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An Evaluation of the Operational Restrictions Imposed to Congonhas Airport by Civil Aviation Instruction121-1013

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São Paulo - Congonhas Airport, founded in 1936, the second busiest airport in Brazil, 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. 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 not an unusual 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. Congonhas Airport (CGH) operational limitations were implemented before the conclusion of the official investigation.

Problem

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. The IAC 121-1013 main restrictions included: Minimum Equipment List, Limitation of Extra Fuel load, Wet runway landing obligations, and Prohibition of Takeoff and Landing.

More than 10 years after the accident, the same Congonhas IAC121-1013 restrictive measures remain in effect. 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. 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.

Purpose

The central objective of this research case is to investigate Congonhas IAC121-1013 measures, analyzing its technical background and safety effectiveness. Simultaneously, the researchers will evaluate which standard of the Advisory Circular most effective, increasing safety, and which is only detrimental to the efficiency of air transportation. This research 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 explored 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).

Literature Review

Two pillars are considered fundamental by the researchers to perform air transportation: 1) the safe conduction of operation, and 2) the economic viability of the operation and its efficiency.

Background

In 1996, 11 years before the 2007 accident, CGH 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 to remain airborne 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. It has always been in the headlines of Brazilian newspapers. At the beginning of 2007, the pavement of the runway at Congonhas airport was restored through phases to eliminate the surface irregularities and prevent water accumulation; both were considered chronic runaway problems. After the pavement restore process was over, more time was needed until the runway could be grooved. At the same time, the airport authority decided to authorize the runway operation with the grooving pavement service not ready to avoid operational disruptions.

Aeronautical Accidents Categories

Aviation organizations worldwide define more than 40 different accident categories. The five more significant accident categories are Runway Excursion (RE), System/Component Failure or Malfunction (SCF), Loss of Control in Flight (LOC-I), Abnormal Runway Contact (ARC), and Controlled Flight Into Terrain (CFIT). 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). 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 July 17th, 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. One central issue was that the plane was dispatched with Engine two reverser pinned (deactivated) by MEL. Before JJ3054 landed, according to CENIPA's Final Report, Congonhas Tower informed them that the active landing runway (RWY35L) was wet and slippery. The airport authority authorized the runway operation without the grooving pavement. During the landing roll, 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 the ground perished (CENIPA, 2009).

Over the years, several incidences related to mistaken thrust levers have occurred. The pinned reverser landing procedure is directed related to these incidents, which are not limited to Airbus aircraft: two occurred in similar conditions on flight JJ3054 from the 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. 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.

Congonhas Civil Aviation Instruction - IAC 121-1013 & Review of Approach and Landing Regulations

One of the ANAC regulatory publications is the Civil Aviation Instruction (IAC), which aims to establish procedures or clarify rules or requirements contained in the RBAC related to civil aviation (IAC 001-1001A, p. 4). It is similar to the FAA Advisory Circular. In April 01st of 2008, ANAC issued the Congonhas Civil Aviation Instruction (IAC 121-1013) that established 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 imposed limits (or prohibition) to the landing operation depending on the aircraft conditions. 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 calculations (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. The (RLD) should consider the weather forecast for the landing time and apply dry and wet runway safety factors.

In Brazil, the flight dispatch process is regulated by the RBAC 121. Furthermore, the RBAC 121.195 states 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). 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 1 below, the actual requirements and factors that must be applied to the actual landing distance are displayed.

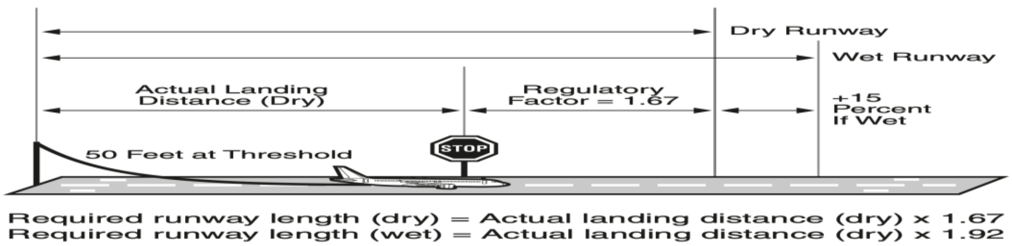

Figure 1. Landing distance dispatch requirements.

Runway End Safety Area (RESA)

Several safety recommendations came during the JJ3054 accident investigation. On September 17th of 2007, CENIPA issued central guidance determining the establishment of the Runway End Safety Area (RESA) in Congonhas Airport (CENIPA Final Report, p. 103). The proposal is based on the ICAO Annex 14, which establishes high priority to the RESA implementation. 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.

Figure 2. Runway End Safety Area (RESA).

In-Flight Landing Distances & Electronic Flight Bag (EFB)

After departure, landing distances verified at the flight dispatch process were 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. With the implementation of the Electronic Flight Bag (EFB), the in-flight landing distance assessments performed significantly changed over the past decade (FAA AC 120-76D, 2017). The EFB In-Flight Landing Distance considers a comprehensive analysis to determine the landing distance performance. According to the Flight Safety Foundation, these published landing distances are seldom achieved in line operations (ALAR, 2000). 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 presented in Figure 3.

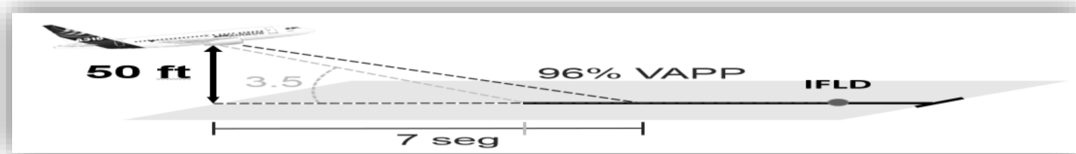

Figure 3. Flare time used in EFB calculations.

Methodology

To improve operating efficiency and maintain flight safety excellence, the researchers identified the most significant constrains, their opportunities for improvement, and the impacts of their implementation on effectiveness and safety based on the Theory of Constraints (TOC), developed by Eliyahu Goldratt (The Goal, 2004). The restrictions imposed on the Congonhas Airport operation are treated as the constraints and considered the Minimum Equipment List items that affect the landing distance, Limitation of Extra Fuel load, Wet runway landing obligations, and Prohibition of takeoff and Landing from the auxiliary runway. The application of RESA on the 17R / 35L runway in Congonhas airport, an enforced restriction, was maintained. Using the EFB tool, the researchers accurately verified how far such limits could be modified. 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 were utilized. The EFB was 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

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 the higher payload. All margins presented in this research 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.

Outcomes

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, We 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, there are 518 meters (1700 feet).

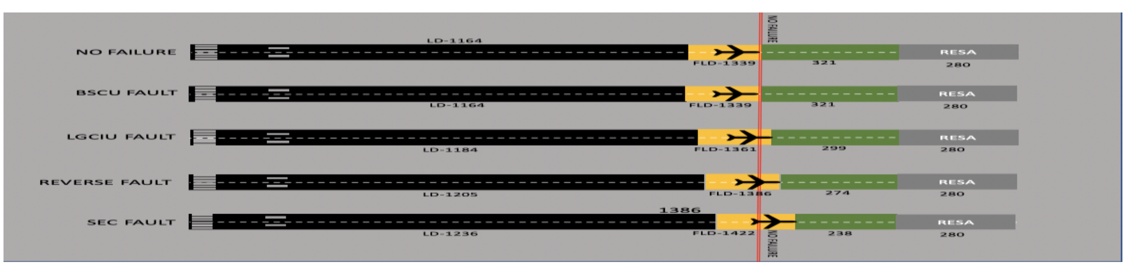

Figure 4. IFLD and Margins for runway 17R (DRY).

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.

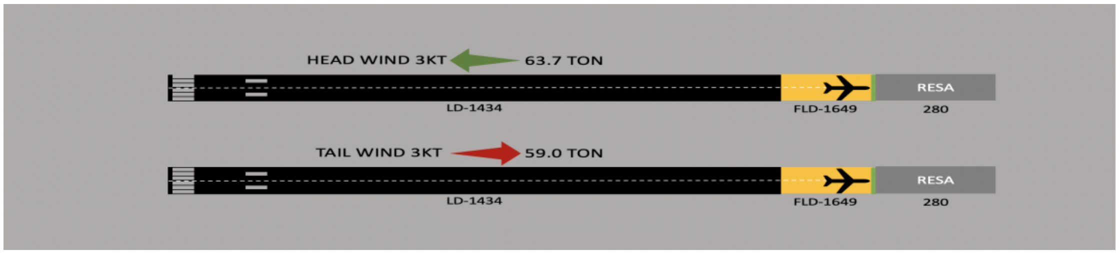

Figure 5. Same margins with different wind directions.

Indeed, the tailwind reduces the aircraft landing performance, increasing landing distance. However, the researchers point out that tailwind makes the same effect on landing performance as higher payloads, high temperatures, growing the landing run. The researchers did compare the "safety margins" of two aircraft landing under different conditions: headwind and tailwind (lightweight) and detected no difference between margins. Although the margin is the same, the tailwind operation (WET) is not allowed by IAC.

The most significant concern of crosswind landing 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. The researchers could not find any relationship between the arbitrary 5-knots reduction in crosswind limitations and risk mitigation, making this reduction pointless. Takeoffs with derated or flex power settings aim to reduce engine maintenance and leasing. 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. Still, it 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.

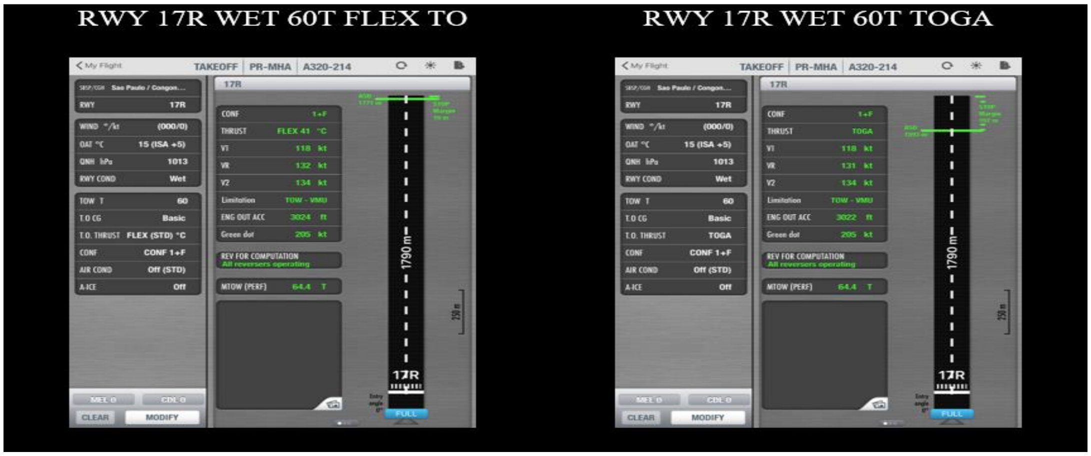

Figure 6. Flex and TOGA setting with the same Takeoff weight.

In Figure 6, the researchers can observe that in aircraft with the same takeoff 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 a TOGA thrust setting that rejects takeoff at Decision Speed (V1), when stopping the aircraft completely, will have 197 meters ahead. While the aircraft taking off at Flex thrust setting will have 19 meters. The EFB is set to maximize efficiency, therefore taking advantage of the entire runway length, reducing takeoff power as much as possible. Thus, the researchers consider the TOGA setting an unnecessary obligation. The Congonhas auxiliary runway was closed for passenger transportation without any apparent reason. 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. The dispatch limited to 3 tons of EXTRA FUEL is a policy that 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 scheduled alternate airport.

Table 1
Extra Fuel Manipulation with Different Alternate Airports

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

Conclusions

The IAC performed an essential role in calling attention to the Congonhas airport. However, after 12 years, new technologies, the EFB, and regulations implemented updated the takeoff and landing performance assessment and increased the safety margin. The researchers identified that the ban of operation of aircraft dispatched with MEL items that impact braking distance, wet runways, and tankering does not represent relevant safety increases. Also, the RESA implementation, complying with the ICAO recommendation, has effectively increased operating safety margins by providing safety operation margin where it matters. As a result, this offers additional space for the landing run.

The researchers acknowledged 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. However, the accident which motivated the Congonhas IAC was a result of the wrong application of the operational procedures related to the reverse thrust failure. The legislation can never prevent faults 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.

In all tests performed, the researchers found no evidence that takeoff and landings with dispatched MEL items make the operation unsafe. Currently, 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. Twelve years passed, and the measures imposed to Congonhas airport has not been revisited by authorities, even though 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 rules, consequently eliminating the prohibition of Operation with MEL performance-affecting differed items; Tankering limitation (3.000 kg) and Wet runway limitations. The results of this research are presented to the aeronautical authority and are being reviewed.

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