual and toward systemic factors. Rather than seeking culprits, the goal is to understand the structural and organizational elements that contributed to the event.

Another key element of this approach is the construction of a trust-based environment in which transparency and protection from retaliation encourage the reporting of adverse events. Such an environment can only be sustained when there is a clear distinction between unintentional human errors and violations.

Dekker advocates a shift from a punitive logic – based on retributive justice – to a restorative justice approach. From this perspective, the focus is on repairing harm, restoring trust, and learning from what happened. The central questions of this model are not *"who made the mistake?"* or *"who should be punished?"*, but rather "*what happened?", "what do those affected need?"*, and "*who is responsible for meeting those needs*?"

In this context, Cognitive Resilience emerges as an essential attribute, especially in high-stakes operational environments such as air traffic control. This form of resilience refers to the ability of individuals and teams to maintain safe and effective performance under pressure, uncertainty, and rapidly changing conditions. It involves focus, critical judgment, situational awareness, and adaptability.

These competencies do not arise in isolation but are cultivated in organizational cultures that value continuous learning, transparency, and mutual support—precisely the pillars of Just Culture. When errors can be acknowledged and addressed without fear of disproportionate punishment, professionals remain open to learning, maintain heightened vigilance, and engage in collaboration, thereby reinforcing the mental readiness needed to cope with the unexpected.

Environments that encourage error reporting directly contribute to strengthening critical judgment, as the permission to make mistakes – without undue fear – fosters early risk

[12] DEKKER, S. Just culture: balancing safety and accountability. Aldershot: Ashgate, 2007.

identification and reduces the tendency to deny problems. Organizational transparency, in turn, enhances collective situational awareness, enabling safer decisions to be made collaboratively.

Furthermore, proportional accountability helps preserve the mental and operational well-being of professionals, who, when not operating under constant disciplinary threat, maintain higher levels of attention and cognitive flexibility. A systemic approach to safety also supports the continuous strengthening of defensive layers, through structural adjustments that enhance the system's overall resilience.

In practice, the convergence between Just Culture and Cognitive Resilience can be observed in a variety of operational settings. Crews working in environments grounded in Just Culture tend to report system failures and operational lapses more frequently. When properly analyzed and utilized, this information serves as the basis for realistic training scenarios – one of the most effective methods for developing cognitive resilience.

Similarly, air traffic controllers operating within organizations where institutional trust exists demonstrate a greater ability to maintain focus and clarity, even during sudden transitions between underload and overload conditions, thus avoiding rash decisions or dangerous omissions.

Just as technical resilience requires robust systems with redundancy, cognitive resilience demands healthy, ethical, and trust-based human environments. In this sense, Just Culture is an indispensable condition for the development of cognitive resilience. In its absence, fear, silence, and mistrust undermine vigilance and adaptability – critical elements in accident prevention.

In contrast, Reactive Safety Culture represents an initial stage of organizational safety maturity, characterized by a predominantly reactive posture in risk management.

In this model, actions are mainly triggered in response to incidents or accidents that have already occurred, rather than being guided by preventive or proactive perspectives. Organizations operating within such a culture tend to treat safety as a matter of reactive compliance, where improvements and adjustments are made only after failures materialize, often without in-depth analysis of underlying causes.

Within this context, the investigation of adverse events typically focuses on active failures – immediate errors made by frontline operators, such as pilots, mechanics, or air traffic controllers – while latent conditions, which represent systemic and organizational vulnerabilities, receive little attention.

This superficial approach leads to isolated fixes rather than structural changes that could prevent similar problems from recurring. Moreover, in a reactive safety culture, a mindset of individual blame tends to prevail, holding professionals accountable for failures without adequately examining contributing factors such as flawed procedures, operational pressures, or insufficient training.

Such a dynamic creates a work environment where the fear of retaliation discourages open communication about errors and near misses, thereby limiting the organization's ability to learn from minor events before they evolve into critical failures. One of the main limitations of reactive culture is its dependence on incidents as the primary driver of change, which results in significant delays in risk identification and mitigation.

In complex systems such as aviation, where the margin for error is extremely narrow, this posture can have severe consequences, as undetected issues may lead to catastrophic accidents.

To evolve beyond a reactive culture, organizations must adopt a more proactive and systemic approach, aligned with the principles of Just Culture and the Safety Management System (SMS). This involves establishing mechanisms that encourage voluntary and non-punitive reporting of events, allowing for data collection and analysis to identify trends and threats before they result in accidents.

In summary, while reactive safety culture persists in some organizations, its limited and failure-driven nature renders it inadequate for the challenges of modern aviation. The transition to more advanced models – such as proactive and generative safety cultures – is essential for building resilient systems in which safety is truly a priority and integrated at all organizational levels. This evolution not only mitigates risks more effectively but also strengthens trust and collaboration among professionals, creating a safer and more sustainable air operations environment.

1.19.21 Sterile Control Room Concept

In the context of ATC, the concept of a sterile control room refers to the implementation of a strictly controlled operational environment, free from non-essential distractions and interferences, with the aim of ensuring the controllers' absolute focus on their duties. This approach is fundamental to operational safety, especially during critical phases such as reduced separation application, simultaneous ground movements, or operations under adverse weather conditions.

Inspired by the sterile cockpit rule adopted by flight crews – which restricts non-operational conversations or activities during takeoff and landing – the concept applied to ATC seeks to ensure that controllers maintain continuous attention to their assigned tasks, minimizing the risk of errors resulting from distractions or loss of situational awareness.

The practical application of this philosophy involves both operational and structural measures. These include the prohibition of side conversations unrelated to control activities, restricted use of personal devices such as cell phones and tablets, access control to the control rooms - limited to authorized personnel only - and guidance for supervisors to avoid unnecessary interactions with ATCOs during high-demand periods.

The physical environment of control rooms must also be designed with a focus on ergonomics and functional efficiency. The layout should ensure broad visibility of radar and communication systems, with lighting adjusted to reduce visual fatigue. Acoustic insulation helps mitigate external noise, and electromagnetic interference control is essential, requiring the sealing off of unauthorized devices that could compromise critical systems.

The study *Distractions at Workplace* (WP-2015-162)[13], published by the International Federation of Air Traffic Controllers' Associations (IFATCA) in 2020, emphasizes that even brief interruptions can impact real-time critical decision-making. The publication recommends the adoption of clear policies regarding behavior in control rooms, prohibition of personal mobile phone use, ergonomic improvements, frequent training, and the promotion of an organizational culture that values full attention and operational discipline.

Distractions, according to IFATCA, are divided into operational and non-operational, with the latter being avoidable and particularly harmful. Their causes may be internal - such as fatigue, stress, or personal concerns – or external – such as conversations, noise, inadequate lighting, physical interruptions, and technical failures. Consequences include loss of focus, separation errors, omitted procedures, and increased risk of accidents.

Also according to IFATCA, mitigating these risks requires actions on multiple fronts: improving operational environment design, preventive maintenance, equipment modernization, institutional policies on conduct in control rooms, educational campaigns, and practices such as Phone-Free Zones, which restrict mobile device use in critical areas.

---

[13] INTERNATIONAL FEDERATION OF AIR TRAFFIC CONTROLLERS' ASSOCIATIONS (IFATCA). Distractions at Workplace (WP-2015-162). Montreal: IFATCA, 2020. Available at: https://ifatca.wiki/ kb/wp-2015-162/. Access on: 15 June 2025.

In summary, the sterile control room represents a preventive pillar of the safety management system. The effective adoption of this concept – supported by robust institutional policies, ongoing training, and a safety-oriented organizational culture – is essential to ensure safer, more resilient air traffic operations free from interference.

With the objective of mitigating the risks associated with distractions in the ATS operational environment – with special emphasis on those of an electronic nature – a collaborative initiative was launched in 2013 between the Federal Aviation Administration (FAA) and the National Air Traffic Controllers Association (NATCA)[14], known as “Turn Off, Tune In”.

Over a five-year period, a joint working group, composed of representatives from both organizations, developed and implemented an awareness campaign aimed at educating professionals on the adverse impacts of distractions on operational safety.

The work was aimed at the internal audience of ATS organizations in the United States, encompassing controllers, supervisors, managers, and other professionals performing duties in the operational environment. Its actions were guided by the promotion of a culture of focus, operational discipline, responsibility, and situational awareness.

The central concept of the “Turn Off, Tune In” campaign was based on the adoption of practices that voluntarily and consciously restricted the use of personal electronic devices during the performance of operational duties. Additionally, the campaign reinforced the importance of maintaining a sterile control room, where all controllers’ attention should be focused on the safe, efficient, and orderly provision of air traffic services.

Throughout its duration, the “Turn Off, Tune In” campaign proved effective in promoting behavioral changes among professionals working in ATS. Data from safety reports and internal assessments indicated a significant reduction in the occurrence of events related to loss of situational awareness due to distractions, especially those associated with cell phone use. Moreover, improvements were observed in operational discipline, adherence to established procedures, and the strengthening of the organizational safety culture.

In the international context, several aviation occurrences illustrate the dangers associated with distractions during ATC operations. These events demonstrate that the absence of a sterile environment compromises not only the professionals’ concentration but operational safety as a whole:

Überlingen (Germany, 2002)

On the night of July 1, 2002, a DHL Boeing 757 and a Bashkirian Airlines Tupolev TU-154 collided midair over Überlingen, Germany, killing all 71 occupants aboard both aircraft. The sole controller on duty, distracted by failures in the telephone system and working alone, was unable to intervene in time to prevent the conflict between the two aircraft, which were on converging routes at 36,000 feet. The accident had worldwide repercussions, prompting changes in international coordination protocols and highlighting the importance of eliminating distractions during critical operational situations.

Chicago O’Hare (USA, 2006)

On July 12, 2006, a controller simultaneously cleared two aircraft to use runway 32L at Chicago O’Hare Airport – United Airlines Flight 923 for takeoff and American Eagle Flight 6273 for runway crossing – without ensuring the required minimum longitudinal separation. Investigations revealed that at the time of the clearance, the controller was distracted by informal conversations with a colleague. A collision was avoided thanks to the United pilot’s visual identification of the incursion and timely decision to abort the takeoff.

---

[14] FEDERAL AVIATION ADMINISTRATION; NATIONAL AIR TRAFFIC CONTROLLERS ASSOCIATION. Turn Off, Tune In. Washington, D.C.: FAA; NATCA, 2013. Available at: https://www.natca.org/foundations-of-professionalism/turn-off-tune-in/. Access on: 5 June 2025.

Melbourne (Australia, 2008)

On November 5, 2008, two Boeing 737 aircraft in cruise flight lost the minimum required vertical separation in the western sector of Melbourne Airport. The ATSB investigation found that the ATCO involved had been reading non-operational material, which impaired his monitoring capacity. The loss of separation triggered onboard collision avoidance systems in both aircraft, requiring evasive maneuvers. The Final Report recommended strengthening “zero distraction” policies during shifts, as well as improvements in situational awareness and continuous monitoring training.

New York (USA, 2009)

On August 8, 2009, a Piper PA-32R and a Eurocopter AS350 collided midair over the Hudson River, resulting in nine fatalities. The NTSB investigation identified a contributing factor as the distraction of an ATCO who was engaged in a personal phone call during duty and failed to correct a frequency error that prevented the Piper pilot from properly receiving traffic instructions. This lapse compromised coordination and mutual alerting between the aircraft involved. As a result of the investigation, the FAA implemented stricter rules on telephone use in ATC facilities, prohibiting personal communications during operational shifts.

Gothenburg (Sweden, 2011)

On October 26, 2011, at Gothenburg Airport, an aircraft on final approach was forced to go around after a service vehicle was erroneously cleared onto the runway. The investigation by the Swedish Accident Investigation Authority (SHK) found that the controller was engaged in a non-operational conversation with another ATCO, which led to a temporary loss of situational awareness. The runway had already been cleared for landing, and the vehicle’s presence went unnoticed in time, resulting in a serious runway incursion. The event led to a revision of communication and surveillance protocols in Swedish towers, with an emphasis on reinforcing the sterile environment.

San Diego (USA, 2015)

On July 4, 2015, during a busy morning at San Diego Airport, an ATCO was engaged in constant conversation with a trainee about non-operational topics, diverting attention from the simultaneous clearances being issued. As a result, two aircraft were cleared to occupy converging runways at the same time, creating a critical near-collision situation. Minimum separation was compromised, but a collision was avoided due to the pilots’ prompt action. The case prompted a review of supervisory practices and reinforcement of training related to situational awareness.

Birmingham (United Kingdom, 2021)

On May 15, 2021, an EC135 helicopter on an urgent aeromedical mission requested priority approach to Birmingham Airport. The ATCO, during a low-demand shift, was using a personal mobile phone for non-operational purposes and missed the initial call from the aircraft, causing a delay in the approach clearance. As a result, additional vectoring was required, leading to a loss of critical operational time in a sensitive mission. Although there were no damages or injuries, the event was classified as a serious incident due to the nature of the operation. The AAIB report cited failure to maintain a sterile environment and recommended the blocking of mobile signals in control rooms.

Ramat David (Israel, 2024)

On October 28, 2024, during operations at the Ramat David Air Base, an air traffic controller, distracted by cellphone use, simultaneously cleared two F-16 fighter jets for takeoff and runway entry on the same strip. A collision was avoided thanks to evasive maneuvers performed by the pilots. In response to the incident, the military base adopted new guidelines completely prohibiting cellphone use in operational areas.

1.19.22 Complacency and Supervision in ATC

The relationship between complacency and managerial supervision in air traffic control is a determining factor for ensuring the safety and efficiency of operations. In this context, complacency is characterized as a psychological state in which operators develop overconfidence, reduced vigilance, and a relaxed attitude toward established procedures.

This phenomenon, often associated with the repetition of routine activities, leads to the underestimation of operational risks, directly compromising safety. Among its main consequences are decreased attention, neglect of critical details, and in more severe cases, the normalization of deviations that undermine the integrity of the system.

Managerial supervision, in turn, plays a key role in mitigating this risk. A proactive, present, and technically competent management can identify early signs of complacency, intervene through constructive feedback, and continuously reinforce the importance of strict adherence to operational procedures. When effective, supervision not only corrects deviations but also helps consolidate an organizational safety culture in which professionals feel valued, supported, and simultaneously accountable for their conduct.

However, it is important to emphasize that the absence of active supervision, or the adoption of overly permissive oversight models, encourages complacent behaviors. In such scenarios, minor operational errors tend to be overlooked, which gives the team the mistaken impression that such deviations are acceptable or tolerable, thereby increasing the likelihood of critical failures. Conversely, excessively rigid supervision, focused on punitive approaches, can have adverse effects, such as fear of error reporting, weakening organizational learning processes and harming the safety culture.

The challenge, therefore, lies in establishing a supervisory model that balances technical rigor with human support. This entails acting firmly but fairly, clearly distinguishing between errors resulting from human limitations – which should be treated as learning opportunities – and acts of negligence or deliberate noncompliance, which require proportionate corrective actions. Additionally, effective management includes promoting regular training, simulation exercises, and fostering an organizational environment characterized by open dialogue, transparency, and continuous learning.

Thus, when well-structured and properly applied, managerial supervision is one of the most effective tools for preventing complacency in air traffic control. Close engagement by supervisors, combined with practices that promote both accountability and professional development, significantly contributes to maintaining operational vigilance, mitigating risks, and ensuring safer and more efficient air traffic operations.

By nature, complacency tends to emerge in situations where operations become highly automated or repetitive, and where teams rely excessively on systems that have operated without failures for extended periods. In such scenarios, managerial supervision is expected to serve as a counterbalance, identifying any tendency toward premature professional relaxation and implementing measures to prevent a decline in vigilance. When managerial monitoring is inadequate or ineffective, complacency is more likely to develop silently and progressively, going unnoticed and unaddressed in time.

Managerial supervision, therefore, bears critical responsibility for mitigating complacency, not only by closely monitoring the activities of operational teams but also by fostering a work environment that prioritizes continuous awareness and self-motivation. This includes the implementation of periodic training based on real-life scenarios, the updating of procedures, and the promotion of regular discussions on safety. Active and engaged management, with clearly defined standards, encourages professionals to remain diligent in their responsibilities while promoting a culture in which errors or deviations are seen as opportunities for learning and improvement.

Moreover, supervisory failures can directly influence the emergence or intensification of complacency by failing to enforce a rigorous accountability system. In environments where managers do not emphasize the consequences of poorly executed processes or where oversight becomes less present, teams may begin to disregard best practices or believe that “minor slip-ups” are acceptable. More concerning is the fact that, in the absence of supervision, complacent behaviors may go unnoticed, creating an environment in which risks accumulate continuously until an accident occurs.

In summary, complacency is a risk behavior that can emerge in any operational environment, especially those marked by repetitiveness and low workload. Supervision is the most effective tool for preventing such conduct. It not only ensures compliance with rules and procedures but also serves as a catalyst for continuous development, heightened situational awareness, and improved performance. Safety in ATC depends decisively on maintaining this balance: countering the silent effects of complacency through active, committed, and consistently engaged supervision.

1.19.23 Effects of Underload in ATC

Underload, or reduced workload, can significantly contribute to air traffic controllers' inattentiveness, being influenced by both operational and psychological factors.

In contexts with few tasks or environmental stimuli, alertness levels tend to decrease, compromising the sustained vigilance required in this critical activity. In such scenarios, the human brain–naturally adapted to respond to constant stimuli – enters a state of excessive relaxation, impairing readiness to respond to unexpected changes in air traffic.

Monotony and boredom resulting from low demand reduce focus and motivation to maintain sustained attention, impairing the ability to detect changes in traffic flow or anticipate potential conflicts. This condition may also generate a specific type of mental fatigue – distinct from that caused by overload – that, although less perceptible, similarly affects cognitive capacity and operational efficiency. It is a silent fatigue that sets in gradually and undermines situational awareness, a key element for decision-making in the air traffic control environment.

Understimulation may lead the controller to forget important operational information, such as temporary restrictions or changes to flight plans. Another associated risk is complacency: during prolonged periods of low activity, there is a tendency to rely excessively on automated systems, such as conflict alerts, which reduces active vigilance. This false sense of security is particularly dangerous in unexpected situations – such as emergencies – when the professional may be mentally unprepared to react with the necessary agility.

This risk is even more pronounced during sudden transitions from underload to overload, as occurs during abrupt increases in traffic. When the brain is not in an ideal state of readiness, response times lengthen, increasing the probability of errors.

Scientific literature supports these findings. A study conducted by the *National Aeronautics and Space Administration* (NASA)[15] in 1998 identified that both overload and underload negatively affect ATCO performance. In the case of underload, there was a higher incidence of attention lapses and longer conflict detection times, especially during low-traffic periods such as nighttime shifts.

---

[15] NASA. The effects of workload on air traffic controller performance. Moffett Field, CA: NASA Ames Research Center, 1998. (NASA Technical Memorandum 112226). Available at: https: //hsi.arc.nasa.gov/publications/Edwards_Martin_et_al_WL2017.pdf. Access on: 10 May 2025.

The inverted-U theory, also known as the Yerkes-Dodson Law[16], reinforces this understanding by demonstrating that human performance reaches its optimal point at moderate levels of arousal. In other words, both the lack and the excess of stimuli impair efficiency, particularly in activities requiring a high level of responsibility.

Complementarily, a EUROCONTROL study (2010)[17] found that controllers handling very light traffic reported difficulty maintaining concentration and constant vigilance, particularly during low-activity shifts. These findings show that underload does not represent a state of operational tranquility but rather a real risk in environments that require continuous attention and active monitoring.

Given this scenario, it is essential that air traffic management implement strategies that help maintain professional engagement, even during low-demand shifts. Recommended measures include task rotation, periodic training focused on situational awareness maintenance, and the adoption of strategic breaks to preserve alertness.

1.19.24 Hot Spots.

Hot spots are areas of an aerodrome that present a heightened potential risk of collision or runway incursion. They are typically located at runway and taxiway intersections with a history of operational conflicts or at points with limited visibility from the control tower.

The primary purpose of identifying hot spots is to alert pilots, air traffic controllers, and vehicle operators to locations that require special attention during ground operations. According to ICAO, in Doc 9870 – *Manual on the Prevention of Runway Incursions*, a hot spot is defined as: "a location on an aerodrome movement area with a history or potential risk of collision or runway incursion, and where heightened attention is necessary."

It is recommended that hot spots be designated sequentially (HS 1, HS 2, etc.) and included in Ground Movement Charts (GMC), in the RMK field of the ROTAER, and in the AIP Brazil, always accompanied by a brief description of the factors that led to their classification as a critical point. Graphical depiction alone is not sufficient: it is essential to inform operators about the type of hazard associated with each hot spot, enabling them to adopt a more vigilant posture during taxiing in the designated area.

The emergence of hot spots is frequently linked to factors such as complex aerodrome layouts, high traffic volume, inadequate signage, and blind spots from the control tower. While some of these issues may be resolved through immediate actions, others require medium- or long-term structural or operational interventions.

Once identified, hot spots must be addressed through specific strategies to eliminate the associated hazards or, when elimination is not feasible, to mitigate the risks effectively. These strategies may include:

- Awareness campaigns for operators and users;
- Installation or enhancement of visual signage (horizontal, vertical, or illuminated);
- Redesignation of taxi routes;
- Construction of new taxiways;
- Adoption of measures to mitigate control tower blind spots;
- Clear and standardized publication of hot spots in the AIP, including hazard descriptions.

---

[16] YERKES, R. M.; DODSON, J. D. The relation of strength of stimulus to rapidity of habit-formation. Journal of Comparative Neurology and Psychology, v. 18, n. 5, p. 459–482, 1908. Available at: https://onlinelibrary.wiley.com/doi/10.1002/cne.920180503. Access on: 26 June 2025.

[17] EUROCONTROL. Challenges of managing low traffic periods in ATM operations. Brussels: EUROCONTROL, 2010. Available at: https://www.eurocontrol.int/publication/challenges-managing-low-traffic-periods-atm-operations. Access on: 26 June 2025.

Common characteristics of hot spots include complex runway/taxiway intersections, areas with limited visibility from the tower, closely spaced parallel runways without clear visual separation, crossings with heavy ground vehicle traffic, and transitional zones between tower-controlled areas and apron areas.

Although hot spots do not represent physical obstacles, they serve as essential operational and cartographic references for safety. Their presence serves as a warning for pilots, drivers, and controllers to adopt more cautious behavior. Additionally, they contribute to the standardization of communications and instructions, enhance operational training, guide safety briefings, and facilitate safer taxi planning by reducing perceptual errors and hasty decision-making.

In aeronautical information publications (AIP), hot spots are marked with the symbol “HS” and must be incorporated into operational briefings and Runway Safety Plans. Effective management of these points includes improving horizontal and vertical signage, using selective lighting at critical intersections, adopting specific phraseology, restricting taxi routes in adverse weather conditions, and conducting scenario-based simulations.

The main ICAO normative references for the identification and mitigation of hot spots are Doc 9870 – *Manual on the Prevention of Runway Incursions*; Annex 14 – Volume I – *Aerodromes*; and *Runway Safety Toolkit*. These documents guide airport operators and air navigation service providers in the ongoing management of these critical areas.

1.19.25 “One Runway, One Frequency” Principle

The principle known as “One Runway, One Frequency” constitutes an essential guideline to ensure the safety of operations involving landings, takeoffs, and movements on active runways. This guideline establishes that all users—whether aircraft, operational vehicles, or support personnel – operating on or near a given runway must use a single, dedicated control frequency. The core objective is to ensure that all parties have full and simultaneous access to relevant communications, thereby fostering mutual situational awareness and preventing conflicts resulting from communication failures.

The normative and technical basis for this principle is consolidated in ICAO documents, particularly Annex 11 (Air Traffic Services), Doc 4444, and Doc 9870. These references recommend that, whenever possible, runway-related communications be centralized on a single frequency.

From a technical standpoint, the use of a single frequency allows all runway users to hear not only the instructions addressed to them but also those directed to other operators. This substantially reduces the risk of misunderstandings, eliminates informational gaps, and strengthens collective vigilance, especially in high-traffic environments. By consolidating communication, the fragmentation of information flow – a major contributing factor to incidents involving active runways – is effectively avoided.

Implementing the “One Runway, One Frequency” principle provides significant operational benefits. Among the most relevant are: enhancing shared situational awareness, reducing coordination workload between control positions, mitigating the risk of runway incursions, and improving the efficiency of emergency response. In addition, unified frequency use facilitates communication between the control tower and ground operators such as maintenance, security, cleaning, or emergency response teams, all of whom require safe and clear runway access.

Several reports issued by international investigative authorities have documented incidents and accidents in which the absence of a common frequency for vehicles and aircraft significantly contributed to runway incursions. These cases reinforce the importance of adopting the “One Runway, One Frequency” principle, as advocated by ICAO, as an essential practice for preventing surface movement conflicts.

In Brisbane, Australia (2006), a Boeing 737-800 began its takeoff roll while a vehicle was crossing the same runway, communicating on a frequency different from that of the aircraft. The incident prompted significant operational discussions and led to the implementation of a single frequency for all runway operations, in line with ICAO recommendations.

In Porto, Portugal (2021), following a near collision between a Boeing 737-400 and a service vehicle, the airport operator was advised to install equipment enabling direct communication between ground vehicles and the tower frequency, thereby allowing a single frequency to be used by both aircraft and vehicles in the maneuvering area.

In Addis Ababa, Ethiopia (2014), a Boeing 767-300 rejected takeoff at 135 knots after identifying a vehicle positioned in the center of the runway, stopping approximately 100 meters short of collision. As a corrective measure, airport authorities were advised to require that vehicle operators on active runways maintain constant listening watch on the tower frequency to ensure greater situational awareness and mitigate risks during airside operations.

In Halim, Indonesia (2016), a Boeing 737 collided with an ATR 42 that was being towed. The investigation identified lack of coordination and the use of different frequencies for runway operations as critical contributing factors, emphasizing failures in communication and shared situational awareness.

In Vnukovo, Russia (2014), a business jet collided with a snow removal vehicle that had entered the active runway without authorization. The investigation highlighted serious failures in operational coordination, aggravated by the use of different frequencies in the maneuvering area, which prevented the tower from maintaining effective contact with the vehicle.

These examples confirm that the absence of a common frequency for all runway operations compromises surface safety, increasing the risk of incursions, loss of separation, and collisions. Standardized communication via the “One Runway, One Frequency” principle thus proves to be a fundamental measure to ensure situational awareness, effective coordination among all maneuvering area users, and the overall integrity of aerodrome operations.

Such occurrences clearly demonstrate that lack of unified communication severely compromises runway safety. In addition to contributing to reduced situational awareness, divided channels prevent operators from detecting anomalous situations in a timely manner, thereby diminishing the system’s overall responsiveness.

In summary, the “One Runway, One Frequency” principle is more than an operational recommendation: it is a vital safety requirement for the prevention of undesired events during active runway operations. Its effectiveness is directly linked to standardized procedures, vigilant controller performance, and effective coordination among all aerodrome users.

The operational experience accumulated through investigations and safety studies shows that ensuring unified communication in critical environments is a simple yet decisive measure to save lives, prevent accidents, and ensure the efficiency of air traffic services (ATS).

1.19.26 Response from *RIOgaleão* Concessionaire to the request for information regarding tree pruning in the operational area.

During the SIPAER Investigation Process, the Investigation Committee contacted the airport operator to identify the actions implemented to eliminate blind spots caused by vegetation in the operational area. Letter CARJ-CA-0602-2025-OPS, dated 30APR2025, provided the following response:

On April 25, 2025, CENIPA requested from the Concessionaire the documentation concerning the request for vegetation removal in the areas surrounding TWYs “M” e “N”.

According to Letter CARJ-CA-1431-2024-OPS1, forwarded to the Command of Aeronautics, the Concessionaire clarified that it conducted an on-site inspection and verified that the tree vegetation mass referred to in the aforementioned letter is composed of a heterogeneous set of predominantly native species, with some exotic specimens, which is part of the Atlantic Forest biome, subject to strict vegetation removal regulations. Moreover, due to the characteristics of the forest composition and vegetative growth, the activity of reducing the canopy volume – such as conducting training pruning – is considered an ineffective measure for vegetation control.

In view of the above, considering that removal and pruning would not be the best solutions for the problem described by the Command of Aeronautics, given the technical and regulatory limitations, as a mitigation measure, an additional computer was installed at TWR-GL, providing real-time access to the new monitoring cameras for visualization of taxiways M and N, as well as RWY 10/28.

Furthermore, even though the vegetation does not obstruct the visibility of the runway or the operational area in general, especially the accident site, on April 8, 2025, access to and control of the new cameras was made available, and instructions on how to use the camera viewing system were provided to the TWR-GL team.

1.19.27 Analysis of the SMS in the SIPAER Investigation Process.

According to ICAO Annex 13[18], accident or incident investigations conducted by the State must include an analysis of the SMS of the service providers involved. This guideline is further detailed in Doc 9756 – Manual of Aircraft Accident and Incident Investigations, especially in Part III, which addresses investigative procedures.

Part III of Doc 9756[19] states that assessing SMS performance is essential to identify organizational and systemic factors that may have contributed to the occurrence. This includes verifying whether hazards were properly identified, whether the associated risks were effectively managed, and whether corrective measures were implemented in a timely and appropriate manner.

Additionally, the document highlights the importance of examining the organization’s safety culture, the effectiveness of internal communications, and the institutional capacity to learn from past events. These elements are essential to understand the contributing factors of an incident and to support the formulation of safety recommendations aimed at preventing future occurrences.

The analysis of the SMS during the investigation allows for an understanding of whether the organization had effective mechanisms for identifying, assessing, and mitigating operational risks. The absence or failure of such mechanisms may indicate structural deficiencies in the safety management system, directly or indirectly contributing to the unfolding of the event. Therefore, the investigation should not be limited to individual actions but should encompass the organizational context in which the operators were working.

Another relevant aspect highlighted in Doc 9756 is the need to assess the oversight exercised by senior management. Leadership’s commitment to safety, through the allocation of resources and continuous monitoring of performance indicators, is a key component for the effectiveness of the SMS. Negligence at this level can result in operational gaps, such as insufficient training, outdated procedures, or failures to address hazard reports, all of which may be contributing factors to incidents or accidents.

---

[18] INTERNATIONAL CIVIL AVIATION ORGANIZATION. Annex 13 to the Convention on International Civil Aviation: Aircraft accident and incident investigation. 11th ed. Montreal: ICAO, 2020.

[19] INTERNATIONAL CIVIL AVIATION ORGANIZATION. Doc 9756: Manual of aircraft accident and incident investigation. Part III – Investigation. 1st ed. Montreal: ICAO, 2006.

Finally, the document recommends that final investigation reports include safety recommendations aimed at improving the SMS of the organizations involved. These recommendations should be practical, feasible, and aligned with the principles of continuous improvement. By focusing on strengthening systemic processes and promoting a strong organizational safety culture, the goal is not merely to attribute causes but, above all, to prevent the recurrence of similar events, fostering a safer and more resilient civil aviation environment.

1.19.28 The importance of direct visual observation for ATCOs.

The International Federation of Air Traffic Controllers' Associations (IFATCA, 2025)[20] consistently addresses the issue of blind spots at aerodromes in the document entitled "Responsibility and Functions of Aerodrome Controllers with Regard to Surface Movement".

In this document, IFATCA emphasizes the importance of direct visual observation as an essential surveillance tool for air traffic controllers operating at aerodromes. The Federation argues that, although technologies such as closed-circuit television cameras may support ATCO activities, they should under no circumstances definitively replace direct surveillance from the TWR. This principle is reinforced by the understanding that controllers' situational awareness depends not only on the information received but also on the quality, context, and reliability of that information – attributes that are better ensured through unobstructed visual observation.

With regard to blind spots, the document acknowledges that the existence of physical obstacles at the aerodrome – such as hangars, terminals, or other buildings – can compromise ATCOs' line of sight. For these cases, IFATCA accepts the use of complementary technological means, provided their implementation is supported by a rigorous technical analysis. Even so, the recommendation remains clear: such resources should be considered support alternatives, never the primary means of surveillance. The introduction of camera systems, sensors, or other tools must be evaluated in terms of effectiveness, reliability, and integration with existing operational procedures.

Additionally, the study emphasizes the controllers' ongoing responsibility to maintain surveillance throughout the movement area, including during nighttime operations, in low-visibility conditions, or in degraded operational situations. IFATCA warns that overreliance on technological solutions can lead to complacency or loss of situational awareness, especially if systems are not properly monitored or fail. Therefore, the Federation reinforces that any change in the surveillance method must preserve the established levels of operational safety, always maintaining direct visual surveillance as the central pillar of the controller's role.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

This was a scheduled passenger transport flight operated by *Gol Linhas Aéreas Inteligentes*. At approximately 01:08 UTC, the aircraft was departing from SBGL, bound for SBFZ, on a public regular air transport, with six crew and 103 passengers on board.

During the takeoff roll, the aircraft collided with a runway-lighting maintenance vehicle that was stationary at the center of runway 10, between taxiways BB and CC.

[20] INTERNATIONAL FEDERATION OF AIR TRAFFIC CONTROLLERS' ASSOCIATIONS. Responsibility and functions of aerodrome controllers with regard to surface movement. Montreal: IFATCA, 2025. Available at: https://ifatca.org/wp-content/uploads/WP-2025-99.pdf. Access on: 4 June 2025.

The SIPAER Investigation Committee initially verified that all operational requirements related to the flight crew and the aircraft were in compliance with the regulations established by the Brazilian Civil Aviation Authority.

The weather conditions were favorable for the conduction of the flight.

No technical anomalies were found in relation to the navigation aids.

According to audio transcripts obtained from the ATS units, it was established that both the aircraft and the runway-lighting maintenance vehicle maintained radio contact with TWR-GL, and no technical abnormalities were observed in the communication equipment.

The configuration of the TWR-GL operational consoles was consistent with the Operational Model in effect at the time.

The individual duty rosters of the air traffic controllers involved in the occurrence – covering the months of December 2024, January, and February 2025 – were analyzed. It was verified that the ATCOs' workload was within the limits established by current legislation, and no discrepancies related to this aspect were reported at interviews.

Given the characteristics of this serious aeronautical incident, the investigation was based on the model developed by *James Reason* (*Reason*, 1997), as it provides a solid framework for understanding the contributing factors of the so-called 'organizational accidents.'

Such events are characterized by multiple causes involving various actors operating at different levels within their respective organizations.

Based on the facts established during the investigation, the active failures were identified. According to the adopted approach, these correspond to the errors committed directly by operators in the execution of their tasks and which result in immediate adverse effects.

In complex and highly reliable systems, such active failures are typically the consequence of a set of latent failures, stemming from decisions or actions taken long before the occurrence of the undesired event, whose effects may remain hidden for extended periods.

From this perspective, the analysis of the factors contributing to this occurrence was structured into two complementary parts: the first one, named "**Active Errors**," addresses the actions taken by the ATCOs that directly contributed to the collision between the aircraft and the vehicle; the second one, "**Latent Conditions**," examines systemic deficiencies within the organizational environment that pose risks for future runway incursions.

4.1 Active Errors

4.1.1. Runway scanning and lock screen with TATIC display

As described in item 1.18 *Operational Information*, the ATCO occupying the TWR Control position cleared aircraft PS-GPP for takeoff while the RWY-lighting maintenance vehicle was still on the runway.

This action was taken without performing the runway visual scanning procedures and locking screen with the TATIC display, as established in items 6.7.3.7 and 6.7.3.9 of TWR-GL Operational Model and item 4.2.6 of ICA 81-4 – *Program for the Prevention of Runway Incursion Occurrences in the Provision of Air Traffic Services*.

Such errors, related to memory or attention - in which the operator inadvertently omits an essential step of the task or temporarily loses awareness of critical elements of the situation - are called lapses and are frequently associated with low situational awareness.

The Human Error Classification Model, developed by Reason (1990), clearly and objectively exemplifies the conditions under which such errors occur, as shown in Figure 57.

According to the author, a necessary condition for the occurrence of a lapse is the capture of the individual's attention, usually associated with distraction. In this case, 'attention capture' means that the limited attention at that moment is focused on something other than the ongoing routine task.

In fact, footage from the internal TWR-GL cameras showed, at the time of the occurrence, the presence of several distracting elements in the operational environment, such as social conversations, use of mobile devices, an excessively informal atmosphere, and a low workload.

These sources of distraction were decisive in lowering the level of situational awareness in the control room, compromising the continuous monitoring by the ATCOs and leading to a loss of focus on critical operational information.

Based on Endsley's Model of Situational Awareness in Dynamic Environments (1995), it is observed that such distractions negatively affected all three levels of situational awareness:

Level 1 – Perception of environmental elements: Distractions diverted the controllers' attention, impairing the timely identification of information relevant to the operation, such as the presence of the vehicle on the runway.

Level 2 – Comprehension of the current situation: The lack of adequate perception impaired the interpretation of the risk involved in authorizing takeoff, leading the controller to act as if the runway was clear.

Level 3 – Projection of future states: Without correctly perceiving the scenario and its critical elements, the ATCO was unable to anticipate the possibility of a collision between the aircraft and the vehicle, compromising the safety of the operation.

With the objective of preventing the degradation of situational awareness in the operational environment, various civil aviation authorities around the world have recommended the adoption of the *sterile control room* concept.

One of the main pillars of the sterile control room is the minimization of distractions. Non work-related conversations are prohibited, and the use of personal devices - such as cell phones, tablets, and laptops – is strictly forbidden to avoid attention shifts.

In addition, the environment is acoustically designed to reduce external noise, contributing to the controllers' concentration. Safety procedures are strict, and behaviors that could affect ATCO concentration are not permitted. In some organizations, there is even continuous monitoring to ensure compliance with established protocols.

The application of this practice contributes significantly to maintaining situational awareness by eliminating or reducing cognitive interferences that compete for the controllers' attention.

By promoting a focused, distraction-free environment, the sterile control room facilitates the accurate perception of relevant elements, a clear understanding of the real-time scenario, and the appropriate projection of possible operational developments. Thus, the consistent implementation of this concept serves as an effective barrier against errors resulting from attentional lapses, strengthening system safety.

4.1.2. ATS Supervision.[21]

In the moments preceding the collision between the aircraft and the vehicle, the ATCO occupying the Supervisor position did not monitor the control and surveillance actions

[21] According to MCA 3-6 — SIPAER Investigation Manual, 'ATS Supervision' refers to the management of operational functions during the duty shift and/or the lack of oversight of actions, when required, at operational positions.

performed by the ATCO occupying the TWR Control position, as set forth in item 4.2.1 – *Supervisor Position Duties*, letters *n* and *z*, of TWR-GL Operational Model.

This inaction occurred due to the ATCO's low situational awareness, as he was handling his mobile phone. Although the Supervisor had formally ended his shift, he remained in the control room, coordinating the movement of the vehicle on the runway. Thus, both the Technical Report and the ATS Technical Report prepared by DECEA considered that the ATCO was still performing his duties at the moment of the collision. This understanding was also adopted by the SIPAER Investigation Committee.

In this regard, item 4.1 – *Operational Positions of TWR-GL Operational Model* established that no ATCO was allowed to use a mobile phone in the operational environment, as required by ICA 200-17. Moreover, according to item 4.2.1 *Supervisor Position Duties*, letter *bb*, one of the functions of this ATCO was precisely to "prohibit the use of electronic devices within TWR-GL operational environment (camcorder, camera, radio, television, cell phone, laptop, tablet, etc.)."

As described in item 4.1.1 of this Analysis, the use of mobile devices in ATC degrades ATCOs' situational awareness, diverting their attention from critical activities and impairing the perception of traffic, communications, and other relevant operational information. This degradation negatively impacts the ability to correctly interpret data and anticipate events, which are essential aspects for safe decision-making in ATS.

Additionally, the cognitive overload caused by dividing attention between operational tasks and mobile phone use can result in delayed responses, failures in error detection, omissions of information, and, consequently, an increased risk of aeronautical occurrences.

As observed in this serious incident, the loss of situational awareness reduces the controller's ability to maintain a clear and continuous picture of traffic development and potential conflicts, directly affecting the efficiency and safety of operations. Therefore, mitigating this distracting factor is essential for preserving safety standards and the integrity of the air traffic control system.

With the aim of mitigating risks associated with distractions in the ATS operational environment – with special emphasis on those of an electronic nature – a collaborative initiative was launched in 2013 by the Federal Aviation Administration (FAA) and the National Air Traffic Controllers Association (NATCA), named *"Turn Off, Tune In."*

During its period of implementation, the "Turn Off, Tune In" campaign proved effective in promoting behavioral changes among professionals working in ATS. Data from safety reports and internal assessments indicated a significant reduction in events related to loss of situational awareness due to distractions, especially those associated with mobile phone use. In addition, improvements were observed in operational discipline, strict adherence to established procedures, and the strengthening of an organizational safety culture.

4.1.3. Use of Headsets

At the time of the aeronautical occurrence, the ATCOs on duty at TWR-GL control room were not using headsets.

This fact contravened the guidelines established in the TWR-GL Operational Model, which, through items 6.7.3 – *Recommendations for the Prevention of Runway Incursions* and 6.10 – *Use of Headsets*, provided specific guidance regarding the mandatory use of this equipment.

TWR-GL Operational Model required that ATCOs assigned to the operational positions 'Clearance Delivery', 'Ground Control', and 'TWR Control' were to "use headsets while performing these functions, in accordance with the provisions of item 4.2.5.2 of ICA 81-4 – *Program for the Prevention of Runway Incursion Occurrences in the Provision of Air Traffic Services* and item 3.11.1 of ICA 100-31 – *Air Traffic Services Requirements*."

Specifically, ICA 100-31, Section XI – *Use of Headsets in ATC Units*, articles 50 and 51, established that the Chief of the ATC Unit ought to mandate the use of headsets, define their operating parameters – including this information in the operational model of the respective Unit – and ensure that headsets were available for each air traffic controller, maintaining a reserve stock a for replacement when necessary.

The adoption of this procedure aimed not only to reduce noise levels but also to preserve communication quality and, above all, to maintain situational awareness – fundamental elements for operational safety in air traffic control.

4.1.4. Error Management

Still within the scope of active errors, the last failure in the chain of events that culminated in the collision between PS-GPP and the maintenance vehicle was the decision by the ATCOs not to abort the aircraft's takeoff as soon as they realized that the said vehicle was still on the runway.

According to the information collected, at that moment, the pilots had not yet applied engine power, and the aircraft was practically positioned over threshold 28, approximately 2,000 meters from the point of impact and about 39 seconds from the collision.

Had the ATCOs canceled the takeoff clearance at the moment they recalled the presence of the vehicle on the runway – or within a period of up to 15 seconds – the rejected takeoff (RTO) would have taken place at a low speed. Under such circumstances, it would have been possible for the aircraft to come to a safe stop and not collide with the vehicle.

Internal TWR footage indicated that the air traffic controllers, after perceiving the error, focused on attempting to visually locate the vehicle's position and have it removed from the runway without interfering with the aircraft's takeoff.

In interviews conducted by the SIPAER Investigation Committee, the ATCOs could not explain the reasons that led them to manage the error in this way. However, it is possible to state that the low level of situational awareness in the control room compromised an adequate assessment of the risk involved, reducing the team's ability to perceive the severity of the situation and to recognize the need to promptly cancel the aircraft's takeoff clearance.

This degradation directly affected Levels 2 and 3 of situational awareness, related to the comprehension of the operational scenario and the projection of future consequences, resulting in a decision-making process incompatible with the principles of flight safety.

According to Dekker (2007), another factor that may have contributed to the ATCOs' inadequate error management is related to some operators' hesitation to act in the face of evident operational failures, driven by fear of being exposed, held accountable, or formally implicated in internal inquiries or State-led investigations.

The author points out that such attitudes are often found in organizational settings where a fully developed just culture is lacking. In these contexts, professionals tend to hide mistakes or downplay their significance, which undermines risk management, degrades collective situational awareness, and hinders sound decision-making.

Hesitation to act in response to an error - due to fear of exposure or accountability - reflects a deeper systemic weakness than the technical error itself. The primary risk lies not in leaving a vehicle on the runway, but in the organizational culture that may discourage proactive action, or in the group culture, where individuals may fear how mistakes will be treated. Correcting this is essential to enhancing ATS system resilience.

4.1.5 Phraseology

When contacting the maintenance vehicle to request its exit from the RWY, the Supervisor simply instructed it to vacate the runway, transmitting the following message: "*Manutenção Balizamento, livre pista 10.*" ("Lighting Maintenance, vacate runway 10.")

In the face of an imminent collision between the aircraft and the vehicle, the most appropriate course of action would have been to explicitly alert the driver about the presence of an aircraft in the takeoff procedure and to issue a clear and emphatic instruction for an immediate exit from the runway. The absence of this critical information contributed to the vehicle occupants' failure to recognize the severity of the situation or the approaching aircraft.

Moreover, the phraseology used by the ATCO was not in accordance with item 6.3.5 of CIRCEA 100-86, which prescribed the RTF phraseology to be utilized in the communications between aerodrome control and vehicle drivers, or other services, operating in the maneuvering area whenever an aircraft was to take off and the presence of a vehicle posed a risk to the operation.

Had the correct phraseology been used, the vehicle's readback would likely have followed the standard: "*Manutenção Balizamento, abandonarei a pista 10 via taxiway Charlie-Charlie à direita. Notificarei pista livre*" *("Lighting Maintenance, will vacate runway 10 via taxiway Charlie-Charlie to the right, will report runway vacated,")* as established in the Directive Circular. This information would have alerted TWR-GL controllers to the vehicle's presence on the runway, enabling immediate corrective actions.

However, the vehicle's response to the Supervisor's request – "*Roger Ground, team vacating the runway here at Charlie-Charlie*" - was interpreted by the ATCO as if the vehicle had already completed the action, as there was clearly an expectation that the runway would be promptly vacated.

It was also observed a delay of 14 seconds before the vehicle occupants responded to the call made by TWR-GL. According to statements from those involved, this delay occurred due to the non-standard phraseology used by the Supervisor, as the prescribed initial call – "*Manutenção Balizamento, Torre Galeão*" ("Lighting Maintenance, Galeão Tower") – was not employed. As a result, the vehicle occupants took a few seconds to realize that the message was directed to them.

Finally, it is worth noting that the ATCO's intervention to request the vehicle's exit from the runway occurred 26 seconds before the collision, at which point the aircraft had an indicated airspeed of 75 kt.

Had the communication been made on the TWR frequency – in accordance with the 'One Runway, One Frequency' principle, to be addressed in item 4.2 *Latent Conditions* - it is possible that the pilots would have become aware of the vehicle's presence on the runway and, consequently, rejected the takeoff while still in a low-energy regime.

4.1.6 Emergency Response

The pilots spotted the vehicle 0.5 second before impact, at a distance of 185 meters, when the aircraft had an indicated airspeed of approximately 153 kt.

After performing an abrupt evasive maneuver on the ground to avoid a direct impact with the vehicle, the crew contacted TWR-GL to report the occurrence.

The first message transmitted by the aircraft after the collision, at 01:08:57 UTC, informed that the takeoff had been aborted due to the presence of a vehicle on the runway.

This message was not answered by TWR-GL. For a few moments, the ATCOs at the TWR Control and Ground Control positions exchanged information among themselves, trying to understand what had happened.

The ATCO at the Ground Control position commented that the aircraft was not cleared for takeoff; the ATCO at the TWR Control position, in turn, confirmed that he had issued the clearance. Subsequently, the Ground Control ATCO questioned whether it was the aircraft waiting at the holding point. The TWR Control ATCO replied that it was not, but rather the GOL airlines aircraft PS-GPP, which had already initiated takeoff.

In the second message, the pilots reiterated that the aircraft had collided with the vehicle: *"We aborted the takeoff; we hit a car in the middle of runway 10."*

Although this condition was reported at 01:09:14 UTC, the activation of the Aerodrome Emergency Plan only occurred at 01:11:40, when one of the maintenance vehicle occupants – visibly in shock – radioed that they had been struck by the aircraft and requested immediate dispatch of the fire brigade to the scene.

The analysis of audio and video recordings showed a delay of 2 minutes and 26 seconds between the confirmation of the collision and the TWR-GL's formal emergency call – a period considered excessive in light of operational guidelines and best practices for critical situation response.

In the face of the runway accident scenario, it would have been the Supervisor's responsibility to promptly initiate the activation of the PLEM, as established by the DECEA's regulations.

However, the Supervisor initially adopted an inert posture, remaining seated at his console and failing to provide the necessary support to the other ATCOs, who were clearly disoriented in carrying out the response measures to the aviation occurrence.

Internal CCTV footage further revealed that, during the unfolding emergency, the Supervisor even abandoned the intercom radio between the TWR Control and Ground Control positions, withdrawing from his responsibilities. This behavior overburdened the remaining ATCOs and compromised the coordination of actions at that critical moment.

A prompt emergency response is not merely a procedural formality; it is an essential requirement for safeguarding lives, protecting the aircraft, preserving airport infrastructure, and ensuring continuity of operations.

This breakdown in the response chain generates additional risks both for those directly involved – in this case, the aircraft and vehicle occupants – and for other operations at the aerodrome, while also creating an environment conducive to further errors due to the absence of control and coordination in managing the emergency.

It should be noted that, although the pilots maintained composure during communications with TWR-GL - and did not formally declare an emergency - the controllers lacked precise information about the condition of the vehicle occupants, who could have been seriously injured and in urgent need of medical assistance.

Additionally, the first fire brigade team to arrive at the scene found that the aircraft's right main landing gear was in an overheated condition, posing an imminent risk of structural damage and fire outbreak – a situation that reinforced the need for a swift, coordinated, and effective emergency response.

Immediate activation is critical because response time, particularly in the initial moments following the occurrence, is a determining factor in the success of rescue and damage mitigation actions. The effectiveness of firefighting, victim assistance, aircraft evacuation, and containment of situations that could escalate into more critical scenarios depends directly on how quickly emergency services are mobilized.

Any delay, even of a few minutes, can worsen the consequences of the accident, such as the onset and intensification of fire, structural collapse of the aircraft, an increase in the number of casualties, or irreversible damage to airport infrastructure.

From an operational standpoint, delays in activation hinder the execution of response actions outlined in the PLEM, undermining the coordinated performance of various agencies and services involved, such as airport fire services, emergency operations centers, medical services, operational safety teams, and ATS units themselves.

Therefore, activation must occur immediately after identifying the emergency, limited only to the time required to recognize the situation and execute the alarm. Failure to observe this principle seriously compromises not only the effectiveness of the response but also the safety of operations in the maneuvering area, leading to operational consequences and, most importantly, unacceptable risks to human life.

4.2. Latent Conditions

4.2.1 Runway Incursion History and Recurrence of Active Errors.

With the objective of identifying the recurrence of contributing factors for runway incursions – both at SBGL and within SISCEAB – the findings from internal investigations of these events conducted by DTCEA-GL, as well as investigations carried out by CENIPA, were analyzed, as detailed in items 1.19.8 – *Recent history of runway incursions at SBGL* and 1.19.9 – *Lessons learned from runway incursion investigations conducted by CENIPA*.

The result of this survey is summarized in Table 1, which consolidates the recurrence of the two main contributing factors identified: the failure to perform a runway visual scan prior to issuing landing and takeoff clearances, and the loss of situational awareness during operations.

Event	**Absence of Runway Visual Scanning**	**Loss of Situation Awareness**
1	x	x
2	x	x
3	x	x
4	-	x
5	x	x
6	x	x
7	x	x
8	x	x

Table 1 – Recurrence of the main contributing factors in the analyzed runway incursions.

NOTE: Events 1 through 4 refer to runway incursions that occurred at SBGL in the 2nd semester of 2024, investigated by the very ANSP. Events 5 through 8 refer to runway incursions classified as serious incidents investigated by CENIPA. Event 8, specifically, refers to the runway incursion that is the subject of this investigation.

The recurrence of these active errors ultimately highlighted the ineffectiveness of the corrective actions implemented thus far. Although measures have been taken with the aim of mitigating these risks, their inability to prevent the repetition of the same operational behaviors suggests that such actions have not effectively addressed the contributing factors behind these deviations.

This scenario reinforces the need to review current mitigation strategies, prioritizing more robust interventions that go beyond the dissemination of procedures, focusing instead on strengthening the safety culture, managing operational barriers, and improving training processes and managerial supervision.

In organizations with a strong safety culture, decision-makers – both at the senior management level and within supervisory structures - play a fundamental role in promoting values and attitudes consistent with best safety practices in the operational environment. It is their responsibility to ensure that policies, processes, and procedures are properly developed, implemented, and enforced, thereby maintaining minimum safety standards.

The relationship between the recurrence of active errors and managerial supervision[22] is one of the central pillars in operational safety analysis, particularly in high-complexity environments such as air traffic control.

As previously mentioned, active errors are defined as failures committed at the front line of operations, whose effects manifest immediately within the system. The repetition of such errors reveals not only individual performance shortcomings but, more importantly, systemic failures in operational management and supervisory processes.

The recurrence of active errors does not occur in isolation or by chance. It is predominantly associated with the absence or ineffectiveness of managerial supervision mechanisms. When management fails to systematically and effectively monitor operations, to provide timely feedback, to identify patterns of behavioral deviations, and to implement corrective measures, conditions are created for initially isolated errors to become internalized by the organization, eventually turning into routine operational practices.

Thus, managerial supervision plays a vital role as a preventive barrier against the repetition of active failures. Its scope extends beyond merely ensuring compliance with rules and procedures, encompassing activities such as continuous monitoring of operational performance, early detection of signs of operator vulnerability, root cause analysis of errors, and, above all, the implementation of proportional and effective corrective interventions.

When absent or ineffective, supervision contributes to the development of a permissive organizational culture in which small deviations are no longer treated as opportunities for correction and learning. In this context, the phenomenon known as normalization of deviance emerges, whereby non-compliant operational practices come to be regarded as acceptable, significantly increasing the risk of more serious adverse events.

4.2.2 One Runway, One Frequency

As described in item 1.18 Operational Information, at the time of the occurrence, vehicle movement authorizations within the maneuvering area were issued by the Supervisor using a handheld radio tuned to the Group 7 frequency, a digital UHF channel. Meanwhile, authorizations for aircraft landings and takeoffs were being issued by TWR Control on frequency 118.20 MHz, as provided for in the TWR-GL Operational Model.

The practice of concentrating all runway-related communications on the same VHF frequency is widely recommended by civil aviation organizations as a means of enhancing situational awareness and reducing the risk of runway incursions. This principle, known as "One Runway, One Frequency," is supported by internationally recognized regulatory and technical foundations.

ICAO's *Manual on the Prevention of Runway Incursions* (Doc 9870) establishes in paragraph 4.2.6 that all communications associated with operations on a given runway – including aircraft and vehicles – should be conducted on the same frequency used for landings and takeoffs. Appendix A of Doc 9870 reinforces this directive, emphasizing that such a practice is essential for maintaining high levels of situational awareness among all operators.

---

[22] According to MCA 3-6 — SIPAER Investigation Manual, 'Managerial Supervision' refers to inadequate supervision, by the organization's management (non-flight crew), of planning and/or execution activities in the administrative, technical, and/or operational areas. This item does not include ATS supervision.

Likewise, EUROCONTROL's European Action Plan for the Prevention of Runway Incursions (Version 3.0) endorses this guidance, recommending that all operations associated with a given runway – such as landings, takeoffs, crossings, and inspections – be conducted on the VHF frequency assigned to that runway.

The Plan also suggests that, for vehicles equipped only with UHF radios, frequency coupling systems should be used to ensure that communications are simultaneously retransmitted on both VHF and UHF, without compromising the integrity of operational information.

Adopting this principle provides significant operational benefits, including enhanced situational awareness among all users of the runway's critical space, mitigation of coordination errors resulting from communication failures between different control positions, and the promotion of mutual vigilance, as pilots, controllers, and drivers share real-time information. Such a scenario greatly contributes to reducing misunderstandings and enables more efficient responses to unforeseen situations.

Its importance is widely recognized, especially in the context of runway incursion prevention. The investigation of aeronautical occurrences by foreign authorities and the safety recommendations issued in their final reports, as cited in item 1.19.25 "One Runway, One Frequency" Principle, reinforce the need for a common frequency for all runway operations, both aircraft and vehicle-related, as a key measure in mitigating operational risks.

In summary, consolidating the "One Runway, One Frequency" principle as an operational practice represents an effective strategy for improving flight safety at aerodromes. However, its implementation must be accompanied by proper alignment with applicable regulations and the continuous training of all professionals involved in airport operations to ensure its effectiveness and regulatory compliance.

4.2.3 Blind Spots

According to data collected during the investigation, the aerodrome had areas where visibility of taxiways M and N was obstructed by surrounding tree vegetation, particularly during nighttime operations. In a restricted segment of runway 10/28, this vegetation had already begun to hinder visibility of the very runway.

Safe ground operations at an aerodrome depend primarily on the control tower's ability to maintain continuous visual surveillance of aircraft and vehicles moving on runways, taxiways, and aprons.

Aerodrome areas that cannot be directly observed by ATCOs due to natural or artificial obstructions – referred to as blind spots – represent a significant safety risk, as they reduce controllers' situational awareness.

To mitigate the risks associated with these limitations, measures such as the installation of video surveillance systems at strategic locations and in critical areas should be adopted, allowing for remote and direct monitoring by the TWR.

In parallel, it is essential to establish standardized operational procedures to compensate for visual limitations, as well as to promote continuous ATCO training, specifically addressing blind spots and applicable mitigation strategies.

Regarding this topic, the International Federation of Air Traffic Controllers' Associations (IFATCA, 2025) addresses the issue of aerodrome blind spots comprehensively in the document entitled "Responsibility and Functions of Aerodrome Controllers with Regard to Surface Movement."

In this publication, IFATCA emphasizes that, at aerodrome control towers, the use of closed-circuit television (CCTV) systems should not permanently replace direct visual observation. According to the Federation, such systems should only be accepted as complementary tools, especially in sectors where the controller's line of sight is obstructed by physical elements such as buildings and operational structures.

Finally, IFATCA reinforces the importance of ensuring that direct visual observation remains the primary method of surveillance, and that any supplementary technological solution must be supported by robust analysis capable of ensuring that operational safety levels are maintained.

4.2.4 Ergonomics

With regard to the ergonomics of the control room, the SIPAER Investigation Committee identified that the workstations occupied by the 'TWR Control' and 'Ground Control' operational positions was positioned below the necessary field of view for ATCOs, regardless of the physical characteristics of the professionals.

According to MCA 63-15 – *Human Factors Manual for Safety Management in the SISCEAB*, item 4.8.4.2, subitem "*h*," no console should obstruct the air traffic controllers' view of essential information.

Furthermore, item 4.8.6.2 of the same Manual established that there should be no visual obstruction to TWR ATCOs, whether caused by other controllers, installed equipment, fixed or movable structures, or airport buildings.

Also in accordance with MCA 63-15, controllers should be able to observe from their workstations all takeoffs, final approaches, runways (in their entire length and direction), taxiways, and aprons adjacent to the TWR, ensuring complete and continuous visual surveillance.

The conditions found at TWR-GL revealed an inadequate workspace layout, failing to comply with regulatory requirements and the operational needs of visual monitoring.

Ergonomics in the ATS environment plays a fundamental role in the efficiency and safety of operations, especially in aerodrome control towers. A particularly relevant aspect of ergonomics – directly related to the ability to visualize the maneuvering area and the runways – is the proper adjustment of the ATCOs' chair height and workstation layout.

Thus, the seated position must allow a clear and unobstructed line of sight over the entire operational area, without the need for the ATCO to stand up constantly to achieve better visibility. Additionally, chairs must provide a wide range of height adjustments, adequate lumbar support, and stability.

The direct correlation between ergonomics and operational safety demonstrates that inadequate furniture design can represent indirect contributing factors to operational failures. Therefore, the integration of ergonomic principles into the design of ATS environments should not be addressed merely as a matter of comfort, but rather as an essential risk mitigation measure, contributing directly to the maintenance of situational awareness, operational efficiency, and, consequently, air traffic safety.

4.2.5 Documentation

4.2.5.1 ICA 81-4

On the date of the aeronautical occurrence, the SBGL Aerodrome Chart (ADC) indicated three hot spots, two of which were located on runway 10/28. The first one was situated at the intersection of taxiways AA and BB (HS 2), and the second at the intersection of taxiways CC and DD (HS 3).

The collision between the aircraft and the vehicle occurred along the centerline of runway 10, within the segment between these two hot spots, as illustrated in Figure 59.

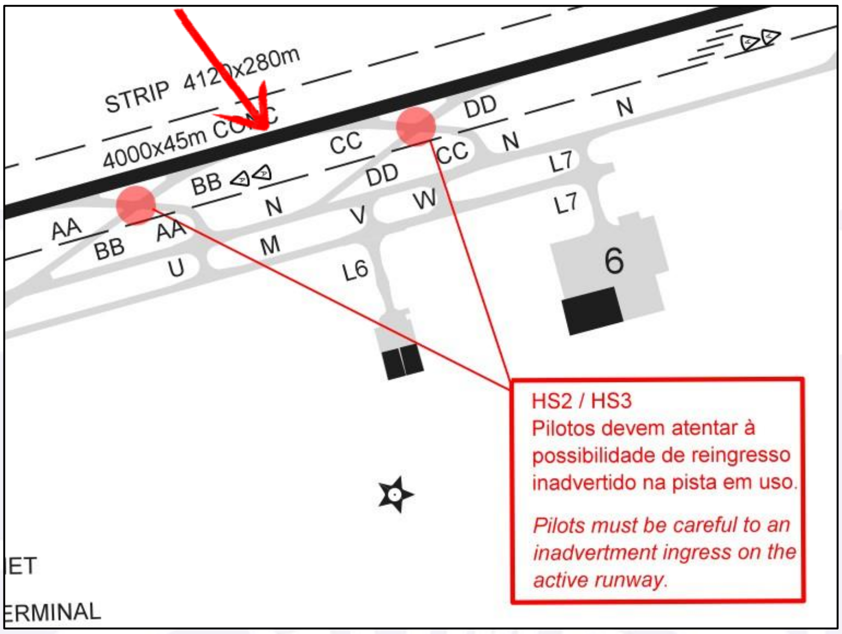

Figure 59 – Runway incursion risk areas on runway 10/28 (hot spots HS2 and HS3).
The arrow indicates the point of collision between the aircraft and the vehicle.
Source: AISWEB.

The term *hot spot* referred to areas of the aerodrome characterized by a high risk of surface incidents, including intersections with a documented history of runway incursions, as well as segments of taxiways and runways not visible from the control tower.

These critical points, already identified and published on ADC charts of several Brazilian airports, primarily aimed to enhance the situational awareness of pilots, drivers, and controllers, alerting them to the highest-risk areas of the aerodrome.

Although some publications by DECEA made brief mention of these critical points – such as ICA 100-37, which addresses Air Traffic Services, and ICA 96-1, which addresses Aeronautical Charts – the guiding document for runway incursion prevention under the purview of SISCEAB, ICA 81-4 – Program for the Prevention of Runway Incursion Events in the Provision of Air Traffic Services, contained no reference to or guidance on this important risk management tool within the maneuvering area.

While the practice of visually scanning the runway is provided for in document ICA 81-4, the absence of explicit reference to hot spots represents a normative weakness, as it neglects one of the fundamental principles of safety management: a focus on areas of greatest operational risk.

Simply conducting the runway scan without specifically targeting previously mapped critical areas may not be sufficient to ensure that ATCOs identify hidden threats, particularly in scenarios involving high workload, fatigue, low visibility, or the presence of distractions in the control room.

Moreover, the very concept of a hot spot, widely adopted by ICAO, EUROCONTROL, and numerous air navigation service providers worldwide, is designed precisely to reinforce operator situational awareness in areas requiring heightened vigilance.

Therefore, ICA 81-4 has to not only incorporate the hot spot concept but also provide clear and objective guidance regarding the need for ATCOs to pay special attention to these areas during runway visual scans.

This includes, for example, directing controllers to prioritize checking these areas before issuing takeoff, landing, or runway crossing clearances, and reinforcing, in training and operational practice, the importance of this procedure.

This approach aligns with international best practices and directly contributes to mitigating operational risks, strengthening ATS defense layers against human error, and promoting safer and more efficient operations.

4.2.5.2 TWR-GL Operational Model and CIRCEA 100-57.

Also regarding the documentation made available to ATCOs, the Operational Model (MOp) of TWR-GL, in force at the time of the serious incident, was revised after the aeronautical occurrence. According to the Preface of the new TWR-GL Operational Model, 61 items were modified, with 39 items updated and 22 excluded.

Among the changes introduced, noteworthy are the revision of item 6.4.1, which now presents more objective and detailed guidelines regarding procedures for deactivating the Supervisor Position, as well as the inclusion of item 6.4.1.2, which now prohibits the deactivation of the Coordinator Position.

In this way, the Coordinator became the sole person responsible for vehicle movements in the maneuvering area, 24 hours a day, as set out in paragraphs (f) and (g), item 4.2.2, of the new MOp.

Regarding this matter, during interviews conducted by the SIPAER Investigation Committee, it was found that some ATCOs believed that, after the deactivation of the Supervisor function at 22:00, the controller previously designated for this function ceased to be responsible for overseeing the control and surveillance actions carried out by the other on-duty ATCOs – as provided in item 4.2.1 Duties of the Supervisor Position, subparagraphs (n) and (z), of the TWR-GL MOp - even while remaining in the operational environment and performing ground traffic coordination, as in the occurrence in question.

Based on this interpretation, the on-duty Supervisor considered themselves prevented from instructing the ATCO at the TWR Control position to abort the takeoff of aircraft PS-GPP, as well as from assisting controllers in emergency response procedures.

In this context, despite the improvements implemented in the MOp, it is evident that there is a need to include - both in this document and in CIRCEA 100-57, which addresses the MOp for all ATC Units – guidelines establishing clearer and more objective criteria on the termination of duties associated with each operational function.

Operational safety within the scope of ATS is intrinsically linked to the existence of clear, precise, and properly structured regulatory and procedural documentation.

The MOp, as a tool supporting operations, must ensure the correct definition of responsibilities, duties, and procedures applicable to each operational position. A lack of clarity in descriptions, as well as the existence of gaps or ambiguities, directly compromises the effectiveness of coordination, surveillance, and communication, negatively impacting controllers' situational awareness.

This scenario increases the potential for operational errors, such as task conflicts, omissions in vehicle and aircraft control on the maneuvering area, and consequently, an increased risk of occurrences such as runway incursions or loss of separation.

Therefore, the revision and improvement of the MOp not only meet the principles of document compliance but are also fundamental risk mitigation measures within the SMS context, directly contributing to the preservation of safety in aerodrome operations.

4.2.6 The Safety Management System (SMS)

The Safety Management System, internationally recognized as SMS, is essentially a total quality program focused on flight safety. It is based on the continuous improvement of safety levels within a proactive approach, driven primarily by the encouragement of voluntary hazard reporting and risk management.

SMS implementation is grounded in the promotion of a safety-oriented culture, risk-based management, continuous process improvement, data-driven decision-making, and ongoing monitoring of the effectiveness of adopted measures.

According to ICAO Annex 13, accident or incident investigations conducted by the State must analyze the SMS of the service providers involved. This directive is detailed in Doc 9756 – Manual of Aircraft Accident and Incident Investigation, especially in Part III, which deals with investigative procedures.

Doc 9756 – Part III states that the analysis of SMS performance is essential to identify organizational and systemic factors that may have contributed to the event. This includes evaluating whether hazards were properly identified, whether risks were effectively managed, and whether corrective actions were appropriately implemented.

Moreover, the document emphasizes the importance of examining the organization's safety culture, the effectiveness of internal communications, and the ability to learn from past events. These elements are fundamental to understanding contributing factors to an accident or incident and to developing safety recommendations that prevent future occurrences.

The CRCEA-SE's SMS Manual aimed to establish guidelines and direct the management of the SMS at the ANSP units under the Regional Center – including the Airspace Control Detachment of *Galeão* (DTCEA-GL), responsible for *Galeão* Control Tower (TWR-GL).

With regard to operational risk management, the ANSP units, as provided in the SMM, were to maintain formal and traceable processes for monitoring operational safety and the continuous identification of hazards in the provision of air navigation services. All identified hazards were to be recorded in a unified database and analyzed by the Local Operational Safety Committee (CLSO), with the goal of monitoring their recurrence and assessing the effectiveness of adopted mitigating measures.

Operational Safety Risk Management was to be applied whenever a hazard was identified, following the steps of identification, assessment, classification, mitigation, and risk control, ensuring that risks remained under control and that safety objectives were met.

The SIPACEA of CRCEA-SE was responsible for monitoring and supervising these processes through VSOs, Operational Safety Management Advisory databases, safety reports, and other tools. The sources for hazard identification included mandatory and voluntary reports, inspections, communication monitoring, surveys on operational factors, and other relevant sources.

Regarding the latter two items, the SMM established that ANSP units providing TWR services with more than 50,000 operations per year – such as DTCEA-GL – were to systematically conduct operational factor surveys during normal operations. Additionally, other sources could be used for hazard identification, such as Investigation Reports of the Airspace Control (RICEA) and ATS Technical Opinions.

However, the recurrence of operational errors and the systematic noncompliance with ATS standards – such as the non-use of headsets, non-operational conversations during service, use of mobile devices in the control room, lack of runway visual scanning, failures in ATS supervision, and an excessively informal environment – revealed systemic shortcomings in the effectiveness of hazard identification and the implementation of corrective actions.

This recurrence may be associated with several factors, notably: superficial analysis of contributing factors to ATS occurrences, resulting in merely palliative measures; lack of continuous monitoring of the effectiveness of corrective actions; fragility of the organizational culture, which tends to tolerate deviations or fails to promote engagement with proposed improvements; and the absence of robust indicators to measure, over time, the performance of implemented actions.

As set forth by ICAO Annex 19, SMS requires not only the adoption of corrective actions following events but also the systematic validation of their effectiveness through internal audits, safety data analysis, operator contributions, and periodic risk reassessments.

When these stages are disregarded, organizations tend to treat symptoms rather than the structural causes of problems, thereby perpetuating failures and undermining the continuous improvement cycle.

Therefore, the recurrence of operational errors in an environment where an SMS has been implemented is, in itself, an indicator of noncompliance with the fundamental principles of the System – particularly in regard to risk management, organizational learning, and the effectiveness of mitigation actions.

To reverse this scenario, it is essential to adopt a systematic and comprehensive, data-driven approach focused on organizational learning and the strengthening of just culture, ensuring that each occurrence effectively contributes to the overall improvement of the system.

In this context, it is important to note that some corrective actions taken by TWR-GL following this serious aeronautical incident – such as identifying an excessive number of vehicles operating in the maneuvering area and later implementing specific service lanes for such vehicles, as described in section 5 *Corrective or Preventive Actions Taken* – show that those risks already existed before the event and could have been mitigated with a broader and more comprehensive approach.

Following SMS principles, such measures should have been anticipated through the analysis of potential hazards, operational observations, internal audits, or voluntary reports, as provided for in CRCEA-SE's SMM.

This situation highlights – not only for TWR-GL but also for other ANSP units – the relevance of effective risk management structures capable of identifying unsafe conditions and patterns before they escalate into serious occurrences, in line with the safety philosophy proposed by the Safety Management System.

Furthermore, the proactive and predictive approach of SMS is not limited to internal hazard identification and risk mitigation. It also involves the continuous observation of the external operational environment, particularly through the pursuit of best practices adopted by similar organizations.

This process of safety benchmarking enables the adaptation and incorporation of lessons learned, risk control methodologies, and safety management innovations successfully implemented elsewhere, thereby strengthening the overall SMS performance.

In this regard, the corrective action of inserting functional strips into TATIC for vehicles entering the maneuvering area - adopted by TWR-GL following the aircraft-vehicle collision, as described in item 5 – Corrective or Preventative Actions Already Taken – had already been successfully used for several years by TWR-BR, demonstrating both effectiveness and low operational cost.

By analyzing data and practices from similar organizations - such as other ANSP units - it is possible to anticipate risks that have not yet materialized locally but have already been faced by other providers. In doing so, SMS moves beyond a reactive system based on isolated actions and evolves into a more mature posture grounded in collective intelligence and systematic, strategic prevention.

In summary, proactive and predictive analysis, combined with the sharing of best operational practices among similar organizations, can decisively contribute to the continuous advancement of safety within the civil aviation system. In this context, SMS should not be regarded by ANSPs as a mere procedural formality. Its guidelines must be effectively incorporated into the operational routine and rigorously implemented by ANSP units, with the aim of enhancing the safety level of operations within the scope of SISCEAB.

3. CONCLUSIONS.

3.1. Findings.

a) the pilots and the air traffic controllers involved in the occurrence held valid CMAs (Aeronautical Medical Certificates);

b) the pilots held valid type ratings for the B739 aircraft, as well as valid ratings for MLTE and IFRA;

c) the air traffic controllers involved in the occurrence held valid licenses and ratings;

d) the pilots were qualified and experienced in the type of flight;

e) the aircraft had a valid CA (Certificate of Airworthiness);

f) the meteorological conditions were favorable for the conduction of the flight;

g) the Supervisor of TWR-GL authorized the night-lighting maintenance vehicle to enter runway 10 for inspection;

h) the ATCO of the TWR position carried out the locking procedure on the TATIC display;

i) approximately three minutes later, the ATCO of the TWR position unlocked the TATIC display and authorized the takeoff of aircraft PS-GPP on runway 10 while the maintenance vehicle was still on the runway;

j) the aircraft collided with the maintenance vehicle the center of runway 10, between taxiway entries BB and CC;

k) the aircraft sustained minor damage;

l) the vehicle sustained substantial damage;

m) the crew and passengers were uninjured; and

n) the vehicle occupants sustained minor injuries.

3.2. Contributing factors.

- **Attention – a contributor.**

The presence of distracting stimuli in the control room led to reduced selective attention, the occurrence of lapses, and loss of situational awareness, impairing risk perception and timely decision-making. As a result, the ATCO performing the TWR Control function did not pay attention to the operational scenario at the time of the occurrence and cleared the takeoff of aircraft PS-GPP on runway 10, which was occupied by a maintenance vehicle.

- **Attitude – a contributor.**

The ATCO performing the TWR Control function did not conduct a visual scan of the runway, evidencing an attitude of noncompliance with the established operational procedures.

At the time of the occurrence, the Supervisor was not attentive to the activities being carried out by the on-duty controllers, as he was handling a cell phone, diverting from his duty to maintain continuous supervision. Furthermore, the passive stance adopted during and after the emergency proved inadequate, contrary to the responsibilities inherent to the role.

- **Work group culture – a contributor.**

The climate of excessive informality, tolerance for cell phone use, and non-operational conversations revealed a permissive group culture that normalized behaviors incompatible with operational safety, fostering the repetition of errors and weakening defensive barriers.

Furthermore, during interviews conducted by the SIPAER Investigation Committee, it was found that some ATCOs believed that, after the formal deactivation of the Supervisor function at 22h00min, the controller previously designated for this role ceased to be responsible for monitoring the control and surveillance actions performed by the other on-duty ATCOs.

Based on this mistaken interpretation, the controller who had been acting as Supervisor considered himself exempt from the responsibility of instructing the ATCO at the TWR Control position to abort the takeoff of aircraft PS-GPP, as well as from providing proper support to the other controllers in the emergency response actions.

- **Organizational culture – a contributor.**

The recurrence of operational failures, even after similar events, combined with the low effectiveness of the corrective actions adopted, revealed weaknesses in the organizational culture. The tolerance of behaviors not in compliance with standards and regulations – particularly regarding cell phone use and failure to use headsets – pointed to shortcomings in the institutional mechanisms for positively reinforcing a safety culture.

- **Team dynamics – a contributor.**

Failures were observed in the interaction among members of the TWR-GL team, characterized by the absence of support from the Supervisor, confusion among the ATCOs after the collision, and inefficiency in task management at this critical moment. These aspects indicated dysfunctions in mutual collaboration mechanisms, which compromised the effectiveness of the services provided by TWR-GL and the timeliness of actions related to the emergency response in the context of the occurrence.

- **Memory – a contributor.**

The omission of the runway visual scan and the verification of the locking screen on the TATIC system evidenced operational lapses related to memory failures associated with the execution of routine procedures. Such lapses were exacerbated by distractions and interruptions in the operational environment, which impaired the retention and retrieval of critical information.

As a result of this memory lapse, the ATCO responsible for the TWR Control function inadvertently cleared the aircraft for takeoff while the runway was still occupied by a vehicle, contributing to the occurrence.

- **Perception – a contributor.**

The failure to perceive the vehicle on the runway indicated impairments in the process of organizing and interpreting environmental stimuli and revealed a degraded state of situational awareness, which facilitated the continuation of an incorrect operational procedure.

Thus, by not correctly perceiving the scenario and its critical elements, the ATCOs were unable to anticipate the high probability of a collision between the aircraft and the vehicle, compromising the safety of the operation.

- **Decision-making process – a contributor.**

The decision to maintain the takeoff clearance, even after recalling the presence of the vehicle on the runway, evidenced a failure in the controllers' decision-making process. The hesitation to cancel the clearance revealed poor judgment and difficulty in assessing the risks, compromising timely analysis of the scenario.

Had the clearance been revoked within seconds after the recollection, the aircraft would have initiated a low-speed rejected takeoff, allowing it to come to a safe stop before the collision. Thus, the ATCOs' incorrect decision proved to be a determining factor for the event, highlighting deficiencies in identifying viable alternatives and executing an appropriate response in the face of imminent risk.

- **Organizational processes – a contributor.**

Although mitigation measures had been adopted, the persistence of the same operational behaviors demonstrated their ineffectiveness in addressing the contributing factors identified in previous events. This indicated the need to revise organizational strategies, focusing on actions that would strengthen the safety culture, the effectiveness of operational barriers, and governance over critical processes. In this way, the prevailing organizational system contributed to the persistence of significant operational vulnerabilities.

- **Supervision (ATS) – a contributor.**

In the moments leading up to the collision between the aircraft and the vehicle, the Supervisor did not adequately monitor the control and surveillance actions performed by the ATCO responsible for the TWR Control position. Such monitoring could have enabled a timely and assertive intervention capable of preventing the occurrence.

- **Managerial oversight (ATS) – a contributor.**

The recurrence of operational errors and of the corrective actions adopted revealed shortcomings in the oversight exercised by CRCEA-SE, whose duties included ensuring compliance with applicable regulations, guaranteeing the effectiveness of the SMS, and promoting an organizational culture focused on operational safety.

4. SAFETY RECOMMENDATIONS

A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident.

In consonance with the Law n°7565/1986, recommendations are made solely for the benefit of safety, and shall be treated as established in the NSCA 3-13 "Protocols for the Investigation of Civil Aviation Aeronautical Occurrences conducted by the Brazilian State".

To DECEA (Department of Airspace Control), it is recommended:

IG-029/CENIPA/2025 - 01 **Issued on: 07/31/2025**

Evaluate the adequacy of including in CIRCEA 100-57 clear guidelines on the remaining responsibilities of ATCOs after the formal deactivation of functions, particularly that of Supervisor, in order to avoid ambiguities, ensure the continuity of surveillance, and maintain situational awareness in the operational environment, especially during critical situations.

IG-029/CENIPA/2025 - 02 **Issued on: 07/31/2025**

Work with CRCEA-SE to reassess its processes for monitoring and measuring operational safety performance, aiming at the continuous improvement of its SMS.

IG-029/CENIPA/2025 - 03 **Issued on: 07/31/2025**

Analyze the relevance of including the concept of *hot spots* in ICA 81-4, with clear guidance on its application in visual scan and runway coordination procedures, to enhance situational awareness regarding the risks involved in operations conducted at these locations.

IG-029/CENIPA/2025 - 04 **Issued on: 07/31/2025**

Work with CRCEA-SE to ensure that periodic assessments of the organizational culture are carried out, focusing on the promotion of a just culture, so that operators feel safe to report errors, reducing barriers to immediate corrective action.

IG-029/CENIPA/2025 - 05 **Issued on: 07/31/2025**

Evaluate, in coordination with ANAC, the feasibility of implementing the principle "One Runway, One Frequency" at class III and IV aerodromes, conducting all communications with vehicles and aircraft operating on the same runway on a single frequency, preferably VHF, as recommended in ICAO Doc 9870.

IG-029/CENIPA/2025 - 06 **Issued on: 07/31/2025**

Evaluate the possibility of implementing the concept of a "Sterile Control Room," with a total restriction on the use of mobile devices and non-operational conversations, in accordance with international best practices.

IG-029/CENIPA/2025 - 07 **Issued on: 07/31/2025**

Work with DTCEA-GL, in coordination with RIOgaleão, to ensure the absence of natural or artificial obstacles that could cause any visibility restrictions, limiting effective supervision of taxiways and runways at the aerodrome.

IG-029/CENIPA/2025 - 08 **Issued on: 07/31/2025**

Disseminate the lessons learned from this investigation to air navigation service providers, to raise situational awareness, emphasizing the mandatory use of headsets, the ergonomic adequacy of workstations, and the importance of visual scanning of the runway and constant monitoring of all ongoing operations.

TO ANAC (National Civil Aviation Agency), it is recommended:

IG-029/CENIPA/2025 - 09 **Issued on: 07/31/2025**

Evaluate, in coordination with DECEA, the feasibility of implementing the principle "One Runway, One Frequency" at class III and IV aerodromes, conducting all communications with vehicles and aircraft operating on the same runway on a single frequency, preferably VHF, as recommended in ICAO Doc 9870.

IG-029/CENIPA/2025 - 10 **Issued on: 07/31/2025**

Work with RIOgaleão, in coordination with DTCEA-GL, to ensure the absence of natural or artificial obstacles that could cause any visibility restrictions, compromising effective supervision of taxiways and runways at the aerodrome.

Disseminate the lessons learned from this investigation to operators of class III and IV aerodromes, so that the risks identified in this report are shared during internal events promoting operational safety.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

Immediately after the serious aeronautical incident, the following actions were taken by DTCEA-GL:

Regarding the ATCOs involved:

a) Immediate removal from operational duty roster;

b) Psychological support provided shortly after the accident;

c) Referral to CEMAL for Letter (P) Health Inspection on the morning of February 12, 2025.

Regarding the operational personnel:

d) Monitoring of team operational briefings for one week by the TWR-GL Chief;

e) Presentation of the topic “Runway Incursion” by Operational Doctrine personnel, based on the CAOP between RIOgaleão concessionaire and TWR-GL;

f) Meeting held between the DTCEA-GL Commander and the TWR-GL staff;

g) Participation of the CRCEA-SE Commander in the TWR-GL duty briefing.

Regarding ATS procedures:

a) Implementation of the procedure for creating a functional strip in the TATIC and use of red LED lights on the TWR-GL consoles to indicate runway occupancy by vehicles, in accordance with the procedure adopted by TWR-BR as referenced in item 1.19.3 – *Technologies* – for the prevention of runway incursions;

b) Revocation of item 4.2.1, subitem “ii,” of the TWR-GL Operational Model, with permanent activation of the Coordinator position on a 24-hour basis;

c) Start of the revision process for updating the CAOPs between TWR-GL and RIOgaleão Concessionaire, as well as the TWR-GL Operational Model (MOp);

d) Meeting with the RIOgaleão Concessionaire to discuss improvements in the circulation of service vehicles, including the completion of the service road parallel to Taxiway M;

e) Implementation of a vehicle control spreadsheet;

f) Change in the modus operandi for updating the MOp and CAOPs, now with full involvement of all personnel;

g) Execution of the Coordinator Improvement Program (PAC);

h) Replacement of the chairs used in the operational environment with the aim of improving ergonomics and the line of sight of the ATCOs during operational activities.

In addition to the corrective and preventive measures mentioned above, two extraordinary meetings of the Runway Safety Team (RST) were held, during which the following matters were discussed with airport administration:

1st Extraordinary RST Meeting with the Concessionaire on February 18, 2025

- Excessive number of vehicles operating in the maneuvering area;
- Need to construct service roads to reduce the communication channel load caused by traffic of vehicles;
- Need to trim trees that obstruct visibility along segments of the 10/28 runway system;
- Possibility of equipping vehicles with VHF radios tuned to the Tower frequency, to enhance situational awareness for drivers accessing protected areas;
- Establishment of more appropriate time windows for performing runway services.

2nd Extraordinary RST Meeting with the Concessionaire on March 19, 2025

- Involvement of TWR-GL in revising the training syllabus on Runway Incursion Prevention provided by RIOgaleão, with emphasis on phraseology in accordance with CIRCEA 100-86;
- Delivery of Runway Incursion Prevention training by the airport administration to the drivers involved in incidents recorded in the TWR-GL's Occurrence Logbook (LRO);
- Weekly reports from the RIOgaleão to the TWR-GL on scheduled maintenance activities within the maneuvering area, for inclusion in the TWR's daily activity spreadsheet;
- Installation of new surveillance cameras to mitigate visibility issues faced by TWR-GL in blind spots of the aerodrome.

Immediately following the serious aeronautical incident, the aerodrome operator implemented the following actions in the areas of communication, training, infrastructure, and procedures:

a) recommendation for the use of spare transceivers with active listening on TWR-GL frequency and interference blocking, for RIOgaleão and contracted companies' teams;

b) issuance of Safety Bulletin No. 14-2025 on the use of standardized aeronautical phraseology, as provided in ICA 100-37, MCA 100-16 and CIRCEA 100-86;

c) holding of Mandatory briefings for construction and maintenance activities in the maneuvering area;

d) awareness campaigns on runway incursion prevention aimed at pedestrians;

e) defensive driving training for operations in the airport environment;

f) delivery of runway incursion prevention training specifically for drivers operating in the maneuvering area;

g) training of the Airport Firefighting Team focused on route recognition to runway thresholds, considering both runway systems; updating of operational safety requirements, including mandatory runway incursion prevention training for vehicle escorts in the operational area;

h) revision of the runway incursion prevention training matrix, adding escorts as a target audience, with practical assessment and TWR-GL participation in instruction sessions;

i) reinforcement of standardized aeronautical phraseology in briefings for construction and maintenance activities in the maneuvering area;

j) development of feasibility studies for implementing runway incursion mitigation technologies (active/passive radars);

k) sharing of the weekly schedule of ongoing contracts within the maneuvering area with DTCEA-GL, including vehicle identification;

l) inclusion of operational spot checks ("*blitz*")[25] in the maneuvering area in the annual Safety action calendar;

m) integration of the Daily Planning Procedure (PPD) activities with current NOTAMs;

n) monitoring and maintenance of the RWY lighting system by the airport maintenance contractor team, in coordination with the AIRSIDE team;

o) request submitted to DTCEA-GL for the implementation of a dedicated controller position for monitoring vehicles in the maneuvering area, until complementary mitigation technologies are adopted.

p) study to enable the replacement of the vehicles' beacons (*giroflex*) with models offering greater visibility.

On July 31th, 2025.

[25] In the maneuvering area of an aerodrome, a "blitz" refers to an inspection and oversight action carried out by the authorities to ensure operational safety, verifying compliance with established rules and procedures.
This oversight may involve the inspection of vehicles, equipment, and safety procedures, with the aim of preventing incidents and ensuring the safety of air operations.