NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

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Attachment 6 – Airbus Changes Before Takeoff Presentation

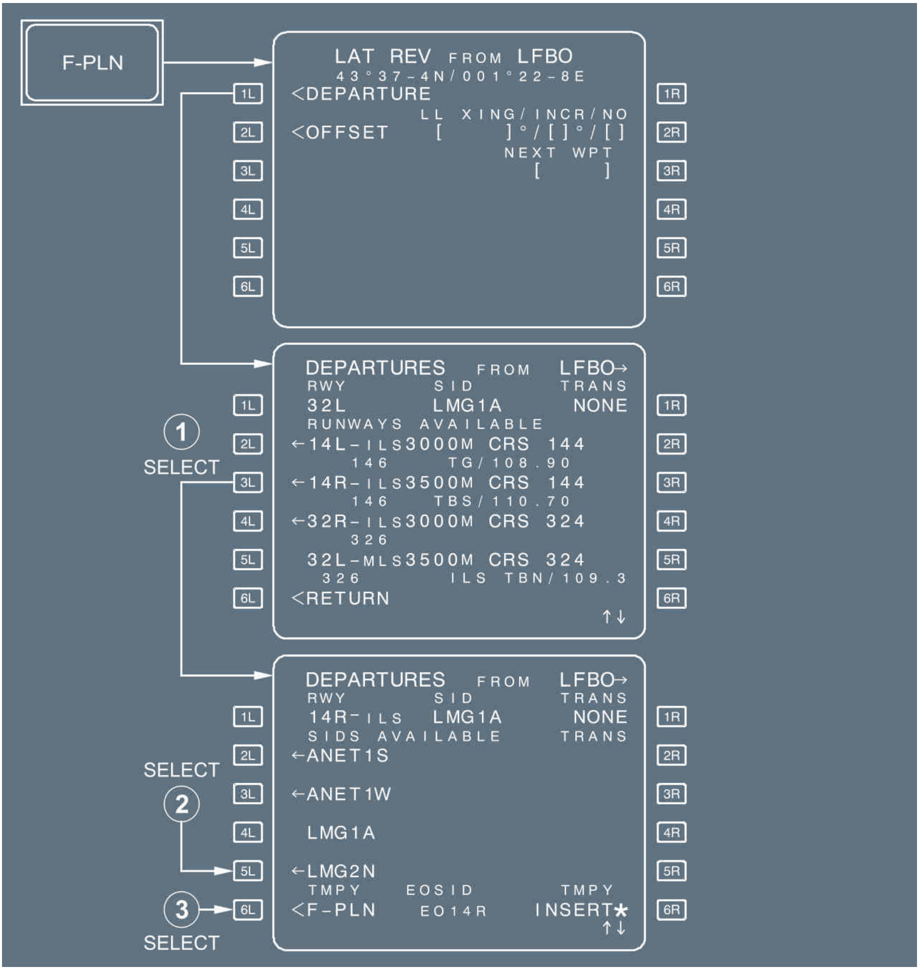
OPERATIONAL FACTORS

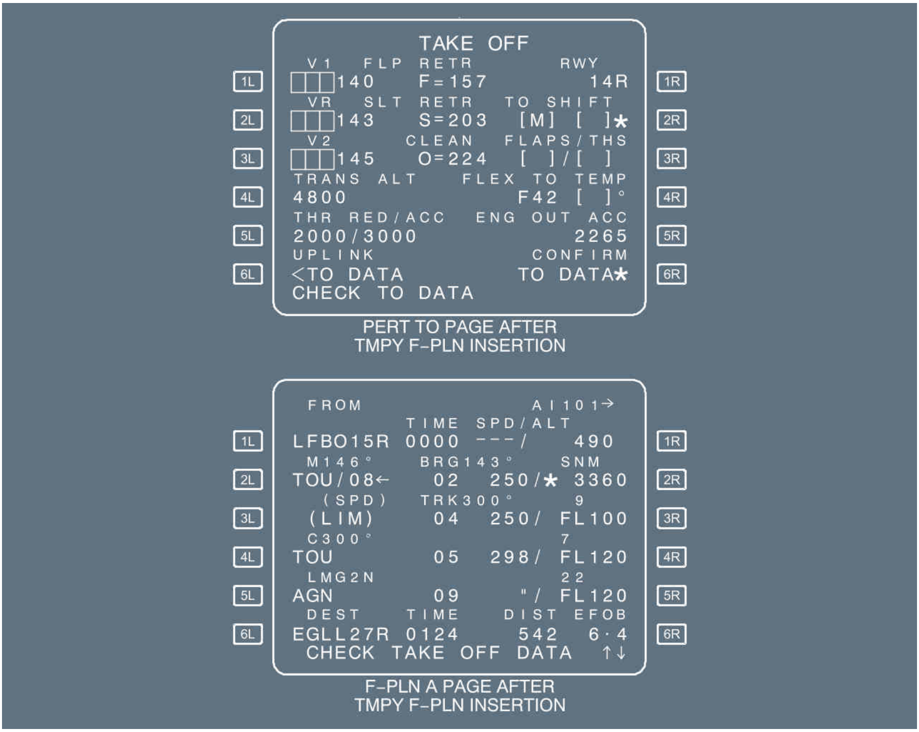
DCA14MA081

Before Pushback or Start

CHANGE OF RUNWAY

Ident.: PRO-NOR-SRP-01-15-00003975.0015001 / 22 MAY 12
Applicable to: ALL





PERT TO PAGE AFTER
TMPY F-PLN INSERTION

F-PLN A PAGE AFTER
TMPY F-PLN INSERTION

PRESS the F-PLN key on the MCDU.
SELECT the LAT REV at origin.
SELECT the DEPARTURE prompt [1L].
SELECT the new RWY in use.

The "CHECK TAKE-OFF DATA" message is displayed.

CHECK/SELECT the appropriate SID and TRANS.
CHECK and INSERT the TMPY F-PLN, or continue with next revision.
PRESS the PERF key to access PERF TAKEOFF page.
CHECK the V1, VR, V2 and FLEX values displayed after the amber boxes. If these values are correct, PRESS [6R] to confirm and insert them. Else, ENTER new values.
ENTER the new V1, VR, V2, FLEX TEMP or CONF, as appropriate.

The previously-entered values, adjacent to the boxes, may be re-selected by pressing the CONFIRM TO DATA on [6R].*

Late changes before takeoff

Presented by
Nicolas Bardou / Flight Safety Director – Accident / Incident Investigator

AIRBUS

Content

- Background
- Case studies
- Conclusion

Background

- Late changes before departure
  - Disturbance during check lists
  - Weather change
  - Runway change
  - Taxiway access change
  - Updated / late takeoff data
  - …

- Last minute changes are **small** changes operated under **high** pressure and may have **big** consequences

Content

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- Case studies
- Way forward

Case study 1 - Description

- A340-500, preparing for a 14hrs flight
- Gross weight error **260t** instead of **360t** (-100t error)

- Leading to the following consequences

Data	Computed values		Correct values
T Flex (°C)	**74°**	**(+31°)**	43°
V1 (kt)	143kt	(-6kt)	149kt
VR (kt)	145kt	(-16kt)	161kt
V2 (kt)	154kt	(-19kt)	173kt
Green Dot (kt)	225kt	(-40kt)	265kt

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Case study 1 - Description

- While entering values in the FMS, crew was constantly interrupted
- Crew noted that the Temp looked high, and intended to check later

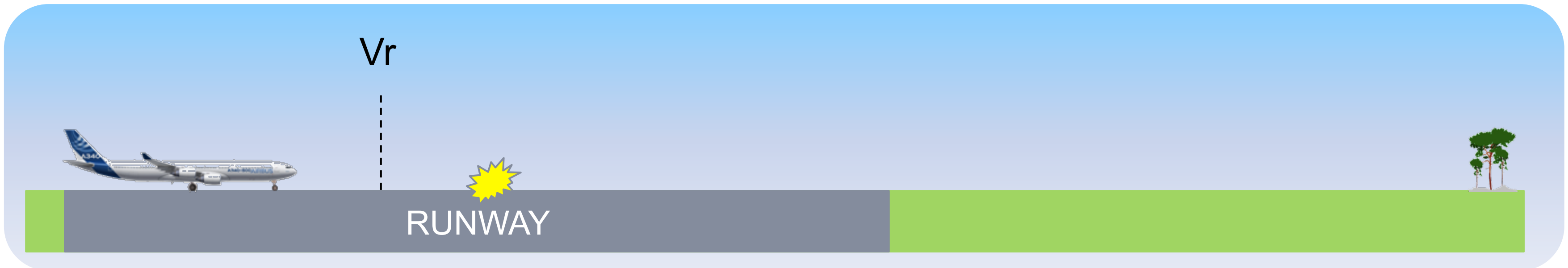
Data	Correct values	Entered values	
T Flex (°C)	43°	74°	(+31°)
V1 (kt)	149kt	143kt	(-6kt)
VR (kt)	161kt	145kt	(-16kt)
V2 (kt)	173kt	154kt	(-19kt)
Green Dot (kt)	265kt	225kt	(-40kt)

Discussion on SID choice
Food & beverages being served
Conversation with ground engineer
Cabin crew interruption
Discussion in the cockpit

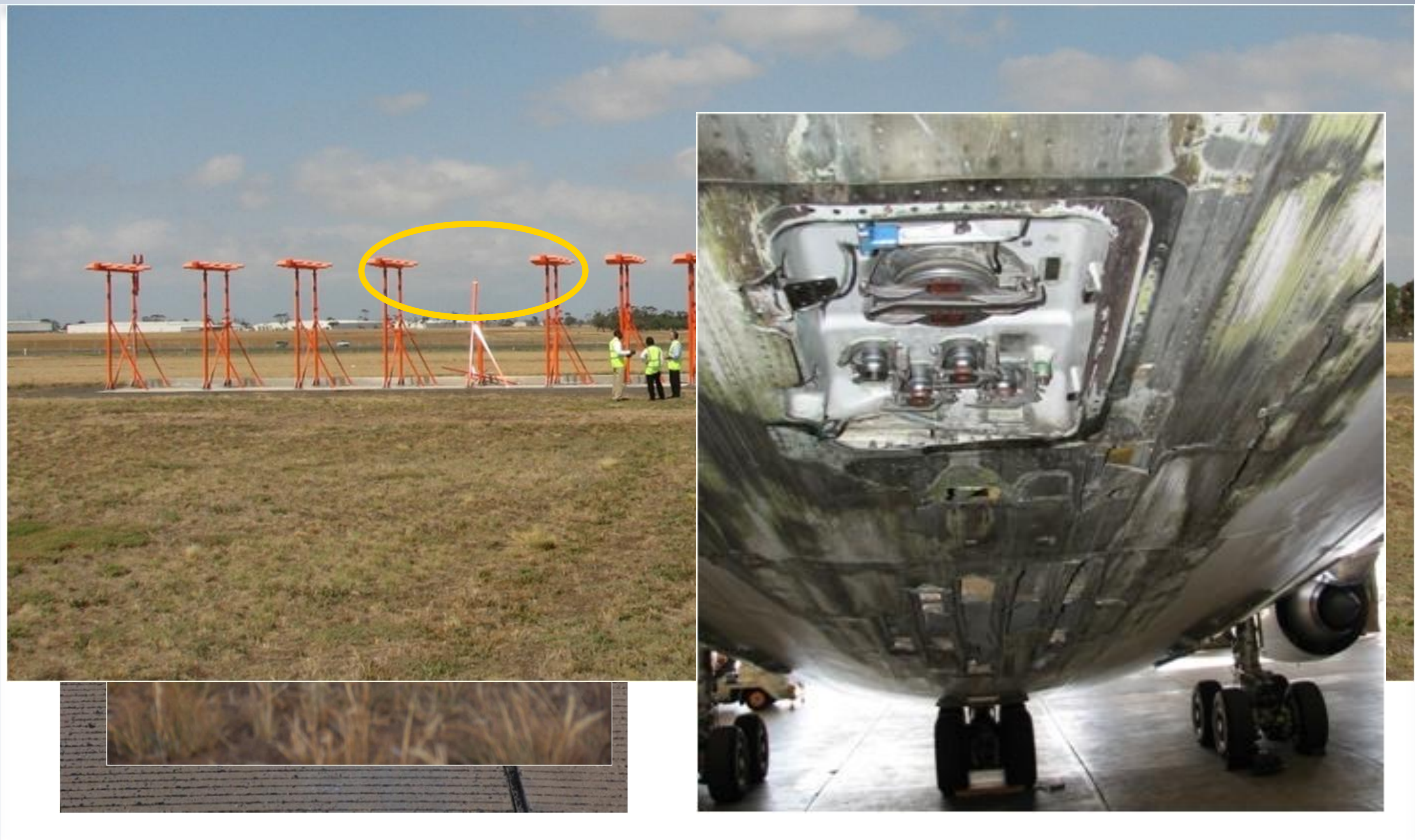
Case study 1 - Consequences

- Takeoff was initiated applying MCT/FLEX
- At rotation speed, almost no response following stick input
- Full Back Stick applied → nose raised, tailstrike
- Aircraft did not lift off → TO/GA applied
- Aircraft took off after the end of the RWY

- ATC was notified of tailstrike, IFTB performed after jettison



Case study 1 - Consequences



Case study 1 – What did we learn?

WRONG WEIGHT

→ Important to recognise large errors in weight, temp, speeds (rough order of magnitude)

CROSSCHECKS

→ In case of doubt, re-check using available means

DISTURBANCES

→ Important to recognize when a checklist or procedure has been interrupted

→ Best practice = restart

Case study 1: What did we learn?

- Additional checks will be introduced in **Takeoff Securing Pack 1**
  - Weight check
    - ZFW entry within defined range per A/C type
  - Speed check
    - V1#Vr<V2
    - Speeds consistent with weight, thrust & conf
  - Trim & S/F conf setting consistency check

Content

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Case study 2 - Description

- A340-300, conf 2, 230t, Flex T/O
- Reported wind 3kt tailwind
- Takeoff speeds computed with full runway length
- Using airports databases not up to date

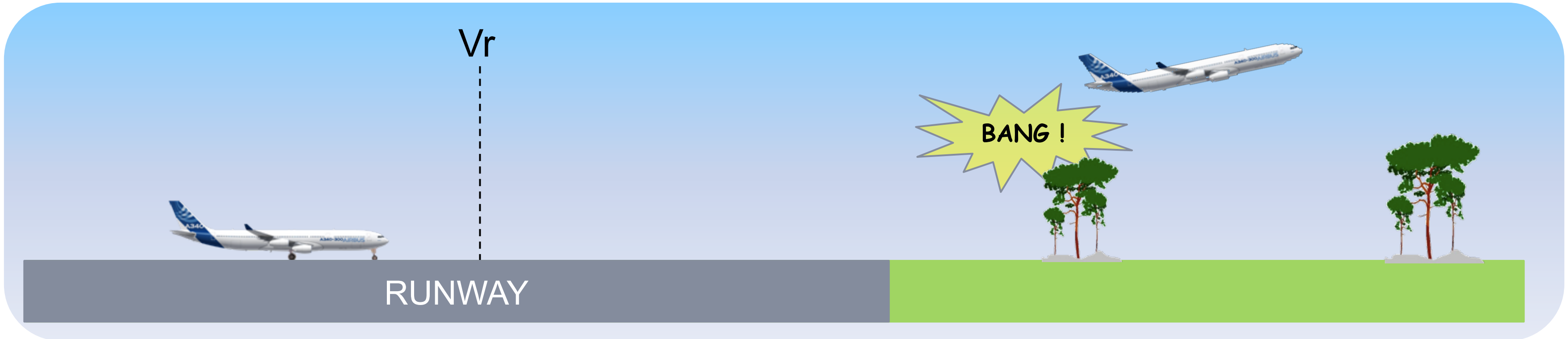
Actual tailwind 8kt

RWY accessed 350m after threshold

Obstacles can change

Case study 2 - Description

- Takeoff was initiated applying MCT/FLEX
- At Vr, rotation was initiated and during climb, a “bang” was heard
- As no adverse effect was noticed flight was continued
- Inspections after landing revealed that engines chopped the top off the trees



Case study 2 - Slow silent changes

Case study 2 - Slow silent changes

Case study 2 – What did we learn?

WEATHER CHANGE → Important to obtain updated weather information

OBSTACLES → Charts had not been updated

COMPUTATION → Re-compute for a shorter runway

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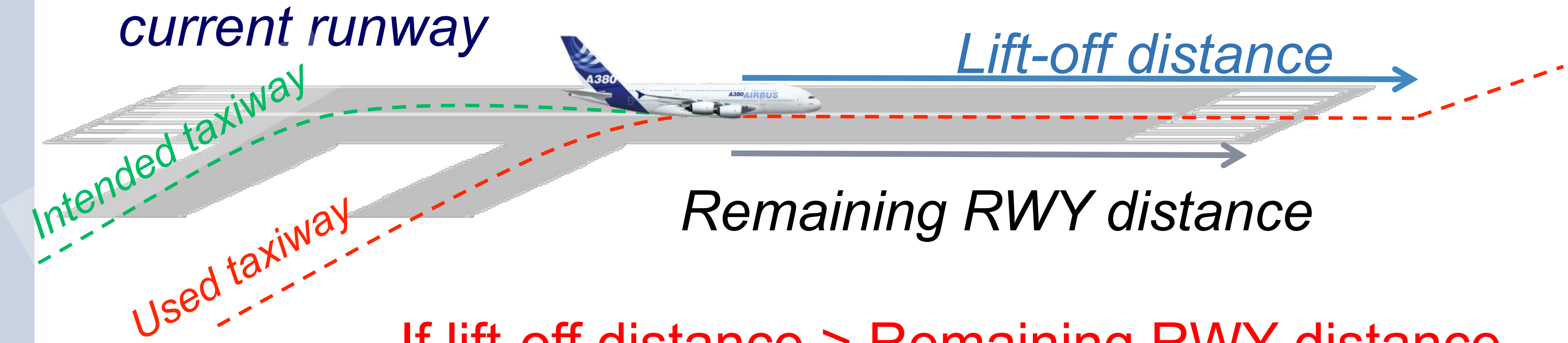
Case study 2: What did we learn?

- **Runway length** check function in **TakeOff Securing pack 2**



If lift-off distance > Remaining RWY distance

ECAM warning ➔

Content

- Background
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Case study 3 - Description

- CPT taxied A340-300, F/O would do the takeoff
- Night time & no traffic ahead
- Aircraft was taxied along the runway

RWY was changed due to maintenance

“Expedite taxi & line up incoming flight on approach”

“Cleared for takeoff”

Case study 3 - Description

- CPT only is trained & allowed to taxi per airline policy
- Aircraft made a premature turn onto a taxiway parallel to runway
- Rolling takeoff was started on the taxiway
- ATC instructed the crew to abort takeoff
- Max ground speed was 75kt

Case study 3 - Description

- High workload in cockpit during the turn

CAPTAIN

- Public Address
- WXR radar
- "Packs off, Line-up checklist"
- Adjust thrust for turn
- Taxi (Left hand)
- Stow EFB (on the left) with his RH

F/O

- Packs off
- Note the FOB
- Line-up checklist
- Stow EFB made difficult due to water bottle
- Prepare for takeoff

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Case study 3 - Description

"EXPEDITE TAXI"

CLEARED FOR TAKEOFF"

"CLEARED FOR TAKEOFF"

- High workload in cockpit during the turn

CAPTAIN

- Public Address
- WXR radar
- "Packs off, Line-up checklist"
- Adjust thrust for turn

/O

difficult due to water

Case study 1 – What did we learn?

RUNWAY CHANGE

→ Important to take ALL changes into account

WORKLOAD

→ Important to recognize when a checklist or procedure requires more time

ATC PRESSURE

→ Crew interpreted early ATC clearance as an "instruction"

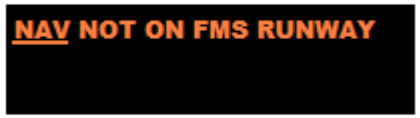
Case study 2: What did we learn?

- A/C position check function in **TakeOff Securing pack 2**
  - Power application on **taxiway**: “ON TAXIWAY”

ECAM

  - Power application from **wrong runway**: “NOT ON FMS RUNWAY”

FMS departure runway



ECAM

Content

- Background
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Conclusion

- Disturbances before departure
  - **Weather**
  - **Runway change**
  - **Taxi routing**
  - **Workload**
  - **ATC pressure**
  - **Multitasking**
  - **Cabin crew**
  - MEL
  - Runway state
  - Fuel figures
  - Updated cargo
  - Late Pax
  - De-icing
  - Ground tech
- Last minute changes will always happen
- Pressure is always present
- Next presentation highlights disturbances occurring during flight

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Late Changes before Departure

1. Introduction

Following the presentation that was made at the 18th Airbus Flight Safety Conference in Berlin, we decided to come back on this topic that affects pilots on nearly all flights.

Additional information will be provided on how a small mistake affects the calculation of aircraft performance and also on design improvements that are now available (update of Safety first n°8 dealing with the Take-Off Securing Function, TOS).

Finally, to balance the "manufacturer's view", an open forum is offered to an experienced airline pilot that will share his views and tips on handling these challenging situations.

2. Examples of Late Changes

Many things can affect departure preparation. Some cause distractions, which can then lead to the introduction of small unnoticed but incorrect changes that affect the safety of the take-off.

A few examples that may occur either individually or often together:

- External disturbance during check lists
- Noisy cockpit ambiance
- Weather change
- Runway change
- Runway state change
- New taxi routing
- Updated take-off data
- ATC pressure
- High workload
- Multitasking
- Technical conditions of aircraft (e.g. MEL)
- New fuel figures
- Updated cargo
- Late pax
- Late luggage
- De-icing
- Ground staff
- NOTAMS
- Passengers pressure
- …

Those are typical examples of changes but they often occur when time pressure and workload are high just before departure and they can have big consequences, as illustrated by the following two case studies.

Figure 1
Time pressure and workload are high just before departure

3. Event Analysis

3.1 Case Study 1

3.1.1 Description

While preparing the flight in the cockpit, the flight crew was constantly interrupted by conversations in the cockpit, cabin crew, ground staff, discussion on SID, etc…

This resulted in crosschecks on take-off data not being properly done and the gross weight entered was lower than the actual aircraft weight by 100 tons. Only one digit difference in the pilot selection, but it resulted in a tailscrape, a liftoff after the end of the runway and a broken runway light. Selection of TOGA provided enough power, in this case, to allow the climb away (fig. 2 and 3).

3.1.2 Understanding the Impact

Entering a lower gross weight than the actual leads to:

► **Lower speeds**

Calculated stall speed will be lower, giving a lower V_2 and lower Vspeeds. As a consequence there will be poor or no rotation at V_R, leading potentially to a tailscrape.

► **Higher Flex temp**

Taking off with a higher Flex temperature reduces the available thrust and take-off performance might not be reached. This is illustrated by fig. 4.

Figure 2
Entry of a gross weight lower than the actual aircraft weight led to a tailscrape…

Figure 3
…and to a collision with a runway light.

The take-off reference speeds

► **V_1**: Maximum speed at which the crew can decide to reject the take-off, and is ensured to stop the aircraft within the limits of the runway.

► **V_R**: Speed at which the pilot initiates the rotation, at the appropriate rate (~3°/s).

► **V_2**: Minimum climb speed that must be reached at a height of 35 ft above the runway surface, in case of engine failure.

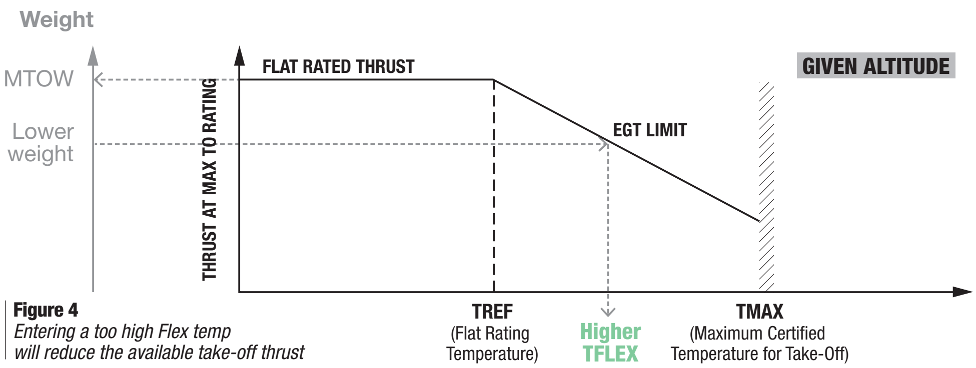

Figure 4
Entering a too high Flex temp will reduce the available take-off thrust

3.2 Case Study 2

3.2.1 Description

Another example is shown below where many pre-flight interruptions led to some mistakes that "normally" would never happen.

Take-off data was computed using the given weather, runway access (thus available runway length) and the obstacles mentioned on the airport charts.

Changes to all those factors led the aircraft to fly through the top of the trees at the end of the runway.

Figure 5
The departure end of the runway before the incident

Figure 6
The same view after the aircraft clipped the trees

3.2.2 Understanding the Impact

► Upon departure, there was a reported 3.5 kt tailwind whilst pre-departure computation was done for zero wind. This alone would have given a lower V_R (-4 kt) and V_2 (-3 kt) and reduced the vertical flight path by 54 ft.

► The initial departure computations were made using the full length of the runway whereas it was entered for take-off via an intersection (350 m shift). This alone would have given a lower V_R (-4 kt) and V_2 (-3 kt) and reduced the vertical flight path by 34 ft.

► The chart was indicating 40 ft high trees at 655 m from the end of the runway, whereas the actual trees were 54 ft high at 393 m from the end of the runway. This alone would have given a lower V_1 (-5 kt), V_R (-7 kt) and V_2 (-5 kt) and reduced the flight path even further.

The combination of these factors ensured that the immediate post take-off climb profile was so reduced as to hit the obstacles whilst the crew thought that the flight path would be clear.

4. Design Improvements

Despite flight crew cross checks, mistakes can be made and some errors might remain undetected. In order to help flight crews, some design improvements have been developed. As a follow up to the Safety First n°8 (July 2009) article, the Take-Off Securing (TOS) pack 1 includes a series of checks of take-off data:

► Weight check: to avoid an erroneous ZFW input in the FMS.

► ZFW entry must be within defined range per aircraft type.

► Speed check:

- Take-off speeds order
- Speeds between their limits
- Speeds consistent with weight, thrust & slat/flap configuration

► Trim setting check: to avoid error of TRIM, erroneous ZFWCG input, auto-rotation or "heavy nose".

► Slat/Flaps configuration check: to avoid error of S/F conf settings that will impact speeds and distance.

► Temperature check: to avoid take-off with MCT (Maxi Continuous Thrust) instead of FLEX thrust.

Those improvements are developed for all fly-by-wire airbus aircraft types, will be available via FMS and/or FWC upgrade (Upgrade depends on actual A/C configuration: approach your field service representatives or customer support directors for detailed information and operational impact).

Reminder

$V_1 \leq V_R \leq V_2$

$V_1 \geq VMCG$

$V_R \geq 1.05 \times VMCA$
$V_R \geq kV_R \times Vs1g$

$V_2 \geq 1.10 \times VMCA$
$V_2 \geq kV_2 \times Vs1g$

5. A Pilot's View

Last minute changes, disturbances and all imaginable versions of disruptions during flight preparation are normal issues to airline pilots, they set the stage for the daily "business as usual"activities.

All the information regarding a flight and all decisions merge in the cockpit where a good part of the flight crew´s duty consists of managing the right things at the right time.

The challenge is that not all things are right things and even less occur at the right time.

To simply promote the idea of not allowing any disturbance during critical phases of flight preparation would be an impracticable solution. By the time somebody "knocks on the door", he or she has already disturbed the flight crew, and if you close the cockpit door, they will certainly return, be it on the interphone, via cell phone or any other creative means. Finally, in contrast to many other professions, problems usually cannot be deferred for long times in airline operations. If not managed they usually return like a boomerang.

Summing up, there is a general experience based acceptance in the pilot community for disruptions. To ensure safe operations anyhow, it is important to have an easy and reliable concept to manage them instead of tilting at the windmills of disruption.

A proven way is to divide all tasks into small packages of measures. These packages should be stringent and complete in themselves, but small enough to allow for short time deferment by disruptions. An easy formula might be: allow for disruptions during overall tasks but do not allow any disruption to break up a defined package. This eases the safe return into the workflow after the disruption is managed.

As an example, during cockpit preparation, the F/O has done all the necessary FMS inputs and now it is your turn to check the entries. While you review the flight plan on the MCDU F-PLN page the ramp agent steps into the cockpit with an important question regarding loading. It would be rather impractical to let him wait until you have completed the entire FMS check. On the other hand, shifting your attention directly to the loading problem could result in an FMS entry error remaining undetected. Starting the complete FMS check anew after the distraction could result in an endless activity because there will certainly be another disruption during your next try. Dividing the task of checking the FMS entries into separate working packages for each MCDU page gives you the chance to finish one of these packages in a reasonable time short enough for any disruption to be deferred and well enough defined to allow for a safe continuation after the interruption.

A second very important point is time management. Captain Murphy has a reliable companion: F/O Hastemakeswaste. A human reaction on time pressure is the intention to speed things up with the motivation being not to bust schedules. Humans have a maximum design speed like every machine and it is hardly possible to exceed it. Ironically, if we exceed our design speed, things get even slower simply because the number of faults increases exponentially. One is lucky if this results only in a slower pace. The history of accident investigation is full of dramatic examples where some well meant shortcuts and quick actions resulted in fatal faults. If a slot expires, there will be a new one. If there is a major bug in take-off data calculation there might not be a second chance.

Always remember: the pacemakers are sitting in the pilot's seats, not in a Central Flow Management Unit, not in a Collaborative Decision Making Computer, not in an Operational Control Center or whatever well intentioned institutions there may be in our worldwide working environment. Take your time and slow down when you are in a hurry!

Finally, there is a very important caesura in your flight: Going Off-Blocks. In the majority of flights, the circumstances for flight preparation do not obey the rule books. This means you can count on disruptions, time pressure, surprises and pretty well any kind of trouble. Often, there is no practicable way to circumnavigate these challenges. However you should never allow them to get airborne. Off-Blocks is the last time to leave all these disturbances behind and revert to an unrushed flight SOP's.

As a conclusion, there is no practicable way to avoid disruptions, they simply exist. To guarantee safe operations, we should not try to avoid, but manage them. Regarding time, we need to know the limitations of human pace and the crews ability to accept them. And whatever the conditions were during flight preparation, make a clear distinction after Off-Blocks and continue thereafter with a regular flight.

6. Lessons learnt

"Anything that can go wrong, will go wrong". *Capt Ed. Murphy*

Interruptions, disturbances, last minute changes will always happen at the worst moment. Normally at that precise moment many issues have to be solved at the same time. It is when pressure is increasing a lot, that a small but critical mistake may sneak into the pilot's computations. That small mistake (maybe only one digit) can have big consequences.

To help the crews, the following hints can be highlighted:

► **At the briefing, explain to the flight crew** what you will be doing in the cockpit to prepare the flight and that there are phases when you can be interrupted and others when you need "sterile environment" for a few minutes.

► **Know the rough order of magnitude** of values before computing them, e.g: for a very long flight (more than 12 hours), an A340-500 will weight over 300 tons. A high Flex temp of 75°C is generally associated with a light weight take-off.

► **Recognize when you are being distracted and double check** at a quieter time using all available means (paper doc, LPC, …).

► **Split your task into small packages** that you can reasonably do and secure before being interrupted.

► Finally, in case of a doubt or a last minute change, take a break, **re-do the computation.**