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An Evaluation of the Operational Restrictions Imposed to Congonhas Airport by IAC 121-1013

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An Evaluation of the Operational Restrictions Imposed to Congonhas Airport by Civil Aviation Instruction 121-1013

Embry-Riddle Aeronautical University

Aviation Management Program – Class of 2019

EMBRY-RIDDLE
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CENTRAL & SOUTH AMERICA

AN EVALUATION OF THE OPERATIONAL RESTRICTIONS IMPOSED TO CONGONHAS AIRPORT BY CIVIL AVIATION INSTRUCTION 121-1013

by

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MARCUS CAMARGO

A Capstone Project Submitted to Embry-Riddle Aeronautical University in Partial Fulfillment of the Requirements for the Aviation Management Certificate Program

Embry-Riddle Aeronautical University
Sao Paulo, Brazil
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This Capstone Project was prepared and approved under the direction of the
Group's Capstone Project Chair, Dr. Leila Halawi
It was submitted to Embry-Riddle Aeronautical
University in partial fulfillment of the requirements
for the Aviation Management
Certificate Program

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Subject-Matter Expert

Date

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Abstract

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Title: An Evaluation Of The Operational Restrictions Imposed To Congonhas Airport By IAC 121-1013

Institution: Embry-Riddle Aeronautical University

Year: 2019

The objective of this study is to propose a review of the operational restrictions imposed on Congonhas airport by IAC 121-1013, seeking a balance between flight safety and operational efficiency.

The researchers calculated the landing performance (using specific software), taking into account particular aircraft system failures that increase landing distance. The results indicated that the measures imposed by the IAC have little or no effect on the operational safety increase. Additionally, the restrictions created operational complexity for the airport and reduced its efficiency by impacting airline costs. At the end of the study, the researchers suggest a reissue of the IAC based on the data presented.

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Chapter I

Introduction

São Paulo - Congonhas Airport is the second busiest airport in the country. It represents one of the essential hubs for business and figures as the most profitable route in Brazilian domestic operation, being the connection between Rio de Janeiro and São Paulo. Its strategic location, in the center of Sao Paulo, benefits the agenda of businesspeople, allowing quick access from the office to air transportation. In 2018, more than 21 million passengers passed through Congonhas Airport.

The airport was founded in 1936, and the city of Sao Paulo developed around the airport. The city growth limited the possibilities of building a better passenger terminal and runways. At the same time, there is no medium-term alternative to offer air transport for more than 21 million people attended by the airport.

In July of 2007, Congonhas airport runway was the protagonist of the most significant Brazilian air crash in history, where 199 people died. An Airbus 320 from TAM Airlines performed a runway excursion and collided with a building nearby the runway threshold.

The accident caused a huge national commotion, demanding immediate official actions and measures to prevent new events from taking place in the airport. At that time, media speculations stated that the junction of a considerably short runway with a potentially slippery runway condition, associated with the heavy-aircraft operation, was incompatible and significantly dangerous.

Together with these assumptions, the aircraft involved in the accident was dispatched with one Engine Thrust Reverser inoperative (which is a routine operational condition). But under the public sight, the lack of an engine reverse sounded like one of the first accident causes. Consequently, the intense public pressure over the government led the authorities to untimely restrict the Airport operation.

Project Definition

Congonhas airport operational limitations were implemented before the conclusion of the official investigation.

In other words, the operational limitations measures were imposed to give a quick answer to the public outcry increasing the airport operational safety margin.

More than ten years after the accident, the researchers' focus is understanding if the limitations imposed on the airport operation indeed represent an increase in safety margin avoiding a new event. Or, if the constraints are oversized, raising costs solely, without a definite increase in safety. At the same time, the researchers will highlight the impact on the airport operation.

These restrictions were issued during the investigations and implemented through the Civil Aviation Instruction IAC 121-1013, published on April 1st, 2008, impacting the heavy-jets operation and, as a result, the airlines.

Below are the IAC 121-1013 main restrictions:

- Minimum Equipment List
- Limitation of Extra Fuel load
- Wet runway landing obligations:
- Prohibition of takeoff and landing

Project Goals and Scope

Until now, the same restrictive measures remain in effect. The central objective of this study case is to deep-dive into Congonhas IAC121-1013 measures, analyzing its technical background and safety effectiveness. At the same time, the researchers will evaluate which measure the Advisory Circular hits the spot, increasing safety, and which is only detrimental to the efficiency of air transportation.

As CGH is one of the most critical HUBs in the country, any limitation to its capacity represents a significant impact on airlines and users. In the limit, lower capacity means higher fares.

Since the event of the accident, several technologies have been implemented by the aircraft manufacturers, which allow the pilot to evaluate in a more precise way the impact of any failure in the landing distance performance.

This study will expand the analysis of the measures applied to the Congonhas Airport through the IAC121-1013, highlighting the actual causes of the accident based on the official conclusive investigation.

One of the new technologies the researchers will explore during our study is the use of Electronic Flight Bag (EFB).

The implementation of the landing performance assessment through EFB allows pilots to have a realistic scenario and precise calculation of the landing condition, even in the case of failures or items deferred by the aircraft Minimum Equipment List (MEL).

The result of this study will be presented to the aeronautical authority. The researchers will request to revisit the restrictions imposed by the IAC 121-1013 and propose new measures foreseeing to make aircraft operation in CGH more efficient as well safe.

Definitions of Terms

Actual Landing Distance	is the distance used in landing and braking to a complete stop (on dry runway) after crossing the runway threshold at 50 feet.
Electronic Flight Bag	is an electronic device that helps flight crews perform flight management tasks more quickly and efficiently, providing precise calculations and information.
Extra fuel	Additional fuel supplied above the minimum required by legislation
Landing distance	Actual landing distance is the distance used in landing and braking to a complete stop (on a dry runway) after crossing the runway threshold at 50 feet.
Minimum Equipment List	is a list that provides for the operation of aircraft, subject to specified conditions, with particular equipment inoperative (which is) prepared by an

	operator in conformity with, or more restrictive than, the MEL established for the aircraft type.
Required Landing Distance	is the distance obtained through the application of a factor to the actual landing distance.
Runway Excursion	A veer-off or overrun off the runway surface.

List of Acronyms

AC	Advisory Circular
AFM	Aircraft Flight Manual
ALD	Actual Landing distance
ANAC	Agência Nacional de Aviação Civil
ARC	Abnormal Runway Contact
CENIPA	Aeronautical Accident Investigations and Prevention Center
CFIT	Controlled Flight IntoTerrain
CGH	IATA code for Congonhas airport
EFB	Electronic Flight Bag
FCOM	Flight Crew Operating Manual
IAC	Civil Aviation Instruction
LOC-I	Loss of Control in Flight
MEL	Minimum Equipment List

TALPA ARC	Takeoff and Landing Performance Assessment Aviation Rulemaking Group
RE	Runway Excursions
RESA	Runway End Safety Area
RBAC	Regulamento Brasileiro de Aviação Civil
RLD	Required Landing Distance
SCF	System/Component Failure
SOP	Standard Operating Procedure

Plan of study

The researchers will evaluate the restrictions currently applied at Congonhas airport after the 2007 accident. This analysis will include four parts: an introduction; an in-depth review of all the regulations regarding the landing safety, the basic regulation like RBAC 121, and an analysis of the restrictions applied in CGH.

In part three, the researchers will review all the restrictions applied through the IAC 121-1013 in Congonhas airport, analyzing the effectiveness of the landing safety.

Finally, in part four, the researchers will present a proposal for the IAC 121-1013 based on the conclusions of this study.

Chapter II

Review of the Relevant Literature

Introduction

To understand all the motivations behind the CGH IAC 121-1013 as well as the characteristics of Congonhas Airport at the time the restrictions were published, the researchers will present relevant regulation and documentation that in this chapter.

Two pillars are considered fundamental by the researchers to perform air transportation. The first pillar is the safe conduction of operation, and the second is the economic viability of the operation and its efficiency.

Therefore, the researchers are committed to understanding to which extent the operation limits imposed to Congonhas Airport operation indeed became safety improvements, and what represents efficiency loss solely.

Background

In 1996, eleven years before the 2007 accident, Congonhas Airport was the scene of a Fokker 100 crash, killing more than 100 people a few minutes after takeoff.

The cause of the accident was a failure in the aircraft's reverser system that was spuriously deployed, not allowing the plane from flying after takeoff.

Due to the repercussion of this accident and other minor crashes, the airport is known by the public’s opinion as a critical airport and has always been in the headlines of Brazilian newspapers.

At the beginning of 2007, the pavement of the runway at Congonhas airport was restored. The purpose of the work was to eliminate the surface irregularities and prevent water accumulation, which was both considered a chronic runaway problem.

The process of restoring the runway pavement was done in steps. After the pavement restore process was ready, more time was needed until the runway could be grooved (cuts in the runway surface transversely to the pavement centerline).

The airport authority decides to authorize the runway operation with the grooving pavement service not ready to avoid operational disruptions.

Aeronautical Accidents Categories

To better understand and separate similar events, the accidents are classified. Aviation organizations worldwide define more than 40 different accident categories. According to the study, A Statistical Analysis of Commercial Aviation Accidents 1958-2018 (AIRBUS, 2019), the five more significant accident categories are:

- **Runway Excursion (RE)**: a lateral veer off or longitudinal overrun off the surface, not caused by any system failure or malfunction or abnormal runway contact. Therefore, the TAM accident is classified as a RE.
- **System/Component Failure or Malfunction (SCF)**: Failure or malfunction of an aircraft system or component, related to either its design, the manufacturing process, or a maintenance issue, which leads to an accident. SCF includes the powerplant, software, and database systems.

- **Loss of Control in Flight (LOC-I):** Loss of aircraft control while in flight, not primarily due to SCF.
- **Abnormal Runway Contact (ARC)**: Hard or unusual landing, not primarily due to SCF, leading to an accident.
- **Controlled Flight Into Terrain (CFIT)**: In-flight collision with terrain, water, or obstacle without indication of loss of control.

According to the Airbus study, Runway Excursions (RE), including both lateral and longitudinal types, are the third more important cause of fatal accidents by numbers, and the single most significant cause 15% of hull losses. (AIRBUS, 2019)

In Figure 2.1 below, the researchers can see how significant the contribution of runway excursions to total accidents is, where more than 35% result in aircraft losses.

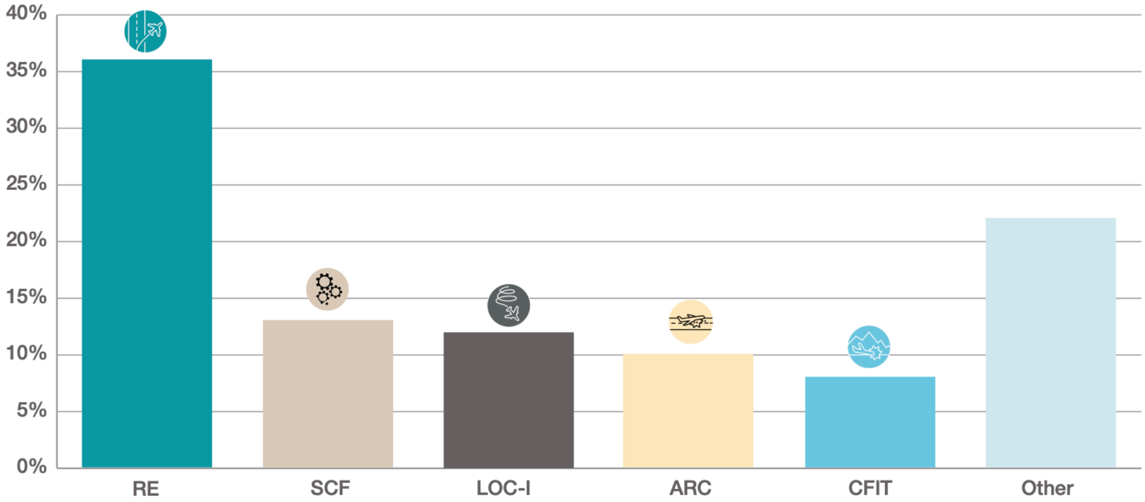


Figure 2.1 - Percentage of hull losses by accident category 1999-2018

Runway Excursions are very related to the subject of takeoff and landing performance assessment, the researchers recognize the importance of this data, with significant industry efforts to reduce these numbers. The researchers consider any reduction in the operating safety margins to be non-negotiable.

One of the last efforts to avoid RE was the development of a new methodology for conveying current runway conditions. This methodology is based on recommendations from the Takeoff and Landing Performance Assessment (TALPA) Aviation Rulemaking Committee (ARC). These recommendations are currently being adopted in Brazil, and it has already been implemented in takeoff and landing performance assessment throughout the Electronic Flight Bag (EFB).

JJ3054 2007 Air Crash in Congonhas Airport

On 17 July 2007, the flight JJ3054, an Airbus model 320 (registration PR-MBK), departed from Porto Alegre (POA) to Congonhas Airport (CGH) with 181 souls on board. The flight can be considered as routine up to the landing.

One central issue was that the plane was dispatched with Engine two reverser pinned (de-activated), by MEL.

Before JJ3054 landing, according to CENIPA’s Final Report, Congonhas Tower informed that the active landing runway (RWY35L) was wet and slippery. As stated in the background section, to avoid disruptions in air operations, the airport authority decided to authorize the runway operation without the grooving pavement.

During the landing run of JJ3054, the aircraft didn't slow down as expected, leading to a runway excursion, overrunning the left edge of the runway near the departure end. The plane crossed over the Washington Luís Avenue and collided with a building and with a gas station. All souls on board plus 12 people on ground perished (CENIPA,2009, pg.71).

According to CENIPA, the inoperative Engine Reverse played a central role in the accident. Table 2.1 below shows several occurrences related to mistaken thrust levers setting. The pinned reverser landing procedure is directed related to these incidents, which are not limited to Airbus aircraft:

DATE	AIRCRAFT	LOCATION
08/Apr/1983	B747	Karachi – Pakistan
30/Mar/1985	A300	Perpignan – France
06/Apr/1987	B747-300	Rio de Janeiro – Brazil
12/Sept/1998	DC-10	Denver - USA
22/Mar/1998	**A320**	Bacolod – Philippines
28/Aug/2002	**A320**	Phoenix – USA
18/Oct/2004	**A320**	Taipei – Taiwan
05/Nov/2005	B747	Paris – France
19/Dec/2003	B737	Libreville - Gabon
14/Dec/2005	B747	McGuire AFB – USA
12/Jun/2006	A310	Irkutsk - Russia

Table 2.1 - Accidents related to a mistaken thrust lever setting (CENIPA, 2009, pg. 58)

Among the accidents listed in table 2.1, two occurred in similar conditions as the flight JJ3054: Philippines and Taiwan. In both cases, one reverser was deactivated (pinned). And pilots kept one thrust lever in CL position, bringing only one thrust lever to IDLE, preventing the aircraft from decelerating.

Due to these events, Airbus changed the A-320F MEL pinned reverser landing procedure regarding the thrust levers setting after touchdown.

Aiming to make the pilot job simpler, Airbus made the procedure the same as the standard landing procedure with both reversers available. So, at the time of the TAM accident, the landing with one inoperative reverser MEL procedure required that after touchdown, both thrust levers moved to "REV," instead of only one lever.

When the Digital Flight Data Recorder (DFDR) was decoded, investigators concluded that “the FDR did not record any thrust lever movement of the number 2 engine (the one with the pinned reverser), from the moment it was positioned at “CL”, up to the collision of the aircraft”(CENIPA, 2009,pg.74).

With one thrust lever in CL position and the other in IDLE, JJ3054 aircraft had one engine still producing forward thrust, and one engine reversing. Consequently, the spoilers and auto brake also didn’t activate. The aircraft kept high speed consuming the total length of the runway, with energy high enough to veer off and crash into the buildings on the other side of the avenue.

The CENIPA Final report issued several recommendations to the Congonhas airport operators. One of the restrictions was the prohibition of operation when the aircraft presents one reverser inoperative. According to CENIPA Final Report:
“Despite the fact that the reverser is a complementary decelerating system not considered for the calculation of the landing distance (dry runway), it is a component whose contribution to the braking of the aircraft is significant. Especially when operating on the runway with reduced dimensions and with a problematic historical background, as was the case of the Congonhas runway” (CENIPA Final Report, pg. 81).

According to CENIPA Final Report, the inoperability of one engine reverser could have somehow influenced the pilot, from a psychological perspective, although the flight was conducted following the manufacturer recommendations to this failure.

Congonhas Civil Aviation Instruction - IAC 121-1013

One of the ANAC regulatory publications is the Civil Aviation Instruction (IAC). The IACs aims to establish procedures or clarify rules or requirements contained in the RBAC related to civil aviation (IAC 001-1001A, pg 4). The Brazilian IAC is similar to the FAA Advisory Circular

In April 01st of 2008, ANAC issued the Congonhas Civil Aviation Instruction (IAC 121-1013). The purpose of this IAC was to establish additional technical-operational procedures and requirements necessary to authorize the safe operation of large reaction transport aircraft at Congonhas Airport (São Paulo).

The Congonhas IAC 121-1013 represents a compilation of operational safety recommendations emitted by CENIPA during the accident investigation.

The following IAC 121-1013 restrictions impact on Airline operations:

- Landing operation in the case of any MEL dispatch with inoperative systems that compromise landing performance, such as command surfaces, brakes, reversers, etc.
- Landing operation in the case of In-Flight failures where “inoperative instruments or equipment that compromise the aircraft landing performance, such as command surfaces (ailerons, flaps, slats, spoilers), brakes, reversers, etc.).”
- Wet runway limitation
    - Landing with tailwind
    - Five knots reduction on the FCOM maximum crosswind landing value
    - Takeoff with reduced thrust (Derated or Flex)

- The auxiliary runway operation when transporting passengers is prohibited
- Dispatch limited to 3 tons of EXTRA FUEL.

It is essential to notice that the operational limitation imposed on Congonhas do not touch thrust levers mishandling. The practical result of the industry is a more complex operational scenario for pilots and airlines.

After applying the IAC 121-1013 in routine operation, it became evident that flights are more prone to diversions and cancelations. Once the IAC directives are restricting landings that would be allowable in other similar airports.

For example, suppose that during a regular flight to CGH, the pilot faces a failure in Landing Gear Control and Interface Unit (LGCIU). This failure affects the reverse operation. In terms of performance, there are no landing increments or penalties, but, due to the IAC 121-1013, the flight is forbidden to land in CGH, being forced to divert to another airport.

Congonhas is the second most crucial HUB in Brazil. If even routine minor failures can avoid aircraft from landing in CGH, it is also true that the Maintenance Centers located in Congonhas will be affected. If, in most cases, the aircraft is obliged to divert (to Campinas VCP, for example). The airline has to deal with a double operational disruption: fix the aircraft out of the main Base and also accommodate the passengers of the diverted flight.

On a lower scale, we have the tailwind together with a wet runway prohibition. This limitation follows the same path of all IAC121-1013 restrictions, which does not authorize the landing even if the assessed aircraft performance permits.

A Review of Approach and Landing Regulations

As seen on the IAC 121-1013 section, the Congonhas IAC imposed limits (or prohibition) to the landing operation depending on the aircraft conditions.

Before making any suggestion to the IAC 121-1013, in the first place, it is essential to fully understand the official regulation fundaments behind the Landing Distance assessment.

As previously mentioned, the Runway Excursions (RE), is the third most important cause of fatal accidents, and the single most significant cause of hull (fuselage) losses (AIRBUS, 2019). Therefore, it is crucial to mention all the regulations behind the landing distance calculation as well as the measures taken by the industry to reduce accidents related to a runway excursion.

Definitions

The Approach-and-landing Accident Reduction (ALAR) issued by the Flight Safety Foundation (FSF), defines the Actual Landing Distance (ALD) as the distance used in landing and braking to a complete stop (on a dry runway) after crossing the runway threshold at 50 feet. It represents the landing distance published on the Aircraft Flight Manual (AFM) by manufacturers and is also the origin of all other landing distance calculation (Flight Safety Foundation, 2009)

The Required Landing Distance (RDL) is the distance obtained by the application of a factor to the ALD. RLD is used during the flight dispatch process.

RBAC 121

In Brazil, the flight dispatch process is regulated by the RBAC 121. This regulation is mostly a transcript of the FAR 121, following aviation standard best practices.

The researchers focused on RBAC 121 to highlight the regulation regarding landing performance calculation. RBAC requires that the destination landing distance is calculated before takeoff, during the dispatch process.

According to RBAC 121.195, it is not allowed to take off a turbine engine airplane in such a way that upon arrival, it exceeds the AFM landing weight. In other words, the RBAC 121.195 prevents an aircraft from being dispatched above the maximum landing weight for a given location. Additionally, the RLD should consider the weather forecast for the landing time and apply dry and wet runway safety factors.

Additionally, the RBAC 121.195 says that the aircraft shall land at the destination aerodrome using 60% of the runway length (1.67 factor) and passes 50 feet above the runway threshold (RBAC 121.195, p.45).

Besides, the RBAC 121.195 also states that when the weather forecast indicates that the destination aerodrome runway may be wet or slippery at the estimated landing time, no Dispatch will be allowed unless the runway length is at least 115% (1.92 factor) of the actual landing distance for the specific conditions (RBAC 121.195, p.42).

In figure 2.2 below, the researchers can see the requirements and factors that must be applied to the actual landing distance.

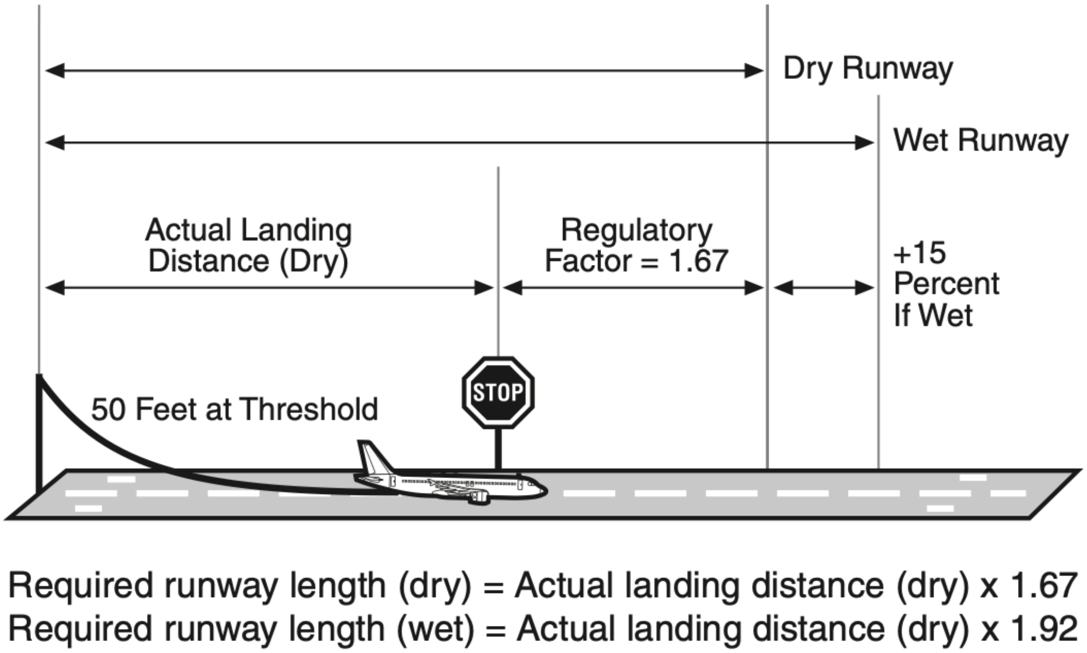


Figure. 2.2 Landing distance dispatch requirements

In simple words, any aircraft must be dispatched to an airport without a landing analysis saying that the actual landing distance multiplied by the factor of 1.67 (dry) or 1.92 (when forecast wet) is following runway length from the destination airport.

The factor mentioned above intends to determine a safe operational runway length and provide a realistic level of performance accounting normal operational variability in day to day service (FAA 121.195):

- Runway surface conditions;
- Piloting techniques;
- Tire and brake deterioration;
- Atmospheric instability such as gusts of wind shear;
- Crosswinds;
- Approach to touchdown; and

- Flightpath deviations.

Runway End Safety Area (RESA)

Several safety recommendations came during the JJ3054 accident investigation, which meant to bring additional safety margins to the Congonhas Airport operation.

On 17th Sept of 2007, CENIPA issued a central recommendation determining the establishment of the Runway End Safety Area (RESA) in Congonhas Airport (CENIPA Final Report, page 103). The proposal is based on the ICAO Annex 14, which establishes high priority to the RESA implementation.

Runway End Safety Area (RESA) can be defined as a symmetrical area along with the runway axis extension, primarily used to reduce the risk of damage to aircraft during takeoff and landing in the event of overshoot, undershoot or excursion (RBAC 154, 2019).

Houses and buildings surround Congonhas Airport; therefore, there was no room to extend the runway to implement the RESA. Consequently, the runway was virtually reduced, to accommodate a 280 meters RESA, following RBAC 154, as shown in figure 2.3.

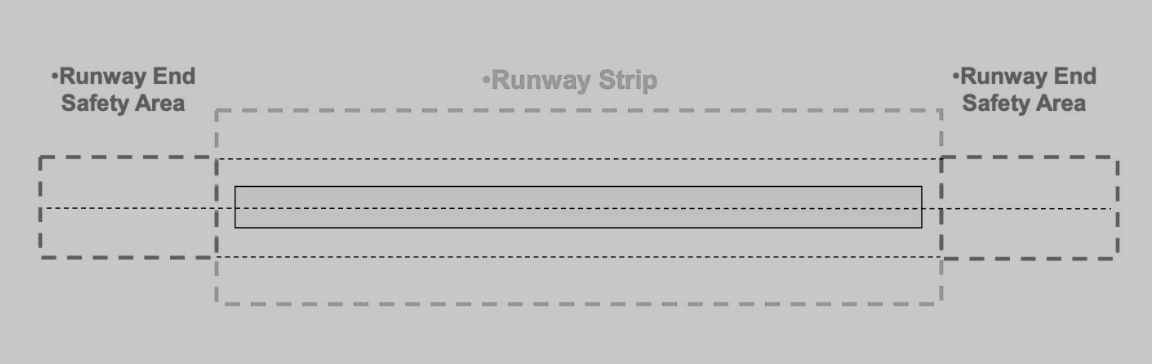


Figure 2.3 Runway End Safety Area (RESA)

In-Flight Landing Distances

After departure, landing distances verified at the flight dispatch process are disregarded. Once airborne, pilots are required to compute the in-flight landing distance, instead of the flight dispatch landing calculations.

The in-flight landing distance assessment takes into account the current aircraft status, actual runway conditions, and possible performance degradation generated by failures during the flight that may affect the landing distance.

The way these in-flight landing distance assessments are performed has significantly changed over the past decade.

Inflight landing distance (IFLD) calculations used to be solely performed thought paper tables available in the cockpit. Such tables required calculations and interpolation methods. Due to the nature of the activity, and considering the cockpit environment, pilot workload, among others, this process could lead to imprecise results. Furthermore, depending on the scenario, such as multiple failures, paper tables can also be challenging and time-consuming.

Electronic Flight Bag (EFB)

The Electronic Flight Bag (EFB) is an electronic management device (portable or installed) that allows pilots to perform the necessary calculations more quickly and efficiently with less paper. It is a computing platform aiming to reduce, or substitute, paper-based material such as performance tables, documentation such as aircraft operating manual, navigational charts (offering moving map for air and ground operations), performance application software designed to automate tasks typically conducted by hand, such as performance take-off and landing calculations (FAA AC 120-76D, 2017). Figure 2.3 is an example of portable and installed EFBs.

Figure 2.4 – Installed and portable EFB examples

The EFB has several benefits over conventional methods:

- Reduces, in some cases, eliminates paper in the cockpit, reducing the flight crew workload.
- Rapid access to information, raising efficiency in day by day service and emergency.

- Dedicated software can perform the necessary calculations, which were previously completed by hand. It reduces paperwork and reduces the space for human error.
- Accurate takeoff and landing performance calculation. Thus enhancing fuel consumption and aircraft engine life.
- Improved safety and flight efficiency throughout precise onboard calculations, and thus eliminating work previously completed by hand.
- It makes it possible to exchange information, enabling the flight crew to access the latest data.
- Real-time weather information.
- Flight reports can be rapidly sent.
- Electronic document storage getting pilots and cockpit rid of hard copies, which are naturally difficult to keep updated.

As stated above, one of the central advantages of the EFB over previous methods is performance applications, which makes the calculations faster and more accurate, reducing human errors.

The Airbus EFB applications will be the example for this study.

Airbus Electronic Flight Bag Performance and Manual Application (FlySmart Plus)

Flysmart+ Ops Lib

Flysmart + Ops Library is an application designed to enable access to all Airbus operational manuals (FCOM, MEL, FCTM, AFM) and in-house manuals. Airbus Ops Library Browser offers an easy way to navigate through all Airbus manuals (thanks to hyperlinks) fully integrated and linked to Flysmart+ Takeoff and Flysmart+ Landing applications.

Flysmart + TakeOff

Flysmart + TakeOff permits compute Airbus aircraft takeoff performance. The optimization process provides optimum Takeoff weight or Flexible temperature based on the actual weather conditions and actual aircraft configuration (considering selected differed MEL and CDL items, if any). Flysmart + TakeOff features enhance graphics regarding runway information, which drastically increases situational awareness.

Flysmart+ Landing

Flysmart + Landing compute aircraft landing performance (dispatch or in-flight assessment). The optimization process provides optimum results based on the actual weather conditions and actual aircraft configuration (considering selected differed MEL and CDL items and ECAM alerts if any).

Flysmart + Landing features enhanced graphics on runway information, which drastically increases situational awareness.

EFB Calculations and Actual Landing Distance Calculation Comparison

Differently, from the dispatch landing distance assessment, the EFB In-Flight Landing Distance considers a comprehensive analysis to determine the landing distance performance. While the previous Actual Landing Distances paper methods are determined considering:

- Flying an optimum flight segment from 50 feet over the runway threshold to the flare.
- Firmly touchdown (not extending the flare).
- Use maximum pedal braking

According to the Flight Safety Foundation, these published landing distances are seldom achieved in line operations (ALAR, 2000).

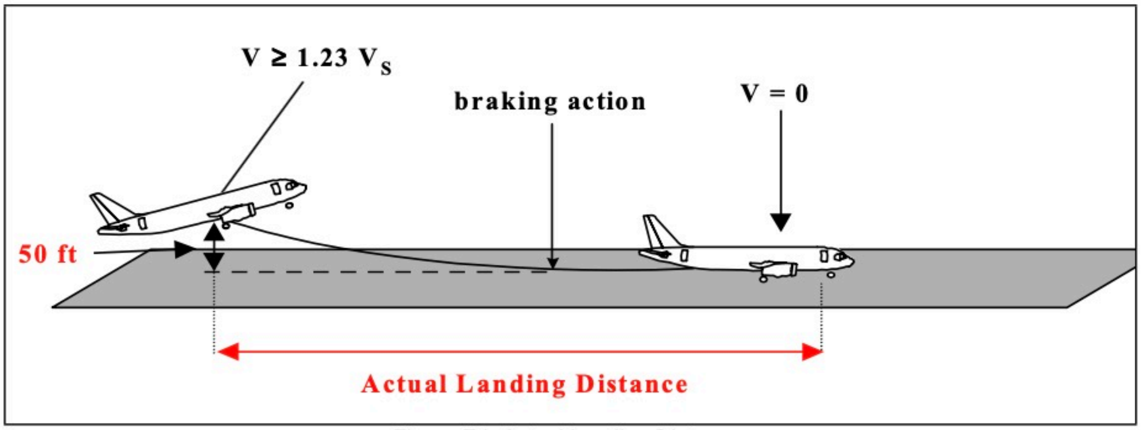
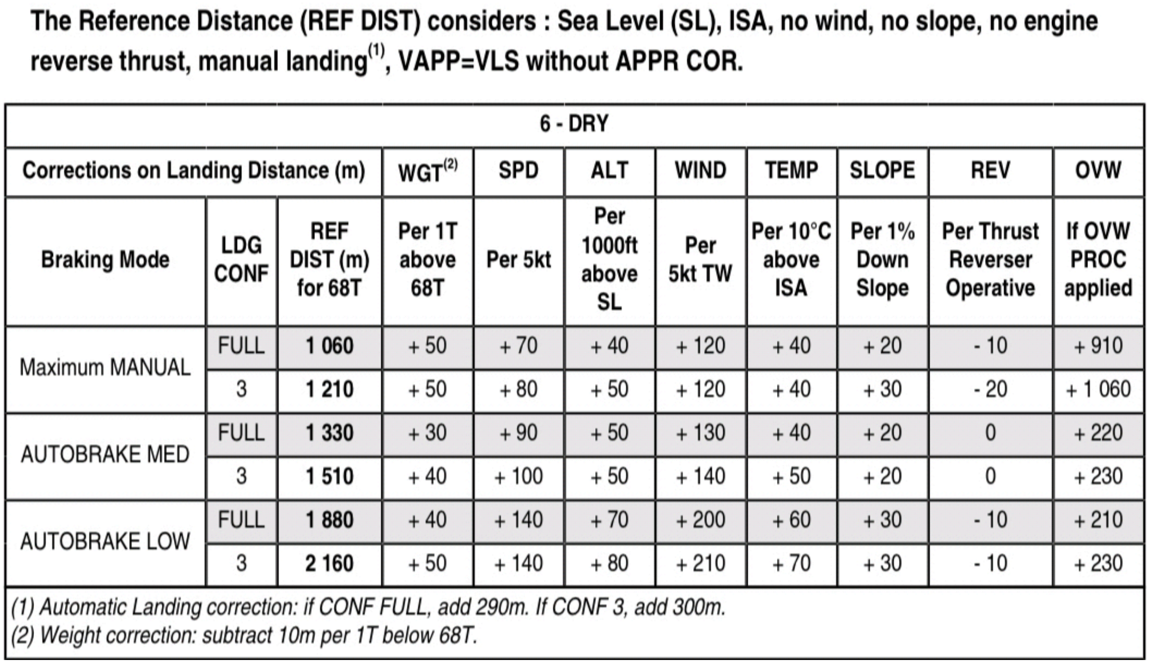


Figure 2.5 - Actual Landing Distance

Figure 2.6 shows an example of an actual landing distance paper table, with all the hand corrections that must be accomplished by the pilots.



The Reference Distance (REF DIST) considers : Sea Level (SL), ISA, no wind, no slope, no engine reverse thrust, manual landing(1), VAPP=VLS without APPR COR.

6 - DRY										
Corrections on Landing Distance (m)			WGT(2)	SPD	ALT	WIND	TEMP	SLOPE	REV	OVW
Braking Mode	LDG CONF	REF DIST (m) for 68T	Per 1T above 68T	Per 5kt	Per 1000ft above SL	Per 5kt TW	Per 10°C above ISA	Per 1% Down Slope	Per Thrust Reverser Operative	If OVW PROC applied
Maximum MANUAL	FULL	**1 060**	+ 50	+ 70	+ 40	+ 120	+ 40	+ 20	- 10	+ 910
	3	**1 210**	+ 50	+ 80	+ 50	+ 120	+ 40	+ 30	- 20	+ 1 060
AUTOBRAKE MED	FULL	**1 330**	+ 30	+ 90	+ 50	+ 130	+ 40	+ 20	0	+ 220
	3	**1 510**	+ 40	+ 100	+ 50	+ 140	+ 50	+ 20	0	+ 230
AUTOBRAKE LOW	FULL	**1 880**	+ 40	+ 140	+ 70	+ 200	+ 60	+ 30	- 10	+ 210
	3	**2 160**	+ 50	+ 140	+ 80	+ 210	+ 70	+ 30	- 10	+ 230

(1) Automatic Landing correction: if CONF FULL, add 290m. If CONF 3, add 300m.
(2) Weight correction: subtract 10m per 1T below 68T.

Figure 2.6 - Actual Landing Distance

EFB Landing Calculation

As shown in figure 2.6, the calculations performed by the EFB consider a 7 seconds flare in the In-Flight Landing Distance. This extended flare time adds a protection layer. As it is closer to the pilot line operation real scenario, instead of flying directly onto the ground aiming a firm touchdown.

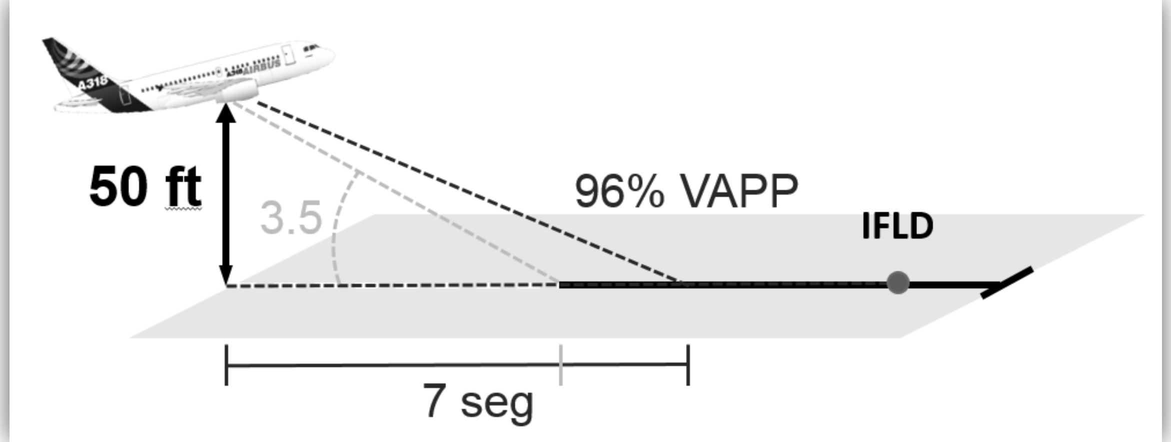


Figure 2.7 – Flare time used in EFB calculations

Aiming to present the EFB potentialities as well as the information provided, you can follow below figure 2.7 and figure 2.8, showing an Airbus 320-214 landing dispatch and in-flight landing performance calculation on both Congonhas runways.


17R DISPATCH - DRY

SBSP/CGH Sao Paulo / Congon…
RWY 17R
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)

VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3115 ft 5 %
MLW (PERF) 64.8 T

REQUIRED LDG DIST 1645 m
margin 15 m
1660 m
250 m
17R

35L DISPATCH - DRY

SBSP/CGH Sao Paulo / Congon…
RWY 17R
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)

VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3115 ft 5 %
MLW (PERF) 64.8 T

REQUIRED LDG DIST 1645 m
margin 15 m
1660 m
250 m
17R

Figure 2.8 – RWY 17R and 35L RLD at Dispatch

The researchers can observe that there are no limitations on Runway 17R/35L for dry conditions, allowing the landing at the maximum landing weight (MLW) 64.5 tons.

It is essential to understand that in case of a wet runway forecast, the flight would be automatically dispatched with the 1.92 factor, instead of 1.67.

According to TALPA ARC, during the in-flight landing distance assessment, pilots should apply a safety margin of at least 15 percent (factored landing distance) when based on manual wheel braking.

One of the configurations options that determine safety margins is the selection of auto brake. If the manual braking distance provides a 15 percent safety margin, then the braking technique may include a combination of auto brakes and manual braking. Even if the selected auto brake landing data does not provide a 15 percent safety margin.

For study purposes, all calculations will consider manual braking selection. This selection is the most conservative configuration and is the threshold of the utilization of auto brakes with the 15 percent safety margin.

17R

SBSP/CGH Sao Paulo / Congon…
RWY 17R
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND 6-Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)
BRK MODE Manual
REV Yes

VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3115 ft 5 %
MLW (PERF) 76.9 T

35L

SBSP/CGH Sao Paulo / Congon…
RWY 35L
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND 6-Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)
BRK MODE Manual
REV Yes

VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3133 ft 5 %
MLW (PERF) 76.4 T

Figure 2.9 – RWY 17R and 35L In-Flight landing distance

In Figure 2.9, despite the thrust reverse being taking into account only for wet runway landing distance calculations, the reverses were applied in both scenarios.

As stated earlier, the SBSP runway has been virtually reduced to include a 280-meter RESA.

In table 2.3 below, the researchers can observe all the values presented in figures 2.7 and 2.8.

RWY	DISPATCH	IN-FLIGHT
	DRY MLW/RDL/MARGIN	DRY MLW/LD/FLD/MARGIN
17R	64.5/1645/15	64.5/1164/1339/321
35L	64.5/1645/15	64.5/1173/1349/311

Table 2. – Dispatch and In-Flight Landing computation for RWY 17R and 35L

Chapter III

Methodology

This chapter describes the methodology used by the researchers to understand the impacts caused by IAC 121-1013 applied in Congonhas Airport, comparing to the desired increment of safety margin intended by the IAC. Researchers applied all restrictions imposed by IAC121-1013 to quantify their practical impact on IFLD operating margins.

Theory of Constraints

To improve operating efficiency and maintain flight safety excellence, the researchers applied a method to find the most significant constrains, their opportunities for improvement, and the impacts of their implementation on efficiency and safety.

A theory choose to guide researchers in the Theory of Constraints (TOC). TOC is widely used to improve the efficiency of business operations. Developed by Eliyahu Goldratt (The Goal, 2004) allows researchers to perform an analysis using the five steps described below:

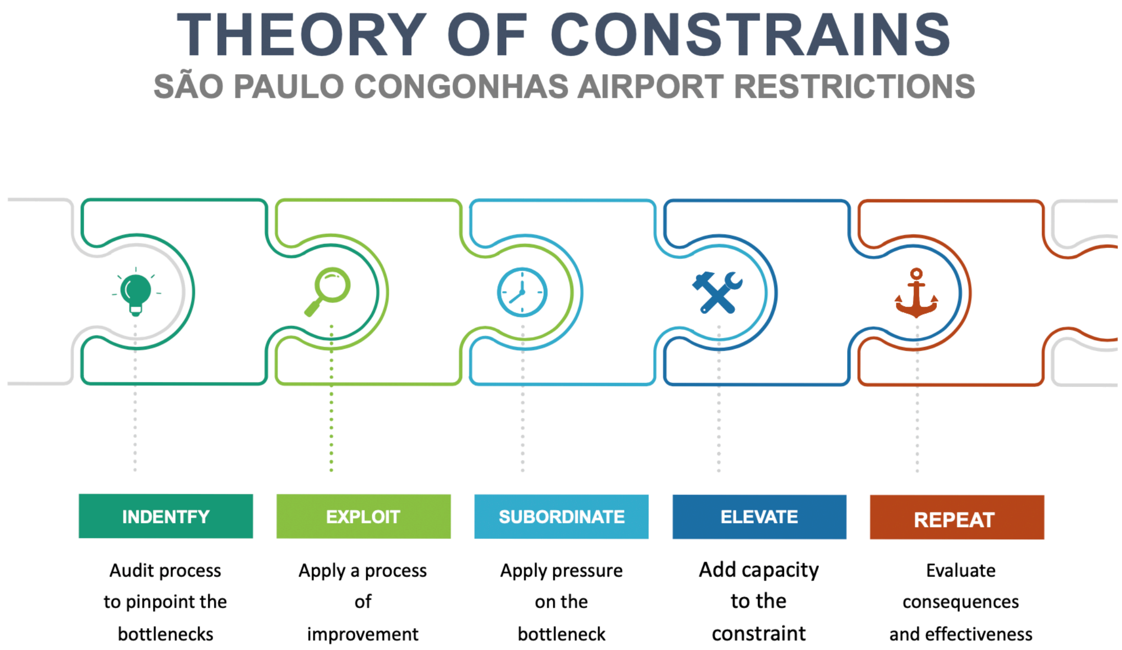


Figure 3.1 – Theory of Constrains

Identify the constraints

In our study case, the restrictions imposed on the Congonhas Airport operation will be treated as the constraints. The list of restrictions considered are:

- Minimum Equipment List items that affect the landing distance
- Limitation of Extra Fuel load
- Wet runway landing obligations
- Prohibition of takeoff and landing from the auxiliary runway

Exploit the constraints

This is one of the most critical phases in our process, as reviewing safety recommendations applied to an accident requires precise criteria. Through an analysis of the purpose of constraints and their effectiveness, the researchers consider that one enforced restriction must be maintained so that all others can be reevaluated.

The application of RESA on the 17R / 35L runway in Congonhas airport increased the safety margins and allowed us to evaluate the removal of the remaining restrictions. Using the EFB tool, the researchers can accurately verify how far such limits could be modified.

Subordinate the constrains

In this step, researchers must evaluate all the processes necessary to remove the process safely. Questions such as: Do we have the tools needed to remove it? Do pilots and operators have the training to operate them and act in case of contingencies? Does the removal of restrictions comply with regulations?

Subjecting initiatives to validation is critical to maintaining safety margins and collaborating with the final step to assess the consequences and effectiveness of actions.

Elevate the constraint

This process seeks to increase capacity by raising the constrains. In an air operation, there will always be restrictions or risk-mitigating measures. The goal is to achieve maximum performance within these limits.

Repeat

Repeat is the last step that leads us to make a final assessment of the measures. This step puts us in the process of continuous improvement because by solving a problem; we can create other needs. In our study case, we focused mainly on maintaining safety margins and identifying possible impacts that the removal of restrictions may have on operations.

Congonhas IAC 121-1013 MEL Restrictions

As previously stated, Congonhas IAC doesn't allow aircraft operating with MEL differed items in which system and equipment inoperability could compromise braking aircraft performance (increasing Landing distance). It is essential to highlight that this prohibition applies even if the calculated actual landing performance fits the runway length.

For this study case, the researchers will use the same tools available in the cockpit to analyze and understand the impact of differed MEL items in landing distance calculations and, consequently, in the safety margins. The EFB will be set up with the corresponding landing data for all failures:

Weather settings

WIND º / kt:	000/0
OAT ºC:	15 (ISA + 5)
QNH hPa:	1013
RWY Condition:	Dry

Aircraft Configuration

Landing Weight: 64.5 or the highest possible

Landing CG: Basic

Flap Configuration: FULL

Air Cond.: ON

Anti-Ice: Off

Approach Type: Normal

Go Around Gradient: 2.5%

MAN LDG A-THR: ON

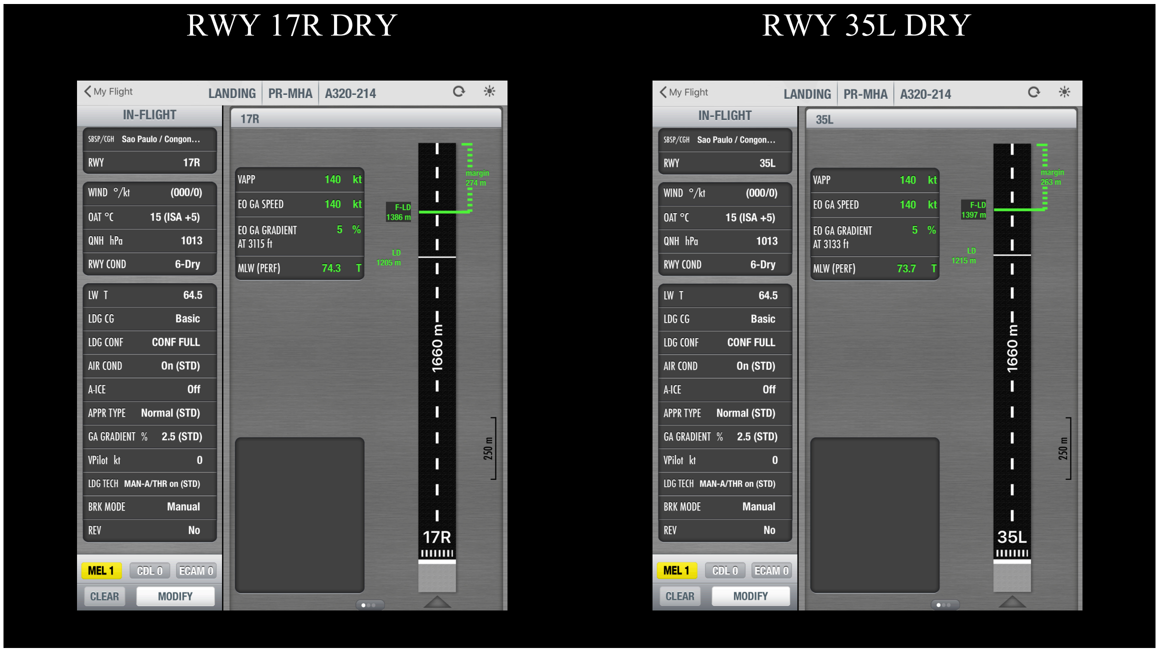
Brake Mode: MANUAL

Reverser Use: Yes

After presenting the calculations, a table will compare the safety margins without failures, with the margins of dispatched MEL items, which operation is forbidden in Congonhas.

Additionally, the researchers will make a comparison of the RLD assessment done during the flight dispatch with the IFLD. The target of this comparison is to highlight that the requirement of applying the factors of 1.67 / 1.92 in dispatch, significantly reduces the exposure to higher payloads.

One Thrust Reverse Inoperative – MEL 78-30-01A



RWY 17R DRY

SBSP/CGH Sao Paulo / Congon…
RWY 17R
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND 6-Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)
BRK MODE Manual
REV No

17R
VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3115 ft 5 %
MLW (PERF) 74.3 T
margin 274 m
F-LD 1386 m
LD 1205 m

RWY 35L DRY

SBSP/CGH Sao Paulo / Congon…
RWY 35L
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND 6-Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)
BRK MODE Manual
REV No

35L
VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3133 ft 5 %
MLW (PERF) 73.7 T
margin 263 m
F-LD 1397 m
LD 1215 m

Figure 3.2 – In-flight LD with One Thrust Reverse Inoperative

MEL ITEM	DRY		
	In-flight Landing Distance		
	LW	LD/FLD	Margin
17R No Failure	64.5	1164/1339	321
17R 78-30-01 One Thrust reverser	64.5	1205/1386	274
35L No Failure	64.5	1173/1349	311
35L 78-30-01 One Thrust reverser	64.5	1215/1397	263

Table 3.1 – Impact of MEL 78-30-01on IFLD

Observing figure 3.1 and table 3.1, the impact on landing distance is neglectable.

Braking/Steering Control Unit (BSCU) System 1 – MEL 32-42-03A

RWY 17R DRY

SBSP/CGH Sao Paulo / Congon...
RWY 17R
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND 6-Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)
BRK MODE Manual
REV Yes

17R
VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3115 ft 5 %
MLW (PERF) 76.9 T
F-LD 1339 m
LD 1164 m
margin 321 m

RWY 35L DRY

SBSP/CGH Sao Paulo / Congon...
RWY 35L
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND 6-Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)
BRK MODE Manual
REV Yes

35L
VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3133 ft 5 %
MLW (PERF) 76.4 T
F-LD 1349 m
LD 1173 m
margin 311 m

Figure 3.3 – In-flight landing distance with (BSCU) System 1 Inoperative

MEL ITEM	**DRY**		
	In-flight Landing Distance		
	LW	**LD/FLD**	**Margin**
17R **No Failure**	64.5	1164/1339	321
17R **32-42-03A** **BSCU 1**	64.5	1399	321
35L **No Failure**	64.5	1173/1349	311
35L **32-42-03A** **BSCU 1**	64.5	1349	311

Table 3.2 – Impact of MEL 32-42-03A on IFLD

In the failure presented in table 3.2, the Brake and Steering Control Unit 1 (BSCU 1) is backed-up by the BSCU 2. Even though the IAC121-1013 forbids the operation when one BSCU is inoperative, there is no impact on landing distance.

Landing Gear Control and Interface Unit (LGCIU) 1 in-flight – MEL 32-31-01

RWY 17R DRY

SBSP/CGH	Sao Paulo / Congon…
RWY	17R
WIND °/kt	(000/0)
OAT °C	15 (ISA +5)
QNH hPa	1013
RWY COND	6-Dry
LW T	64.5
LDG CG	Basic
LDG CONF	CONF FULL
AIR COND	On (STD)
A-ICE	Off
APPR TYPE	Normal (STD)
GA GRADIENT %	2.5 (STD)
VPilot kt	0
LDG TECH	MAN-A/THR on (STD)
BRK MODE	Manual
REV	Yes

17R		
VAPP	140	kt
EO GA SPEED	140	kt
EO GA GRADIENT AT 3115 ft	5	%
MLW (PERF)	75.5	T

F-LD 1361 m

LD 1184 m

margin 299 m

RWY 35L DRY

SBSP/CGH	Sao Paulo / Congon…
RWY	35L
WIND °/kt	(000/0)
OAT °C	15 (ISA +5)
QNH hPa	1013
RWY COND	6-Dry
LW T	64.5
LDG CG	Basic
LDG CONF	CONF FULL
AIR COND	On (STD)
A-ICE	Off
APPR TYPE	Normal (STD)
GA GRADIENT %	2.5 (STD)
VPilot kt	0
LDG TECH	MAN-A/THR on (STD)
BRK MODE	Manual
REV	Yes

35L		
VAPP	140	kt
EO GA SPEED	140	kt
EO GA GRADIENT AT 3133 ft	5	%
MLW (PERF)	75	T

F-LD 1372 m

LD 1193 m

margin 288 m

Figure 3.4 – In-flight landing distance with LGCIU 1 Inoperative

MEL ITEM	**DRY**		
	In-flight Landing Distance		
	LW	**LD/FLD**	**Margin**
17R **No Failure**	64.5	1164/1339	321
17R **32-31-01** **LCGIU 1**	64.5	1184/1361	299
35L **No Failure**	64.5	1173/1349	311
35L **32-31-01** **LGCIU 1**	64.5	1193/1372	288

Table 3.3 – Impact of MEL 32-31-01 on IFLD

The LGCIU 1 failure shown in table 3.3, is a no-dispatch condition; this means that the aircraft will not take off when this failure is present. However, in case it occurs during the flight, the EFB can calculate the landing distances.

The EFB offers calculations taking account systems failures that could impact the landing performance, being precise even with multiple failures. The landing performance calculation outputs take less than 30 seconds to be electronically presented for pilots.

Taking a closer look at the landing distance numbers for LGCIU 1 failure, the researchers observe that the impacts are not significant. Once again, even though the calculation assures that the operation even with the LGCIU 1 is possible, the IAC 121-1013 doesn't allow such operation, once the LGCIU 1 failure affects the Reverser 1 (inoperative).

Spoiler Elevator Computer (SEC) 1 – MEL 27-94-01A


RWY 17R DRY

My Flight | LANDING | PR-MHA | A320-214

IN-FLIGHT

SBSP/CGH Sao Paulo / Congon...
RWY 17R
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND 6-Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)
BRK MODE Manual
REV Yes

17R
VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3115 ft 5 %
MLW (PERF) 75.4 T

RWY 35L DRY

My Flight | LANDING | PR-MHA | A320-214

IN-FLIGHT

SBSP/CGH Sao Paulo / Congon...
RWY 35L
WIND °/kt (000/0)
OAT °C 15 (ISA +5)
QNH hPa 1013
RWY COND 6-Dry
LW T 64.5
LDG CG Basic
LDG CONF CONF FULL
AIR COND On (STD)
A-ICE Off
APPR TYPE Normal (STD)
GA GRADIENT % 2.5 (STD)
VPilot kt 0
LDG TECH MAN-A/THR on (STD)
BRK MODE Manual
REV Yes

35L
VAPP 140 kt
EO GA SPEED 140 kt
EO GA GRADIENT AT 3133 ft 5 %
MLW (PERF) 74.8 T

Figure 3.5 – In-flight landing distance with SEC 1 Inoperative RWY 17R

MEL ITEM	DRY		
	In-flight Landing Distance		
	LW	**LD/FLD**	**Margin**
17R **No Failure**	64.5	1164/1339	321
17R **27-94-01A** **SEC 1**	64.5	1236/1422	238
35L **No Failure**	64.5	1173/1349	311
35L **27-94-01A** **SEC 1**	64.5	1246/1333	277

Table 3.4 – Impact of MEL 27-94-01A on IFLD

The Spoiler and Elevator Computer 1 failure have a minimum impact on landing distance. Even though the landing with SEC 1 failure is possible according to the EFB calculation, the IAC121-1013 doesn't allow such operation, as long as the operation without spoiler is forbidden.

Limitation of Extra Fuel load

The extra fuel is all the additional fuel supply to a flight above the minimum fuel required, respecting the regulations. The CGH IAC121-1013 forbids airlines from supplying their aircraft with more than 3 tons of extra fuel.

The IAC objective is to limit the aircraft landing weight.

But the IAC doesn't establish an Alternate airport distance. So, in case the flight is planned with a distant alternate airport, there will be less extra fuel "hidden" in the alternate airport route.

In other words, the alternate airport could be used to manipulate the extra fuel. And instead of choosing a 1-hour distant alternate airport, the flight dispatcher can select a 2-hour distant airport, and the minimum fuel required will be increased. The aircraft will be landing with a higher landing weight despite the limitation of extra fuel.

The industry has a practice of transporting extra fuel loaded in airports where the price is lower. This practice makes it worthy to carry the extra fuel to an airport where the price is higher. This practice is called tankering. (Thumber, 2015)

Wet Runway Landing Obligations

Tailwind is a significative landing distance factor. In other words, the higher the tailwind, the longer will be the landing distance (Flight Safety Foundation ALAR, 2000) On the other hand, landing with a headwind is desired, as long as the headwind reduces the landing distance.

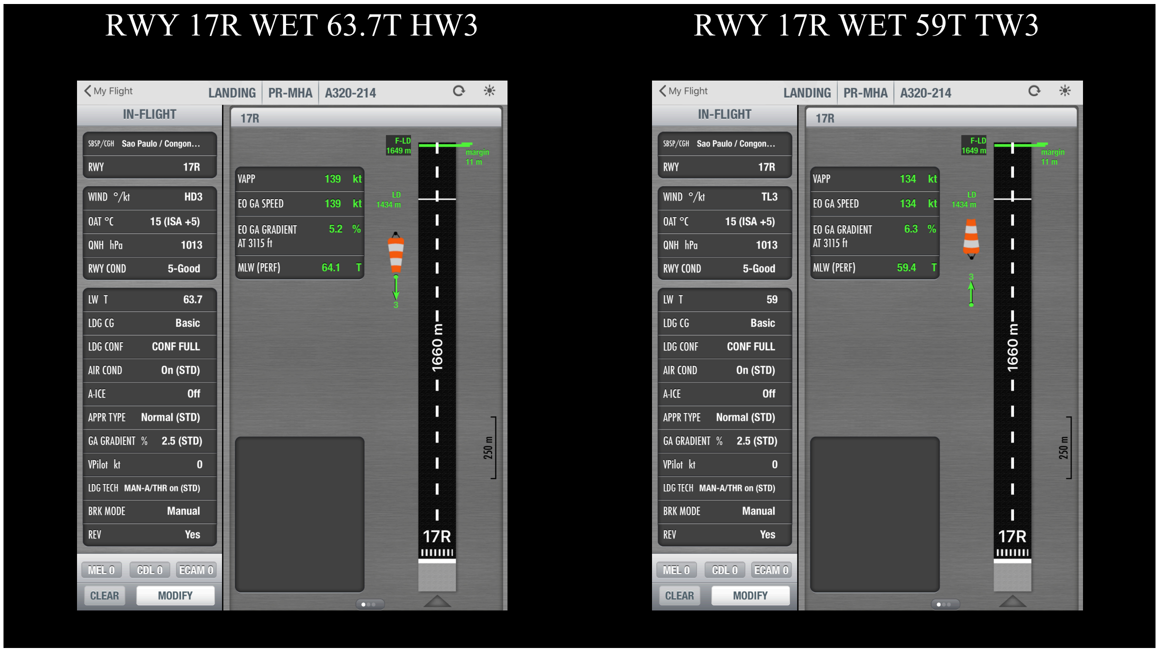
So, figure 3.5 compares two different wet runways landing scenarios: 3 knots headwind (HW3), with 3 knots tailwind (TW3). Obviously, for the same aircraft weight, the tailwind will produce more landing distance. But, as previously mentioned, the research methodology consists of analyzing the landing performance under the IAC121-1013 restrictions and compare with performance assessment.

In figure 3.5, the first analysis considered 63.7 tons of Landing Weight, and for the second scenario, consider a lighter weight of 59 tons of Landing Weight.

The landing distance calculated for both conditions is exactly (the same, A landing with a headwind could have less margin at a specific landing weight that a landing in a lightweight with a tailwind.

So, this restriction does not improve safety margins and is focusing on the wrong parameter.

As an example, let us make a comparison of two flights with the same landing margins, one with 3 knots of headwind and the other with 3 knots of tailwind.



RWY 17R WET 63.7T HW3

SBSP/CGH	Sao Paulo / Congon…
RWY	17R
WIND °/kt	HD3
OAT °C	15 (ISA +5)
QNH hPa	1013
RWY COND	5-Good
LW T	63.7
LDG CG	Basic
LDG CONF	CONF FULL
AIR COND	On (STD)
A-ICE	Off
APPR TYPE	Normal (STD)
GA GRADIENT %	2.5 (STD)
VPilot kt	0
LDG TECH	MAN-A/THR on (STD)
BRK MODE	Manual
REV	Yes

VAPP	139	kt
EO GA SPEED	139	kt
EO GA GRADIENT AT 3115 ft	5.2	%
MLW (PERF)	64.1	T

RWY 17R WET 59T TW3

SBSP/CGH	Sao Paulo / Congon…
RWY	17R
WIND °/kt	TL3
OAT °C	15 (ISA +5)
QNH hPa	1013
RWY COND	5-Good
LW T	59
LDG CG	Basic
LDG CONF	CONF FULL
AIR COND	On (STD)
A-ICE	Off
APPR TYPE	Normal (STD)
GA GRADIENT %	2.5 (STD)
VPilot kt	0
LDG TECH	MAN-A/THR on (STD)
BRK MODE	Manual
REV	Yes

VAPP	134	kt
EO GA SPEED	134	kt
EO GA GRADIENT AT 3115 ft	6.3	%
MLW (PERF)	59.4	T

Figure 3.6 – Same margins with different wind direction

WIND	**WET**		
	In-flight Landing Distance		
	LW	**LD/FLD**	**Margin**
17R **HeadWind 3 KTS**	63.7	1434/1649	11
35L **TailWind 3 KTS**	59.0	1434/1649	11

Table 3.5– Same margins with different wind direction

In figure 15, it is evident that a restriction of the tailwind operation does not increase the safety of the operation. It all depends on the landing weight of the aircraft. Of course, this restriction could limit the MLW with a tailwind, but in fact, if the only reason to limit operation is a reduction on safety margins.

Prohibition of Flex Takeoff and Reduced Takeoff when the Runway is Wet

The use of the maximum thrust of an engine generates high costs and reduces the engine life, so it is desirable to takeoff with reduced thrust setting whenever applicable (Airbus FCOM, 2018).

RWY 17R WET 60T FLEX TO

My Flight | TAKEOFF | PR-MHA | A320-214

SBSP/CGH	Sao Paulo / Congon…
RWY	17R
WIND °/kt	(000/0)
OAT °C	15 (ISA +5)
QNH hPa	1013
RWY COND	Wet
TOW T	60
T.O CG	Basic
T.O. THRUST	FLEX (STD) °C
CONF	CONF 1+F
AIR COND	Off (STD)
A-ICE	Off

17R

CONF	1+F
THRUST	FLEX 41 °C
V1	118 kt
VR	132 kt
V2	134 kt
Limitation	TOW - VMU
ENG OUT ACC	3024 ft
Green dot	205 kt
REV FOR COMPUTATION	All reversers operating
MTOW (PERF)	64.4 T

RWY 17R WET 60T TOGA

My Flight | TAKEOFF | PR-MHA | A320-214

SBSP/CGH	Sao Paulo / Congon…
RWY	17R
WIND °/kt	(000/0)
OAT °C	15 (ISA +5)
QNH hPa	1013
RWY COND	Wet
TOW T	60
T.O CG	Basic
T.O. THRUST	TOGA
CONF	CONF 1+F
AIR COND	Off (STD)
A-ICE	Off

17R

CONF	1+F
THRUST	TOGA
V1	118 kt
VR	131 kt
V2	134 kt
Limitation	TOW - VMU
ENG OUT ACC	3022 ft
Green dot	205 kt
REV FOR COMPUTATION	All reversers operating
MTOW (PERF)	64.4 T

Figure 3.7 – Flex and TOGA setting with the same Takeoff weight

In Figure 3.7, the researchers can see that even on takeoffs with smaller power thrust setting, the safety margin is achieved. The limiting factor will always be the MLW and not the determination of maximum power.

Prohibition of Takeoff and Landing from the Auxiliary Runway (when transporting passengers).

Neither the IAC121-1013 nor the Accident Final Report gives any explanation for the prohibition of the Congonhas Airport's secondary runway operation for aircraft transporting passengers.

Summary

This study aims to deeply analyze the IAC 121-1013 that restricts operation in the Congonhas Airport. The IAC came as a response from the TAM airlines flight JJ3054 accident, which official investigation concluded that a pilot mishandling of the thrust levers led to a runway excursion, killing 188 people on board.

The Final Investigation Report made several recommendations, such as training, aircraft engineering changes, runway infrastructure enhancements, and operational restrictions to Congonhas.

As a consequence, the IAC 121-1013 limited the operation in Congonhas with any failure that could affect the landing distance performance. Under a first sight, it may sound sensate. But, taking a closer look, these restrictions, create operational challenges for pilots and airlines, with unclear increment in safety.

Minor failures (inflight or deferred by MEL) represents a normal operational condition, being part of the routine of any airline. Therefore, limiting the operation in CGH in such situations creates some additional challenges for pilots and maintenance management. Instead of executing the landing distance assessment considering the failure (pair of spoilers, for example), the pilot is forced to divert, increasing costs, with unclear gain in safety.

The landing distance assessment performed nowadays is a robust process accomplished through the pilot EFBs (Electronic Flight Bag). This is a lot more accurate and comprehensive method than previous paper tables, the only option available at the time of the accident.

Together with a more precise landing distance calculation, came the ICAO RESA (International Civil Aviation Organization Runway Extended Safety Area), that virtually reduced the Congonhas runway in 280 meters. Consequently reducing the aircraft weight and providing extra area for contingencies.

Putting all together, researchers intend to prove that most of IAC 121-1013 restrictions represent airline efficiency loss solely, with no increase in safety margin.

Chapter IV

Outcomes

It has been twelve years since the accident. After all this time, the measures imposed to Congonhas airport has not been revisited by authorities, even though after new safety improvements (EFB and RESA) were implemented. The researchers are proposing a review of the restrictive measures applied to Congonhas airport through an analysis of the actual effectiveness and impact of the measures.

Some of the restrictions imposed are effective and must be maintained so that safety margins can prevent a new runway excursion.

The airport-imposed restrictions may have made some sense just after the accident, as long as the claim for an immediate response was too heavy. Authorities should be given some answers to society after the deaths of 199 people.

On the other hand, after twelve years of passed, it is relevant to reanalyze the measures under a new sight.

Under the researcher's sight, there is one measure that was the most effective decision at that time: the implementation of RESA. This measure brought a virtual (but effective) scape area and increasing the safety margin. The RESA implementation allows a takeoff and landing performance assessment with a component that brought a measurable impact, mainly in the event of unexpected contingencies.

Even though the implementation of the RESA may have brought payload operational limitations, financially impacting the airlines, the decision was in line with ICAO recommendation, bringing additional safety margin to operation.

All margins presented in this study have an additional 280 meters margin due to the virtual reduction of the Congonhas runway, the RESA. So, in any case, every presented landing margin has an extra 280m RESA. For instance, if we have an EFB calculated margin of 300; in fact, there is a real 580 meters margin. Pilots and flight dispatchers could not consider this margin during landing assessment. But it will be used in case of emergency and will not be considered a runway excursion.

In the next sessions, the researchers will present the conclusions about each restriction imposed.

MEL and IN-FLIGHT failures

Since the beginning of the study, researchers evaluate the effectiveness of the restrictions applied to the Congonhas Airport operation.

Some of these restrictions were intended to mitigate risks focusing on the impact that such failures could have on landing distance. The implementation of EFBs in aircraft cockpits has allowed pilots to determine landing performance impacts and accurately make decisions based on margins and visual presentations displayed on EFBs.

After performing the landing analysis of the main failures that affect landing performance and comparing the respectively achieved margins, the researchers can conclude that the impact of the failures for the presented configuration and runway condition is minimal and does not justify being in place.

In figure 4.1, the researchers can observe that the failures have minimal impact on safety margins. In the worst-case scenario (SEC FAULT), the margin is 238 meters, already included 15% for a factored landing distance. Including RESA, created by the virtual reduction of the track, we have 518 meters, equivalent to 1700ft.

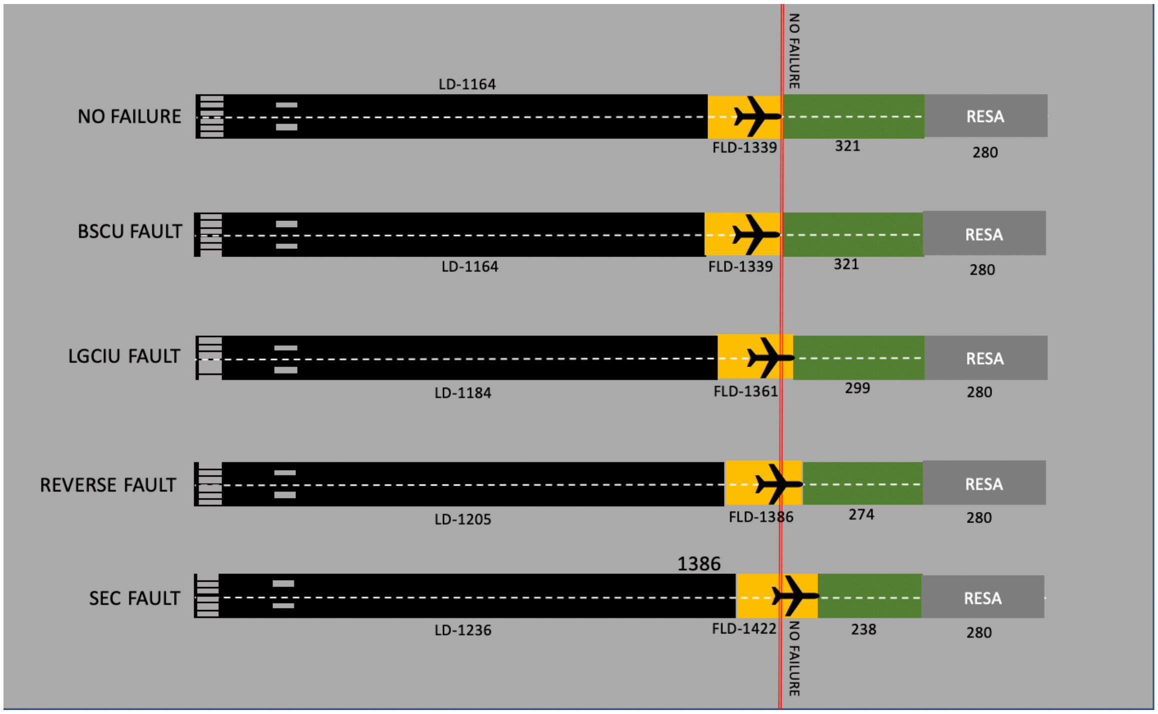


Figure 4.1 – IFLD and Margins for runway 17R (DRY)

Wet Runway Limitations

Wet runway operation implies a reduction of takeoff and landing margins. The primary purpose of the restrictions was to, somehow, compensate for the impact of these reductions.

However, the researchers believe the virtual reduction of runway adds an extra margin to the operation. And together with company policies and restrictions related to the factored landing distance represents more precise risk mitigation.

Landing with tailwind

Tailwind operations have their limits set by aircraft manufacturers and in specific operations by airline policies. Respecting the manufacturer's limitation, the main focus for safe operation should be its safety margins.

Due to performance, it is preferable to land with a headwind. Therefore, airport towers will generally set the landing runway observing the headwind criteria. On the other hand, during unstable weather or wind direction transition, it is possible to operate with a tailwind.

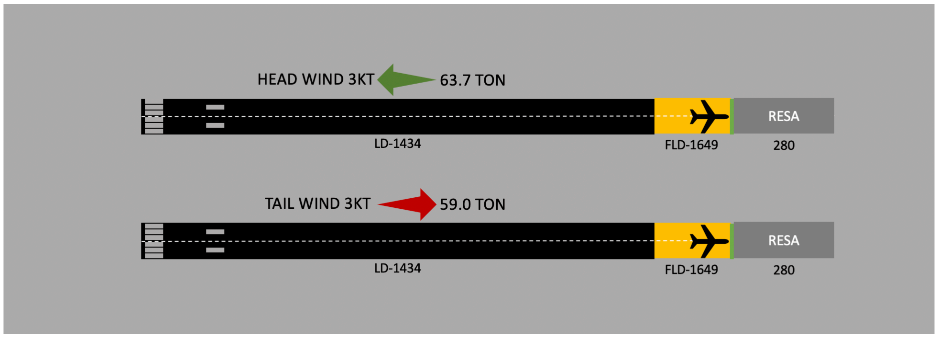


Figure 4.2 – Same margins with different wind direction

Indeed, that tailwind reduces the aircraft landing performance, increasing landing distance. However, researchers point out that tailwind makes the same effect on landing performance as higher payloads, high temperatures, increasing the landing run.

In other words, safety margin can be understood as available landing distance in exceedance of the required landing distance needed to make the aircraft perform a complete stop. In the case shown in figure 4.2, the researchers can compare the "safety margins" of two aircraft landing under different conditions: headwind and tailwind (lightweight). Observe that there is no difference between margins. Although the margin is the same, the tailwind operation (WET) is not allowed by IAC.

Concluding, limiting tailwind operation on a wet runway does not bring effective risk management. Risk management is about making an accurate landing assessment with up-to-date information and high situational awareness of flight crews

Five knots reduction on the FCOM maximum crosswind landing value

Crosswind landing is a technique widely practiced by pilots in flight simulators. The most significant concern of this operation is the possibility of lateral veer off. Congonhas main runway is 45 meters wide, which is the standard width of almost all runways in Brazil.

Therefore, the researchers could not find any relationship between the arbitrary 5-knots reduction in crosswind limitations and risk mitigation, making this reduction pointless.

Prohibition of Takeoff with Reduced Thrust (Derated or Flex)

Takeoffs with derated or flex power settings aim to reduce engine maintenance and leasing costs (the lower the takeoff power, the higher the efficiency). These power settings are used on long runways that allow for better Accelerating and Stop margins management.

According to FCOM, the requirement for maximum power utilization is justifiable on contaminated tracks or in the presence of heavy rain but has less impact on the dump or wet tracks.

The researchers believe that the runway reduced power setting prohibition should be applied only in cases of a contaminated runway or the presence of heavy rain. In other cases, pilots and flight dispatchers should use EFB power settings.

RWY 17R WET 60T FLEX TO

SBSP/CGH Sao Paulo / Congon…

RWY	17R
WIND °/kt	(000/0)
OAT °C	15 (ISA +5)
QNH hPa	1013
RWY COND	Wet
TOW T	60
T.O CG	Basic
T.O. THRUST	FLEX (STD) °C
CONF	CONF 1+F
AIR COND	Off (STD)
A-ICE	Off

17R

CONF	1+F
THRUST	FLEX 41 °C
V1	118 kt
VR	132 kt
V2	134 kt
Limitation	TOW - VMU
ENG OUT ACC	3024 ft
Green dot	205 kt

REV FOR COMPUTATION
All reversers operating

MTOW (PERF) 64.4 T

RWY 17R WET 60T TOGA

SBSP/CGH Sao Paulo / Congon…

RWY	17R
WIND °/kt	(000/0)
OAT °C	15 (ISA +5)
QNH hPa	1013
RWY COND	Wet
TOW T	60
T.O CG	Basic
T.O. THRUST	TOGA
CONF	CONF 1+F
AIR COND	Off (STD)
A-ICE	Off

17R

CONF	1+F
THRUST	TOGA
V1	118 kt
VR	131 kt
V2	134 kt
Limitation	TOW - VMU
ENG OUT ACC	3022 ft
Green dot	205 kt

REV FOR COMPUTATION
All reversers operating

MTOW (PERF) 64.4 T

Figure 4.3 – Flex and TOGA setting with the same Takeoff weight

In Figure 4.3, the researchers can observe that in aircraft with the same take-off weight (60T), there is an increase in Accelerating and Stopping Distance (ASD) that results in a reduction in the final margin.

An aircraft taking off with TOGA thrust setting that rejects take-off at Decision Speed (V1), when stopping the aircraft completely, will have 197 meters ahead. And the aircraft taking off at Flex thrust setting will have 19 meters.

It is important to note that comparing several other runways or operations with high take-off weights (including DRY runway), the industry accepts operation with small take-off margins. This is usual for efficiency purposes. It is usual to obtain calculated margins of 4, 3, or even 1 meter.

The EFB is set to maximize efficiency, therefore taking advantage of the entire runway length, reducing take-off power as much as possible.

Once again, the researchers must remember that the virtual reduction of the runway (RESA), brought an additional 280 meters margin. Furthermore, all calculations made by EFB are following take-off regulations. As long as the EFB takes into account all relative environmental factors outputting a precise and conservative result, there is no reasonable motivation to modify an already conservative operation.

Therefore, researchers consider the TOGA setting an unnecessary obligation.

Auxiliary runway operation

As the researchers stated in previous chapters, the Congonhas auxiliary runway was closed for passenger transportation.

No reason was given.

Operationally speaking, the auxiliary runway will naturally not be used for takeoff or landing due to its dimensioning (shorter than the main runway). On the other hand, under very low weights, the runway is useful, mainly as an option for Air Traffic Control fluidness.

As long as there is no reasonable motivation for auxiliary runway closure for regular transportation aircraft, the researchers believe that the auxiliary runway should be available, at least for takeoff operation, as it has a positive impact on air traffic control management.

Dispatch limited to 3 tons of EXTRA FUEL

This policy intends to reduce aircraft landing weight. The problem is that Extra Fuel depends not only on the amount of fuel load but also on the way the flight dispatcher distributed this fuel. Mainly, the planned alternate airport.

The same fuel quantity may produce different Extra Fuels depending on the planned alternate airport.

CLOSEST ALT AIRPORT		**LONGER ALT AIRPORT**	
SBCT/SBSP – ALT SBKP		**SBCT/SBSP – ALT SBGL**	
FUEL (Tons)		**FUEL (Tons)**	
DEST	1731	DEST	1731
RRSV	200	RRSV	200
ALT - SBKP	1335	ALT - SBGL	1821
HOLD	1.075	HOLD	1075
COMP	1.96	COMP	196
MFR	4537	MFR	5023
TANKERING	3.486	TANKERING	3000
BLOCK	8023	BLOCK	8023
TAXI	228	TAXI	228
TOF	7795	TOF	7795
EZFW	54500	EZFW	54500
TOW	62295	TOW	62295
LDW	60564	LDW	60564

Table 4.1 – Extra fuel manipulation with different alternate airports.

In table 4.1, the researchers can observe that the same amount of fuel, a close-to-destination alternate airport will result in a higher Extra Fuel than a distant alternate airport. So, in case the Extra Fuel is eventually greater than 3.000kg, the solution is selecting a more distant alternate airport in the flight dispatch. Consequently, reducing the Extra Fuel, bring it to a value below 3.000. The result is that the final aircraft weight will be the same.

The conclusion is that this policy fails to reduce the dispatched aircraft weight and makes the pilot work even harder. Once the more fuel loaded, the easier it is the in-flight fuel management. Therefore, researchers believe that authorities should review this limitation.

Chapter V

Conclusions and Recommendations

Following an analysis of the presented data, the researchers conclude that IAC played an essential role in calling attention to the Congonhas airport. The IAC reached the goal at the time of the accident, as long as it created immediate additional protection to the operation, compatible with the scenario in 2007. At the same time, responding to society with quick emergency measures assuring the continuity of operation and giving to the public a feeling that everything was under control.

After 12 years, new technologies and regulations implemented in the aviation industry changed the game in terms of takeoff and landing performance assessment and safety margin. The researchers believe it is time for an IAC review.

Conclusions

Considering the new technologies and regulations, the researchers noted that most of the implemented measures do not effectively increase operation safety. But these measures are indeed adding complexity to the Congonhas environment and jeopardizing efficiency.

The researchers identified that the ban of operation of aircraft dispatched with MEL items that impact braking distance, wet runways, and tankering doesn't represent relevant safety increases. Once these failures have minimal impact on the aircraft performance and they are all pre-accessed through a calculation tool, the EFB.

On the other hand, the RESA implementation, complying with the ICAO recommendation, has effectively increased operating safety margins by providing safety operation margin where it matters. Thus, providing additional space for the landing run.

The researchers agree that Congonhas, due to its characteristics, represent a unique airport. Therefore, the regulatory agency, jointly with the airlines, must be committed to preventing new accidents from occurring. In other words, the IAC must be updated, not eliminated.

The researchers can observe that the restriction imposed on the operation related to MEL items had its origin in the assumption that a possible dispatched MEL items can lead to additional pilot mistakes. That is the limit, could cause an accident.

However, it is evident that the accident which motivated the Congonhas IAC was a result of the wrong application of the operational procedures related to the reverse thrust failure.

CENIPA final report stated: "Following the FDR, in the last 28 landing operations performed, including the one of the accident, five different procedures for landing with a deactivated reverser were performed. Four of which not prescribed by the manufacturer. The last three landings were made with distinct procedures" (CENIPA,2009, pg.63)

As previously stated, the aircraft mishandling happened in different airports around the world. Limiting the operation solely in Congonhas doesn't make any reasonable sense. Well-trained pilots are prone to perform a safe operation, and it is contradictory to prohibit operations with dispatched MEL items or simple failures to increase safety. The legislation can never prevent failures from occurring, but it is capable of ensuring companies to have well-trained pilots.

The use of new technologies can give pilots a more accurate perspective of the landing and takeoff operation. EFB is a precise tool that enables pilots to quickly and accurately analyze the operation, even with dispatched MEL items or failures. As noted, the analyzed IAC-restricted items do not significantly impact aircraft performance in comparison with normal operation.

Currently, some companies restrict airport operation to the flight captain, thus obliging the most experienced pilot to operate. This is a valid mitigation measure, but the researchers believe each company should evaluate it and implement it through airline polices.

In all tests performed, the researchers found no evidence that takeoff and landings with dispatched MEL items make the operation unsafe. What makes the operation safe is the realization of a precise performance assessment with an up to date information.

Metaphorically speaking, the IAC mitigation can be compared to the prevention of house robbery. Instead of increasing the effective measures to avoid the thieves from breaking in, you prefer to tear the house down.

Information Gained from the Study

The researchers are professionals currently working in the aviation industry (operation), but none of us had actually realized the important changes that were gradually implemented in the aircraft performance calculation and new regulation that indeed increased safety.

At the same time, researchers also noticed with the study results that the actions implemented by Congonhas IAC have few practical relations with the original motivation, the Congonhas accident. So, the IAC was implemented mainly as an answer to the public outcry, then a measurable increase in safety.

Conceptual implications

The study hit the spot in pointing out that the Congonhas IAC limited the operation without bringing extra safety margin as the IAC was supposed to.

On the contrary, depending on the situation, the IAC can make the operation more challenging. For instance, a simple in-flight failure as a BSCU fault (Brake and Steering Control Unit). Today the IAC prohibits the operation in Congonhas even though there is zero increase in landing distance. So, obeying the IAC, the pilot will have to divert the flight to another airport. What if the weather in close airports are not good? The flight would be diverted to an airport, some times with worst weather conditions, impacting the operation (flight delay, crew labor hours), instead of landing in the planned destination (Congonhas), because a misdirected regulation says so.

Recommendations

Finally, as a recommendation, researchers want to propose the revisit of the Congonhas IAC. Fundamentally, the new technologies (EFB) and regulations regarding landing performance and safety are taken into account, consequently eliminating the prohibition of:

- Operation with MEL performance-affecting differed items;
- Tankering limitation (3.000 kg);
- Wet runway limitations

Limitations of the Study

Researchers have full access to Airbus documentation, which means that most of the common aircraft performance can be considered as covered. The Airbus A320 is an aircraft that is similar in size and weight as the Boeing 737-800; therefore, as a general role, all conclusions and assumptions of the study apply to the B737s. But, it must be stated that the calculations were not run for the Boeing family.

Another limitation is the absence of cost raise. The IAC limitations increased the operation costs, but the researchers were not able to calculate this value.

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