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D-A-D-A

DETECT
See, hear or feel cues
Instrument Displays
Pattern recognition

ASSESS
Compare with something familiar
Form a mental model
Pattern Match

DECIDE
Evaluate relative importance of the information
Review patterns & mental models
Identify suitable action - a pattern or mental model

ACT
Monitor
Review the situation
Plan ahead

Editorial

There have been many incidents of tail strikes and runway overruns arising due to errors in computation of takeoff performance parameters. While efforts to prevent this continue, these errors and the consequent incidents do occur. Airbus has come up with an automatic secure function to keep a check on these errors in takeoff performance calculations. We look at this function in detail.

Press-on-itis is a psychological phenomenon that can affect even the most experienced pilots. It is a causal factor for many serious incidents and accidents. We discuss this phenomenon and the means to safe guard against it.

As always, we look forward to your feed-back, suggestions and contributions which can be sent to our office address given in this page. Happy reading and many more safe landings.

Take - Off Securing function (TOS)

Dr.M.S.Rajamurthy

Entry of erroneous data into Flight Management System (FMS) or other performance calculators are frequent and occur irrespective of aircraft type or airline. This results in erroneous takeoff performance parameters being used for takeoff which could lead to a tail strike, a Rejected Takeoff (RTO) or a runway overrun. The final outcome is a damage to the aircraft accompanied at times with loss of life.

In the April 2009 issue of Flight Safety, we discussed few of these accidents and the measures to counter these errors. Let us look back at these accidents.

In March 2003, Singapore Airlines B747-400, during takeoff at Auckland, had a tail strike with substantial damage to the aft end of fuselage. The tail strike occurred because the rotation speed was 33Kt less than the speed required for the airplane weight. The rotation speed was wrongly calculated with a weight 100 Tons less than the actual weight (see May 2009 issue of Flight Safety for a detailed account of this accident).

In October 2004, an MK Airlines Limited Boeing 747-244SF on a cargo flight from Halifax, Nova Scotia, to Zaragoza, Spain, attempted to take off from Runway 24 at the Halifax International Airport. The aircraft had a tail strike, overshot the end of the runway, became airborne and then struck an earthen berm. The aircraft's tail section broke away from the fuselage, and the aircraft remained in the air for a while before it struck terrain and burst into flames. The aircraft was destroyed by impact forces and a severe post-crash fire. All seven members onboard were killed (see June 2007 Issue of Flight Safety for more details).

The Transport Safety Board of Canada who investigated the accident concluded that the crew unknowingly used the previous flight takeoff weight (Bradley) to generate the Halifax takeoff performance data which resulted in incorrect V speeds and thrust settings being transcribed to the take-off data card. These were too low to enable the aircraft to take off safely for the actual weight of the aircraft.

In March 2009, an Emirates A340 had a tail strike during takeoff at Melbourne resulting in substantial damage to the aft fuselage. This again was due to wrong weight inputs to the performance calculations resulting in a much lower rotation speed (see Flight Safety July 2009 for more details and pictures of damage to the aircraft).

In a study initiated by BEA, France, to review the "processes for errors specific to the flight phase prior to takeoff and to analyze the reasons why skilled and correctly trained crews were unable to detect them, " the Laboratorie d'Anthropologie Appliqu'ee (LAA) studied 10 incidents where inappropriate takeoff parameters were used and found:

- Nine of the ten incidents were due to major error in calculations.
- There were errors in cross checks. In

one case, cross check also produced an erroneous result. In another case, check was carried out without confirming the TOW and so the same erroneous values were arrived.

♦ Five of these were due to erroneous entry of speed values into FMS.

There also have been serious incidents caused by wrong takeoff configuration, C.G. and wrong setting of controls during takeoff (see April 2009 issue of Flight Safety).

Triggered by these accidents, Airbus has developed Take-Off Securing function (TOS) which automatically checks the entered data for consistency. This basic one is referred as TOS pack1.

The second pack, which is under development will have more safety enhancing functionalities which includes the real time Runway length /Remaining distance on runway function. This will reduce the probability of take-off runway excursions.

Before going into the TOS, let us review the take-off preparation by the pilots.

Computation of aircraft weights (Zero Fuel Weight, Take-Off Weight) and respective CG positions, as well as the calculation of the different Take-Off speeds (V1, VR, V2) and thrust rating is part of the preparation for take-off. These data are derived either by using load sheets and take-off charts, or by means of non aircraft software applications (i.e. flight operations laptops).

Three types of errors can occur during this process:

i. Parameters entered into the tables or into the programs may be wrong (carried load, outside temperature, runway length etc…)
ii. Computations may be inaccurate (wrong interpretation of charts, bug in the software etc…)
iii. The data entry process into the FMS may be incorrect (distraction, stress. etc…).

The consequence of these errors on takeoff is as follows:

- Low VR inserted through the Multipurpose Control & Display Unit (MCDU), may lead to a tail strike.
- Low V2 may lead to the flight path not clearing the obstacles in one engine out condition.
- Too high Take-Off speed may lead to a runway overrun or too high energy RTO.
- A wrong thrust rating may result in a tail strike, a runway overrun or a shift of the climb path.

Other possible errors and their consequence on take off are:

- An error on the A/C configuration at take-off (CONF/TRIM setting) may lead to an “auto rotation” or a nose heavy condition
- A take-off from a different runway from the intended one, or even from a taxiway, may lead to:
  - A collision on ground with another aircraft, vehicle or obstacle
  - A collision in the air with an obstacle
  - An overrun if no lift-off before the end of the runway (even more so if combined with a high temperature FLEX take-off)
  - A low or high energy runaway overrun (in case of RTO).

Take-Off Securing function (TOS)

The TOS detects to the best extend possible, wrong data entered into the FMS by performing consistency checks between several take-off parameters. TOS function is offered in two packs called TOS Pack1 and TOS Pack2.

TOS pack 1

This Take-Off Securing package checks Zero Fuel Weight (ZFW) range and Take-Off speeds consistency. The table below summarizes the checks carried out by this pack.

TOS pack 1 is implemented on the A320 family of aircraft equipped with FMS release 1A.

The Thales system checks:

- The Zero Fuel Weight (ZFW) range
- The Take-Off speeds consistency.

The Honeywell system checks:

- The Zero Fuel Weight (ZFW) range
- The Take-Off speeds consistency
- The Take-Off speeds limitations.

Summary of TOS pack 1 checks:

CHECKS	Risks covered	Implementation
TO speeds consistency	Inversion between two speeds and gross erroneous input of one TO speed	FMS release 1A THALES and HONEYWELL
ZFW refined range	Gross erroneous ZFW input in the FMS	
VS1G/VMU limitation (V2 > V2min and VR > VRmin	Erroneous input of too low V2 and VR in FMS and inconsistency between TO weight/CONF/THRUST and V2/VR for any weight. TO performances computation with erroneous parameters	FMS release 1A HONEYWELL
VMC limitation (V1 > V1min, V2 > V2min and VR > VRmin	Erroneous input of a too low TO speed in FMS (taking into account thrust rating)	
PITCH TRIM / MCDU / CG DISAGREE alert on 320 family	Incorrect TRIM setting, Auto rotation, nose heavy	EIS S9.0, FAC 621 and FWS H2 F6 standards

Note:

VMU *minimum unstick speed, is the calibrated airspeed at and above which the aeroplane can safely lift off the ground, and continue the take-off.*

VMCG *minimum control speed on the ground. It is the calibrated airspeed during the take-off run, at which (when the critical engine is suddenly made inoperative) it is possible to minimize the deviation of the airplane by the use of the primary aerodynamic controls alone, to enable the take-off to be safely continued using normal piloting skill.*

VMCA *minimum control speed in the air. It is the calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to minimize deviation of the airplane with that engine still inoperative, and maintain straight flight with an angle of bank of not more than 5 degrees.*

VS1G *speed that corresponds to the maximum lift coefficient (i.e. just before the lift starts decreasing).*

In the following, the procedure carried for each of these checks are detailed along with the display indications.

1. Zero Fuel Weight

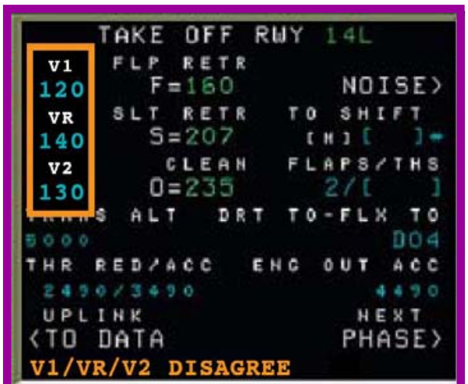
When ZFW value is entered, a range check is performed to ascertain whether the entered value is within the prescribed range i.e. ZFW min ≤ ZFW ≤ ZFW max. If the check fails, the ZFW entry is rejected and an "**ENTRY OUT OF RANGE**" caution message appears on the MCDU scratchpad. This range check considers ZFW relevant to each aircraft type.

MCDU scratchpad message for ZFW range check

2. Takeoff speed consistency

Take-Off speeds consistency check is performed as soon as all Take-Off speeds are inserted in the PERF take-off page, or each time a take-off speed is modified.

When the condition **V1** ≤ **VR** ≤ **V2** is not satisfied, a "**V1/VR/V2 DISAGREE**" caution message will appear on the MCDU scratchpad.



MCDU scratchpad message for TO speeds consistency check

3. Take-Off speeds limitations

This function check ensures that the takeoff speeds are above the minimum control speeds VMCG & VMCA, and the max. lift coefficient speed VS1G. Based on pilot inputted takeoff data, VMC and VS1G limitations as defined below are checked.

VMC limitation check:

V1 ≥ VMCG
VR ≥ 1.05 VMCA
V2 ≥ 1.10VMCA

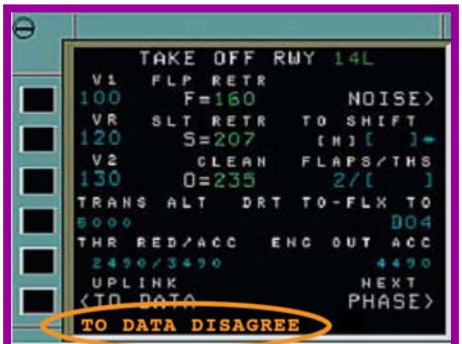
VS1G limitation check:

VR ≥ KVR * VS1G
V2 ≥ KV2 * VS1G (KVR & KV2 are margin coefficients)

This functional check is done when

- ZFW, BLOCK and CONF are entered on the MCDU
- ZFW, BLOCK, CONF or take-off thrust setting are modified
- Engines are started.

In case of an abnormal TO speed, the "**TO DATA/TOW DISAGREE**" caution message appears on the MCDU scratch-pad.



MCDU scratchpad message for TO speed limitation check

4. PITCH TRIM/MCDU/CG disagree alert

This function checks the consistency of trim setting of the Horizontal stabilizer, the trim required as per the C.G. location and the actual trim.

It is performed when the TO Configuration Push Button is pressed, and during flight phase 3.

The parameters checked for consistency are:

- The Trimmable Horizontal Stabilizer (THS) setting (TRIM) entered in the FMS
- The theoretical TRIM calculated from the CG by the Flight Augmentation Computer (FAC)
- The real position of the TRIM from flight controls.

When one of these parameters differs from the two others by more than 1.3° of THS, the **PITCH TRIM/MCDU/CG DISAGREE** caution is displayed on the ECAM and a single chime aural alert is triggered.

TOS pack1, except for the "PITCH TRIM/MCDU/CG disagree alert," is implemented for the A320 family. TOS pack1 update with the PITCH TRIM/MCDU/CG disagree alert is under development for A320 family.

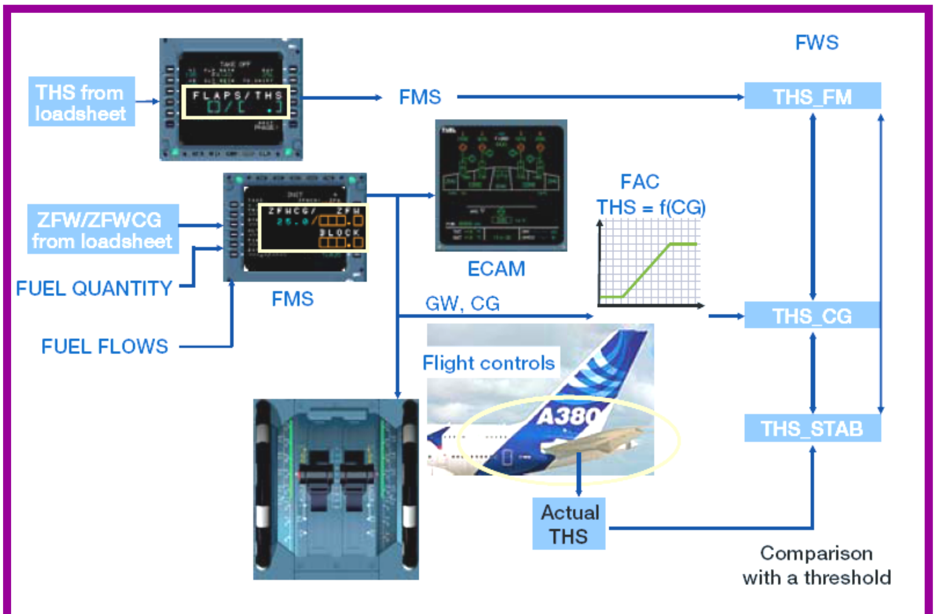
The **TOS pack1** is under development for A330/A340 and A380. The PITCH TRIM/MCDU/CG disagree alert exists on the A330/A340 and A380.

TOS PACK2

TOS pack2 currently under development is an enhancement on pack1. It offers a more complete safety net against erroneous take-off parameters entered in the FMS.

Additional checks covered by TOS pack 2 are:

- Take-Off speeds availability
- Runway limitation and remaining runway length
- Aircraft position on runway
- FLEX temperature setting.



PITCH TRIM / MCDU / CG disagree check schematic

1. Take-Off speeds availability

The objective of this check is to avoid a take-off without Take-Off (TO) speeds (due to a last minute change, for example). The system checks that the TO speeds have been inserted during the flight preparation.

It is launched when the crew checks the aircraft configuration before take-off and is relaunched automatically at take-off power application.

If the TO speeds are not available, the TO CONFIG test is invalidated and triggers a “**NO FMS TO SPEEDS**” caution message on the ECAM along with a single chime aural alert.

2. Runway length/Remaining distance on runway

To reduce the probability of runway overruns, this function does the following:

- During the pre-flight phase, the system checks for the consistency of the inserted TO data with the planned departure runway. The estimated lift-off run distance is compared with the distance available on the runway (including TO shift).

MCDU message for runway limitation check (MCDU)

- During the take-off phase, the system compares the estimated lift-off run distance with the remaining distance on the runway, taking into account the real time position and speed of the aircraft.

If the system detects a risk of runway overrun during the pre-flight phase, a caution message is displayed on both the MCDU scratchpad and the ECAM.

If the system detects a risk of runway overrun during the take-off phase (thrust levers set in a position higher than the Climb (CLB) detent), a “RWY

ECAM alarm when the Lift-off run check detects a risk of overrun at take-off (take-off power condition is false)

ECAM alarm when the Lift-off run check detects a risk of overrun at take-off (take-off power condition is true)

TOO SHORT” warning is displayed on the ECAM and a single chime aural alert is triggered.

3. Aircraft position on airport

The aim of this function is to prevent take-off from a taxiway or a wrong runway.

As soon as the thrust levers are set in a position higher than the CLB detent, the system compares the position of the aircraft with the FMS navigation database.

If the aircraft is not on a runway, an “**ON TAXIWAY**” warning is displayed on the Navigation Display (ND) (all the ranges are concerned) and an “ON TAXIWAY!” specific aural alert is triggered.

If the aircraft is not on the runway selected by the pilot, a “**NOT ON FMS**

MCDU message for runway limitation check (MFD)

On Taxiway message on ND

RWY” caution message is displayed on the ND (all the ranges are concerned) and a “NOT ON FMS RWY!” aural alert is triggered.

4. Take-off FLEX temperature setting

Here the objective is to check the FLEX temperature setting upon selection of FLEX take-off.

On current aircraft, when the thrust levers are set on the MCT/FLX detent, the FADEC compares the entered FLEX setting with the outside temperature.

In case of incompatibility, the “ENG THR LEVERS NOT SET” caution, as well as the procedure to follow, are displayed on the ECAM and a single chime aural alert is triggered.

In the frame of TOS2, the above ECAM caution message will be changed to indicate “SAT ABOVE FLX TEMP”.

TOS pack2, is under development for the A350 and will later be applied on the A380.

In conclusion, Airbus has developed an automatic check called TOS function, a safety net against erroneous take-off parameters, and is expected to reduce tail strikes, runway overruns and loss of control during take-off.

On similar lines, Airbus is developing two more packs exclusively for take-off monitoring and weight & CG estimations.

Reference:

1. Stephane Puig., “ The Take-off Securing function ”, SAFETY FIRST - The Airbus Safety Magazine, #8, July 2009.

Press-on-itis

Adapted from " Press-on-itis" - a Skybrary briefing note on Human performance and limitations

Press-on-itis is a psychological phenomenon associated with flight deck crew. It is also known as "get-home-itis," "hurry syndrome," "plan continuation" and "goal fixation." Irrespective of the name, it presents a serious problem to flight safety and can affect the best and most experienced pilots. It is important for a pilot to understand the causes of press-on-itis and to recognize when he or she is suffering from the condition. This will allow a pilot to recover before anything goes wrong terribly.

In simple terms, Press-on-itis is the decision to continue to the planned destination or toward the planned goal despite a lack of readiness of the airplane or crew and the availability of reasonable lower-risk alternatives. A typical example is the decision to continue with an unstabilized approach even though there is an alternative of go-around.

Examples of press-on-itis include:

- multiple approaches despite the weather being unlikely to improve
- Violating MDA/DH minima
- Racing a thunderstorm to a destination or Landing in a thunderstorm
- Failure to
  - abide by aircraft performance limits
  - plan for a go-around or diversion.

Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) study, examined 76 approach & landing accidents and serious incidents and found that poor professional judgment/ airmanship was the most frequent causal factor(74%). Press-on-it is accounted for 42% of all occurrences in which the crew continued an approach and landing when conditions warranted other action.

Omission of action/inappropriate action (deviation from SOPs) was the second most listed causal factor (72%). In 40% of the cases, there was deliberate non-adherence to procedures.

Flight deck crew must abide by many laws, rules and SOPs. They are required to choose the safest strategies. Real life flight operation involves decisions which are not always simple "yes/no" or "go/stop", but complicated with many options, each of which can lead to an another decision.

When pilots intentionally deviate from SOPs, it is seldom malicious. If no flight deck crew deliberately crashes an aircraft, possibly killing themselves and their passengers, why do well-intentioned people make decisions that in hindsight appear grossly inappropriate? To understand this, let us look at an example of press-on-itis.

An aircraft sustained major damage to the tail area, when it struck the ground to the right of the runway in an attempt to land from a low-level visual circuit after two unsuccessful instrument approaches in poor weather.

The accident investigation found that there were numerous deviations from SOPs by the flight crew which prevented attaining a stabilized approach and increased the workload of the captain.

The visual circuit required aggressive maneuvering, but the captain was unable to place the aircraft on the runway. The first officer called too late for a go-around. As a result, there was a tail strike causing substantial damage.

The accident investigation report made the following observations on the captain.

- Deviating from SOPs probably came from *professional pride in his ability and concern to provide superior service.*
- He was aware of the relative importance of commercial and safety considerations and previously had diverted when the situation demanded it.
- He did not appear to be exceptionally prone to reckless behavior.
- It was likely that he took the *challenge of completing this flight as planned under difficult conditions and allowed himself to be deceived into pursuing that challenge in a gradually increasingly risky manner*.

<u>The insidious acceptance of increasing risk in pursuit of a goal is best averted by means of clear planning, considering all the relevant options, and decisive adherence to the plan by all crew members.</u>

These comments identify a classic example of press-on-itis in which a pilot deviates from SOPs with the best of intentions, but nevertheless presses on in an increasingly risky manner to achieve a goal.

According to the investigation report, the aims of the pre-descent briefing were not achieved because the first officer was unaware of any proposed deviation from the SOP and that there was no cohesive plan for the approach. Clearly, attempting to achieve the objective of landing the aircraft at the destination without carefully considering the situation and a lack of understanding between the crew can present a significant danger.

Much of aviation safety comes from managing risks, and press-on-itis is one of the risks that can be managed through awareness, understanding and institutionalizing defenses and response strategies.

Flight crew may succumb to press-on-itis for the following reasons:

- They want to "just get the job done" (excessive commitment to task accomplishment) and are influenced by organizational goals such as on-time arrival, fuel savings and passenger convenience
- They may be competitive – "if XXX airline made it, so can we!"
- Personal ego that makes the crew reluctant not to achieve their objective of landing at the original destination
- "We are almost there, let's just do it and get it over with"
- "We do not want to divert, with all the associated additional work"
- They may have diverted once when everyone else landed safely and felt somewhat embarrassed about it or were questioned about their decision
- "Not getting in" may be deemed to be a loss of face
- They are over-confident that nothing will go wrong
- They welcome a chance to demonstrate their skills in challenging situations
- They have a personal commitment/ appointment at the completion of the flight, or they may simply want to get to the destination

- They are fatigued
- They become task-saturated
- They focus solely on aircraft flight path control due to turbulence and other distractions
- They miss the significance of ATC calls of changing winds and runway conditions
- They lose situational awareness and are not fully aware of the potentially perilous situation
- They have not set performance limits and trigger gates that require a go-around
- They may have poor CRM skills, and, even if one of the crew feels uncomfortable about continuing, he or she may therefore not speak up
- They do not conduct a risk assessment based on current and developing (possibly deteriorating) conditions
- They do not anticipate and plan for things that may go wrong
- They are not fully aware of their own limitations and/or that of the aircraft.
- They feel nothing matters if they can just get it on the runway and get it stopped.

Knowledge of how press-on-itis can negatively affect flight deck crew decision making can help in the recognition of its hazards and, hence, reduce decision errors.

The following are the various means to prevent press-on-itis:

The company should

- commit to safety as a priority and act in such a way that does not contradict that commitment. Excessive pressure for potentially risky actions such as on-time arrivals, fuel savings and passenger convenience can result in press-on-itis.
- have a sound training program about the dangers of press-on-itis and other matters relating to safety and human factors.
- emphasize the importance of observing the minima and procedures.

Flight deck crew should be

- indoctrinated in the error-reducing benefits of proper planning. Preplanning among captain, first officer and dispatcher allows everyone a chance to comment and gain a shared mental model of possible alternate plans.
- taught to ask "why?" when they select the more risky of two alternatives.
- to carry out a risk assessment based on crew fatigue level and type of approach. For example, a circling approach at night entails much more risk than flying a precision approach.
- trained in selecting alternates (a "close-in alternate" may be affected by the same weather system)
- trained and required to calculate the increased stopping distance required for a contaminated runway based on the estimated ground speed, MEL limits, etc.

The Company policy and crew training should emphasize carrying enough fuel for diversion and/or holding.

SOPs and training should stress the selection of a runway with vertical guidance even if it is not the noise abatement runway.

Training should emphasize the need to:

– Review and brief the crosswind/tailwind limits for weather and runway conditions.

– Brief the planned approach including aircraft configuration, navigation and automation procedures.

– Clearly brief performance limits and minima for approach Review and brief the crosswind/tailwind limits for weather and runway.

– Be go-around minded. If everything is not within limits, go around.

– Take the necessary time to re-brief and set up for a new approach if plans change. Do not rush, and do not let ATC pressure you into a rushed approach.

– Fly the aircraft onto the runway at the proper touchdown point. If the approach does not look right or feel right, then go around.

– Be mindful of the danger of letting one's own commitments or circumstances or the commitments of the rest of the crew influence your decisions.

– Conduct a debrief after every flight. Recognize that just because you made it in safely this time does not mean it was a wise decision. Learn from those experiences, recognize the precursors of an accident and divert or go around early.

PHOTO OF THE MONTH

Over to Hamburg

February 16, 2009, Toulouse. Air France's first A380 took off to Hamburg from Toulouse for painting and cabin outfitting. The unpainted fuselage and wing reveals the massiveness of the aircraft, unlike a fully painted one.

The aircraft was delivered to Air France on Oct.30, 2009 and had its first commercial flight to New York JFK on Nov.23, 2009.