Islamic Republic of IRAN

Civil Aviation Organization

Aircraft Accident Investigation Board (AAIB)

Incident Investigation Final Report

State File Number:	**950524EPTTA**
Type of Occurrence:	**Serious Incident**
Date of Occurrence:	**August 13, 2016**
Place of Occurrence:	**Tehran Mehrabad Airport**
Aircraft Type:	**A320**
Registration:	**EP-TTA**
Operator:	**Atrak Airlines**

Aircraft Accident Investigation Board (AAIB(

Date of Issue: 06 May 2017

Islamic Republic Of Iran

Civil Aviation Organization

Aircraft Accident Investigation Department

Final Report

Basic Information

State File Number:	S950523EP-TTA
Type of occurrence:	Serious incident
Date of occurrence:	August 13, 2016
Place of Occurrence:	Islamic Republic of Iran (Mehrabad International Airport)
Aircraft Model:	A320-231
Registration:	EP-TTA
Operator:	ATRAK Air

Civil Aviation Organization of I.R. of Iran

(Aircraft Accident Investigation Board)

Mehrabad International Airport

Tehran/Iran

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Contents: **page**

Foreword:

According to Aircraft Accident Investigation Act of Civil Aviation Organization of the Islamic Republic of Iran,

Accident investigation shall be conducted separately from any judicial, administrative disposition, administrative lawsuit proceedings associated with civil or criminal liability.

Base on Annex 13 to the Convention on International Civil Aviation, Chapter 3, Paragraph 3.1, and Chapter 5, Paragraph 5.4.1; it is stipulated and recommended as follows;

The sole objective of the investigation of an incident or accident shall be the prevention of incidents and accidents. It is not the purpose of this activity to apportion blame or liability.

Any judicial or administrative proceedings to apportion blame or liability should be separated from any investigation conducted under the provisions of this Annex.

Abbreviations:

ARM	Aircraft Recovery manual
ATR	Atrak Air
A/THR	Auto throttle system
BEA	Bureau d’Enquêtes et d’Analyses, France
CG	Centre of Gravity
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
FDR	Flight Data Recorder
EPRA	Engine Pressure Ratio Actual
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
GS	Ground Speed
GW	Gross Weight
HDG	Heading
HPC	High Pressure Compressor
I.R.I	Islamic Republic of Iran
LATG	Lateral G force
LOC	Localizer
LPC	Low Pressure Compressor
MCT	Maximum Continuous Thrust
MRO	Maintenance Repair Organization
MSN	Manufacturer Serial Number
MTOW	Maximum Take-Off Weight
NWS	Nose Wheel Steering
QFU	Magnetic orientation of runway
SSFDR	Solid State FDR
THR	TEHRAN
TLA	Thrust Lever Angle
TOGA	Take-Off Go-Around Thrust
UTC	Coordinated Universal Time

Synopsis:

On Saturday, August 13 , 2016, the Accident Investigation Board of Civil Aviation Organization of I.R of Iran was notified that an A320, EP-TTA, operated by ATRAK air with flight No; ATR1943 from Tehran(OIII) to Mashahd (OIMM) has experienced a low speed lateral **Runway Excursion** while performing a take-off from runway 29L at Mehrabad International Airport. There were not any injuries as result of this incident.

The Aircraft Accident Investigation Board of I.R of Iran Civil Aviation Organization instituted the investigation of this serious incident. According to Annex 13, chapter 5, the "Notification" was sent to state of Design & Manufacture (French Aircraft Accident Investigation Bureau-BEA). Therefore the Accredited Representative of BEA and his adviser from Airbus Company were introduced to investigation team and joined to the investigation.

The probable cause of this incident was the pilot failure to set engine power to take off power without initial stabilization on both engine parameters and also timely manner to safely aborting take-off and stop the aircraft after rolling, which resulted in a runway excursion. This failure occurred because the pilots' lack of attention with the aircraft FCOM.

1. FACTUAL INFORMATION:

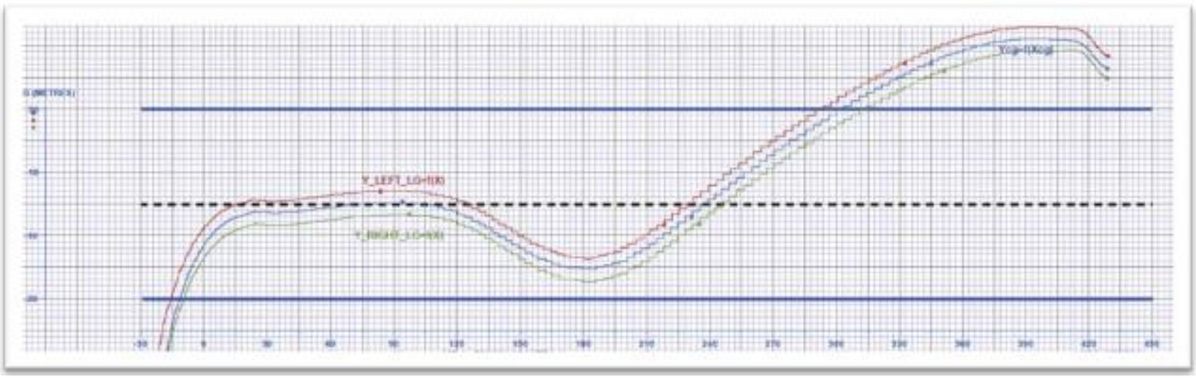
1.1 History of the flight:

On August 13, 2016, an A320 MSN0393 (registration EP-TTA), operated by Atrak Air was planned to have scheduled passenger flight No; ATR.1943 from Mehrabad International Airport (OIII) to Hasheminejad Mashhad Airport (OIMM). The aircraft experienced a low speed lateral runway excursion while performing a take-off from runway 29L at Mehrabad International Airport in the IR of Iran.

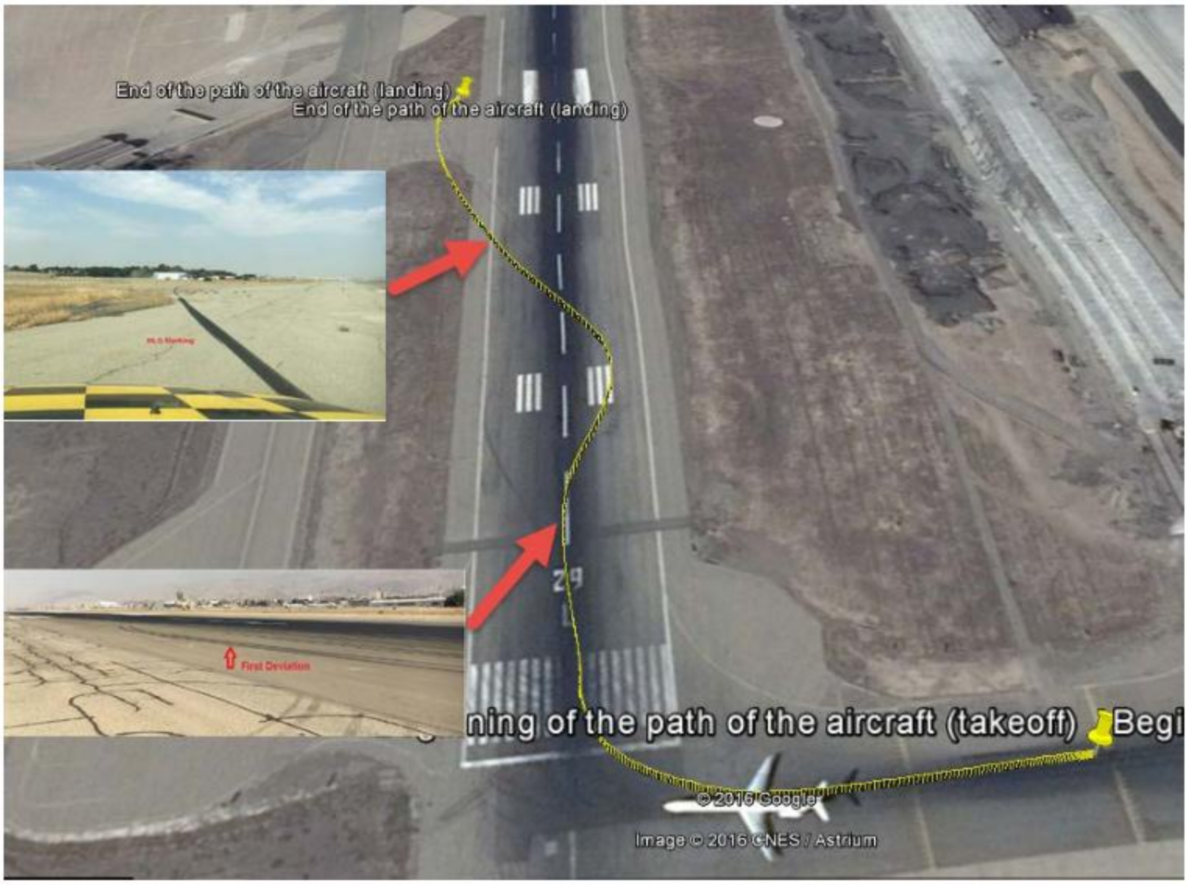
Finally the aircraft stopped in the soil area out of the RWY and the pilot requested stand to evacuate the passengers.

AIRCRAFT TRAJECTOGRAPHY

As per computed trajectography, the aircraft exited the runway at about 300m after runway threshold and 47m from the runway centerline.



Below is the trajectory and provided photographs of the incident site which are taken shortly after the event.



1.2 *Injuries to persons*:

All 9 persons of the crew and 154 Passengers were not injured and disembarked from the stair normally.

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor/None	9	154	

1.3 *Damage to aircraft:*

The aircraft was towed to the parking area and its operation was suspended and the manufacturer issued structural inspections to comply before the next flight.

- The inspections were done by FARSCO aviation MRO and both nose wheel assemblies were damaged so replaced.
- Some minor FOD damages sustained on the both engine blades.
- According related inspection programs accomplished without any findings or major structural damages.
- Landing light was damaged

1.4 Other Damages to aircraft:

There is not any damage on the airport facilities.

1.5 Personnel Information:

1.5.1 Pilot Flying :(Left Hand Seat)

- Pilot in command
- Male, 52 years old, Iranian Nationality
- Commercial pilot, ATPL (A) No1700 Class 1, from Iran CAO
- Type Rating: A320
- Valid Medical Certification
- Total flight time: 10100 H.
- Flight time on type: 250 H.

1.5.2 Pilot None Flying: (Right Hand Seat)

- First Officer - Male, 33 years old, Iranian Nationality
- Commercial pilot, CPL (A) No.4175 Class 2, from Iran CAO
- Type Rating: A320
- Valid Medical Certification
- Total flight time: 2100 H.
- Flight time on type: 1200 H.

1.6 Aircraft information:

The Airbus A320 aircraft with registration EP-TTA was manufactured in 1993. It had valid airworthiness certificate (C of A) issued by I.R.I civil aviation organization. The general information of this aircraft was as followed:

Aircraft model:	A320-231
Manufacturer Serial Number (MSN):	393
Production Delivery:	26_{th} February 1993
Aircraft registration:	EP-TTA
Engine:	International Aero Engines (IAE) V2500-A1
Operator:	Atrak Air (ATR)
Total Flight Hours:	50084
Total Flight Cycles:	25596

1.7 Meteorological information:

The related aviation routine Meteorological Reports (METAR) in the Mehrabad Airport on 13/08 /2016 was issued as following:

13/08/2016, 17:30 > METAR OIII 131730Z 06004KT 9999 FEW040 33/02 Q1013 A2994

NOSIG

As per the METAR
a wind of 4kts was present from 060
no other significant weather.
clouds: few at 4000 feet
Dew point: 02 degrees Celsius
Temp: 33 degrees Celsius
Visibility: 10 km
QNH: 29.94 inHg

1.8 Aids to Navigation:

No problems with any navigational aids were reported.

1.9 Communications:

The Communication of the crew with ATC both on Ground (121.7MHZ) and tower (118.1 MHZ) Frequency was normal. No technical problems were reported by the flight crew or any of the air traffic controllers who handled this flight.

1.10 Airport Information:

Mehrabad International Airport is located west of the city of Tehran. The airport elevation is 3962 feet and has four runways. Two runways 29L/11R, 29R/11L are available in the airport but at the time of incident, there was reconstruction work on RWY 29R.
Flight **Atrak1943** was scheduled to take off on the runway 29L, which is 4030 M long, and 60 M wide with an asphalt surface and a 1.2% gradient.
When incident was happened the operation of the airport was suspended to save evidences of the incident so far after transferring the aircraft to the Parking, the normal operation of the airport was continued.

1.11Flight Recorders:

This aircraft has been equipped with SSFDR and CVR. The SSFDR was picked up from compartment of aircraft in a very good condition. the Row Data File of SSFDR was sent to BEA for further investigation.

1.11.1 Cockpit Voice Recorder:

After happening of this serious incident, cockpit voice recorder was picked up by CAO.IR in order to analysis and further investigation. These analyzing findings were raised from audio files of the CVR:

- ✓ The pilot took the responsibility to fly and copilot made communication and monitoring.
- ✓ The take-off Thrust was applied when copilot was read backing ATC clearance for take-off.

- ✓ Some jerking sounds were appeared from the nose landing gear.
- ✓ The copilot requested to abort rolling but the pilot disagreed.
- ✓ Due to low consequence severity situation of the incident , the pilot did not commenced emergency evacuation.

1.11.2 Flight Data Recorder:

Condition of the Recorder: no damaged and serviceable.

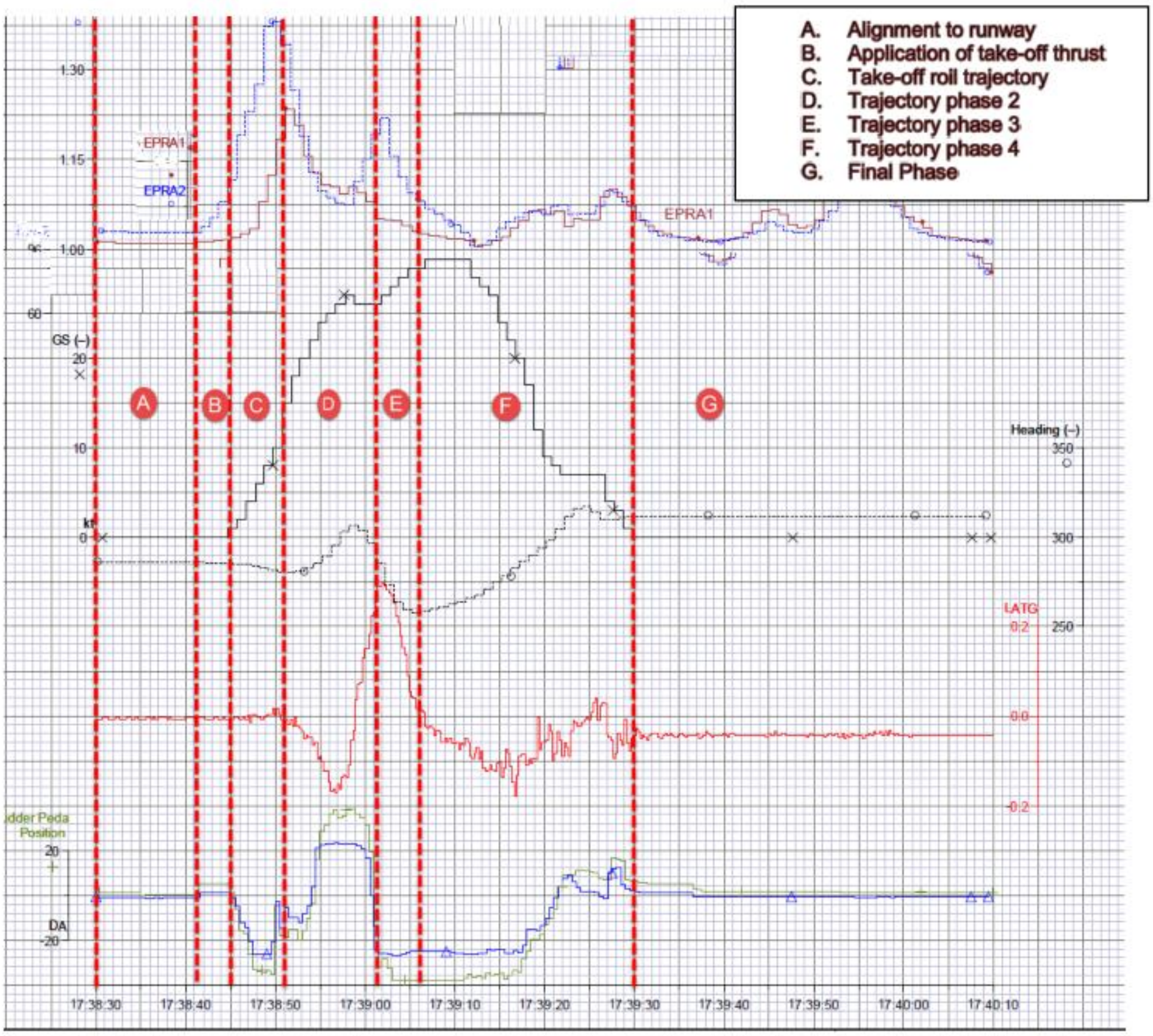
Made: FAIRCHILD (L3 Communication) Type: SSFDR

Type Number: 2100-4043-02 Serial number: 000460909

This type of FDR has a digital solid state with a recording time of at least 25 hours.

The "Flight Data Recorders" removed from the aircraft and the flight data was downloaded from the flight data recorder. Also according to request of French Authority (BEA, the Row Data File was sent to the France for further investigation.

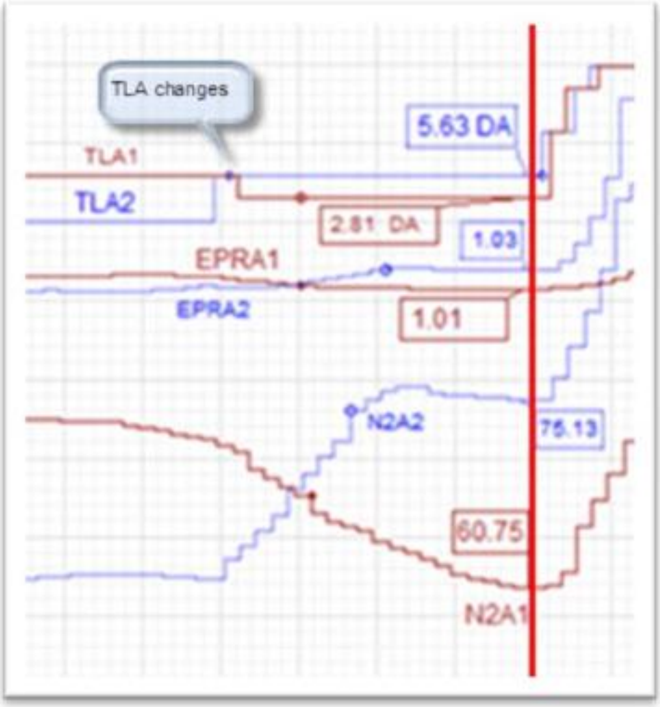
The DFDR data analyzed and description split into following section.



A. ALIGNMENT TO RUNWAY

17:38:30 UTC: A/C was stopped on the runway 29L (QFU = 285° / HDG=286.2°) with the following configuration:

- GW=65.7t (MTOW = 77t)
- CONF 2 (flaps 15°/ slats 22°)
- Ground spoilers armed
- Auto brake MAX was armed
- Anti-skid was ON
- A/THR not engaged
- TLA1 was at 2.81° and TLA2 was at 5.63°
- EPRA1 was at 1.01 and EPRA2 was at 1.03
- N2A1 had decreased to 60.75% while N2A2 had increased to 75.13%



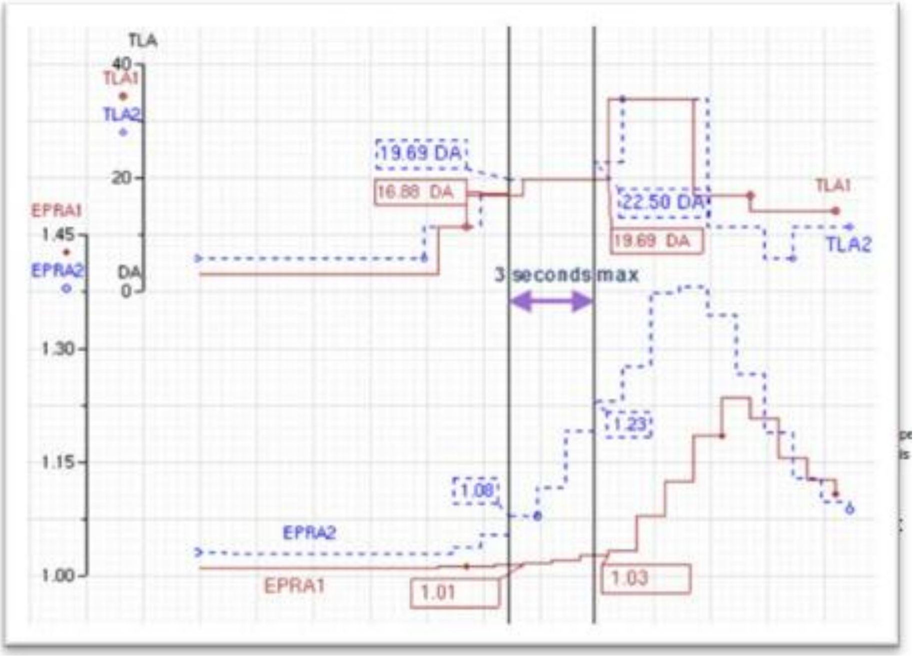
Comment:
The aircraft completed its taxi on to the runway, coming to a standstill once aligned with the runway centerline. TLA1 was reduced to 2.81° while TLA2 was increased to 5.63°, resulting in respective changes in engine N2A and EPR parameters. Ground speed remained zero during these TLA changes.

B. APPLICATION OF TAKE-OFF THRUST

- Just before the take-off, TLA1 was recorded at 2.81° and TLA2 was recorded at 5.63°. N2A2 was at 75.1% while N2A1 was at 61%

17:38:41 UTC:
Both TLAs were symmetrically pushed up towards the MCT/FLEX notch (33°) over a duration of 6s:

- EPRA2 increased immediately, EPRA1 increased at a slower rate



Comment:
Both TLAs were advanced, pausing momentarily for between 2s and 3s (taking into account the sampling rate) at 20°, just before the Climb gate. During that time, EPRA1 increased from 1.01 to 1.03 while EPRA2 increased from 1.08 to 1.24.

This differential between the 2 engines is as expected, due to the initial difference in N2 speeds. The gradient of the spool up is similar between both engines.

The FCOM states to stabilize engines at 1.05 EPR before advancing TLAs to take-off thrust.

Ident.: PRO-NOR-SOP-12-A-00011560.0011001 / 23 JUN 15
Applicable to: MSN 0393

THRUST SETTING

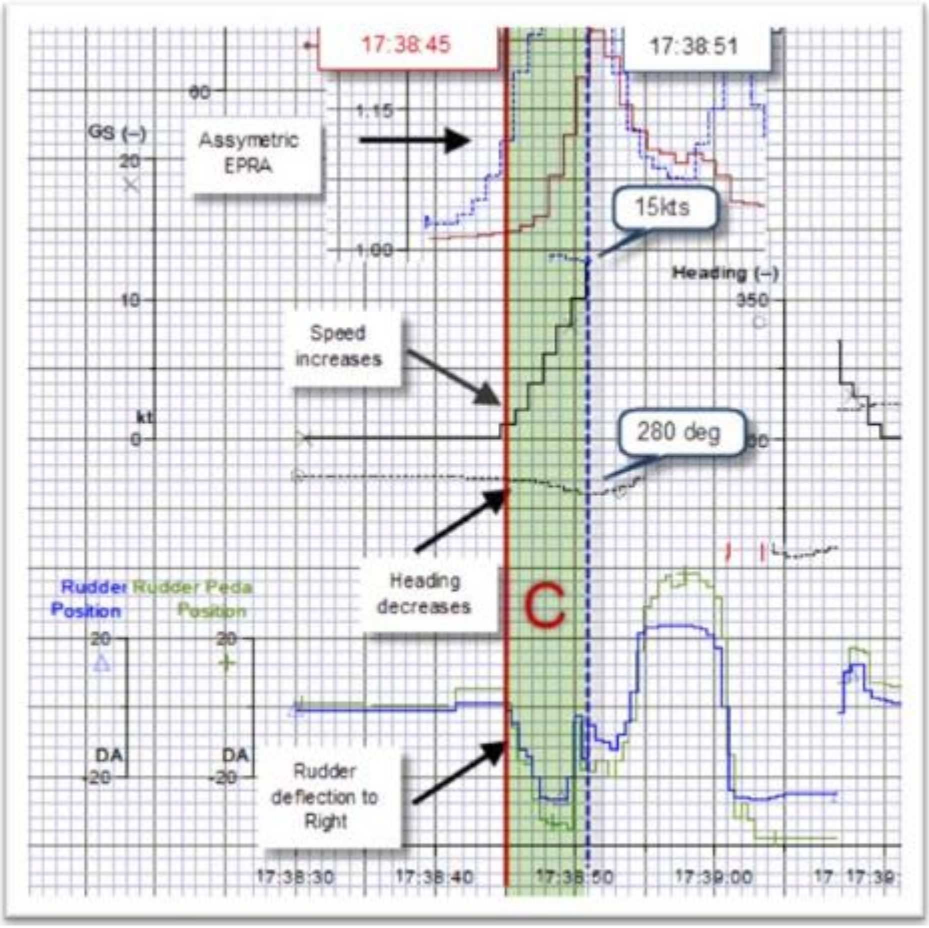
THRUST LEVERS...50 % N1 (1.05 EPR)

C. TAKE OFF ROLL TRAJECTORY

17:38:45 UTC:

- EPRA1 was at 1.02 while EPRA2 was at 1.12
- • N2A1 was at 69.5% while N2A2 was at 84.9%

Ground speed started to increase and heading started to decrease. A right rudder pedal input was applied, reaching -34.7° within 3s; rudder deflected to the right at 26.0° max



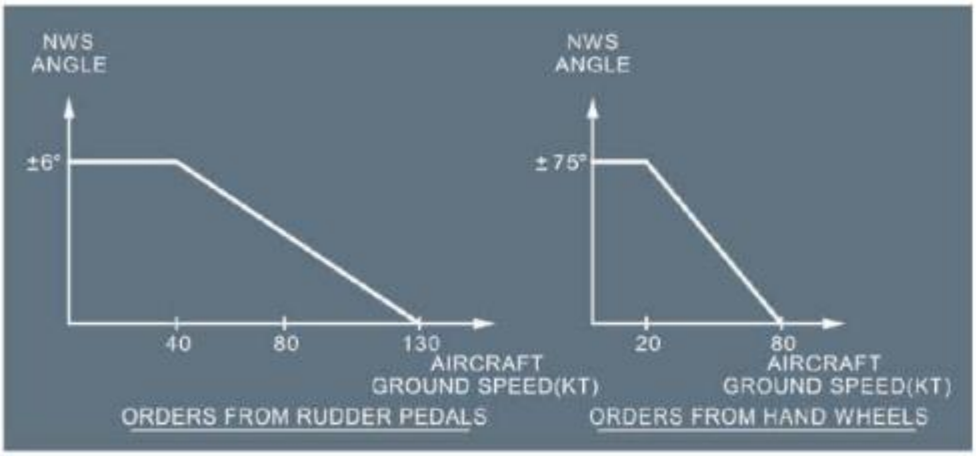
17:38:47 UTC:

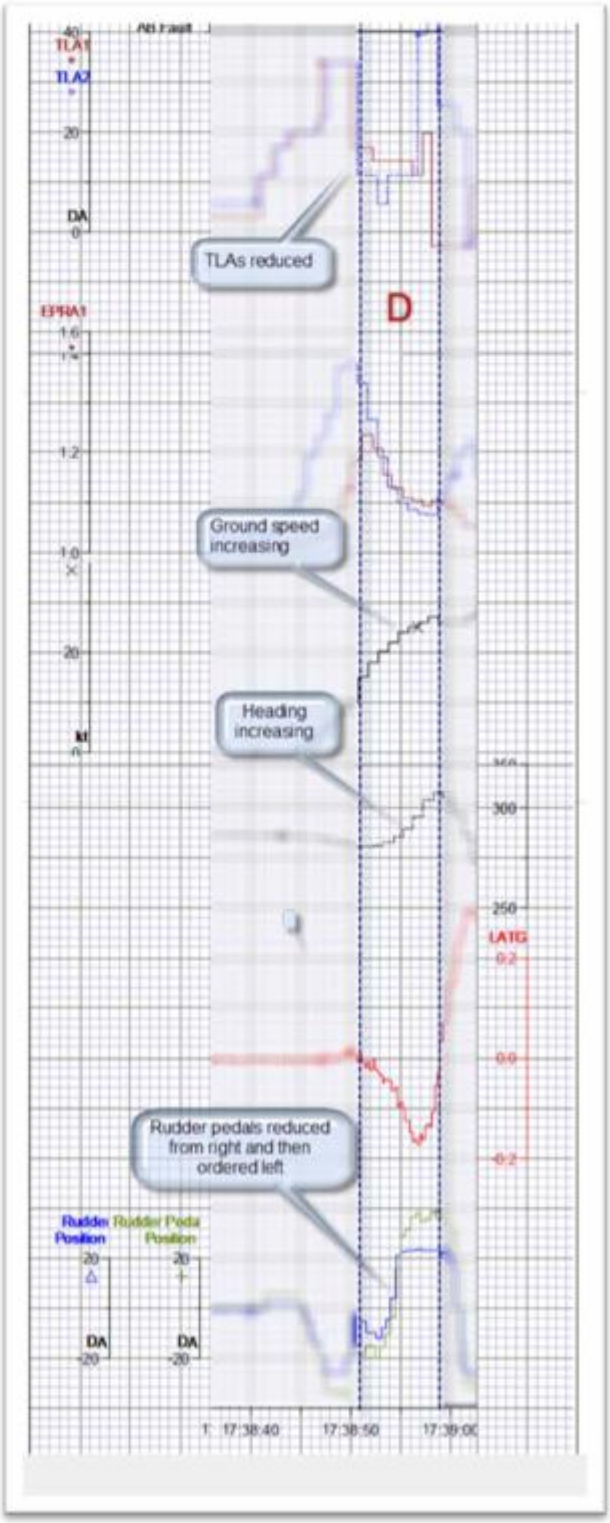
- EPRA1 was at 1.03 while EPRA2 was at 1.24
- N2A1 was at 78.0% while N2A2 was at 91.3%

Comment:
TLAs were advanced to MCT/FLEX while engines were not stabilized at 1.05 EPR.

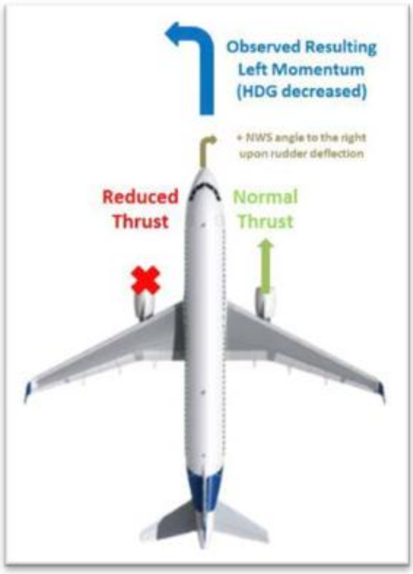
At 4kt (GS), A/C veering slightly to the left; Heading decreased from 285.1° down to 280.5 with- in 3s while speed increased to 10kts

Comment:
During the event, the ground speed did not exceed 31kt, therefore rudder deflection would not have any influence on the aircraft handling. However rudder pedal inputs would also be directed to the nose wheel steering. Below 40kts, this is upto +/- 6





As the aircraft started to move forward, the heading decreased (aircraft turning towards the left). A thrust dissymmetry leads to a yawing moment towards the engine with the lowest thrust. Rudder pedal deflection resulted in the NWS steering to the right hand side to counter the veer towards the left. The overall result is a slight left yawing moment, as heading was recorded decreasing.

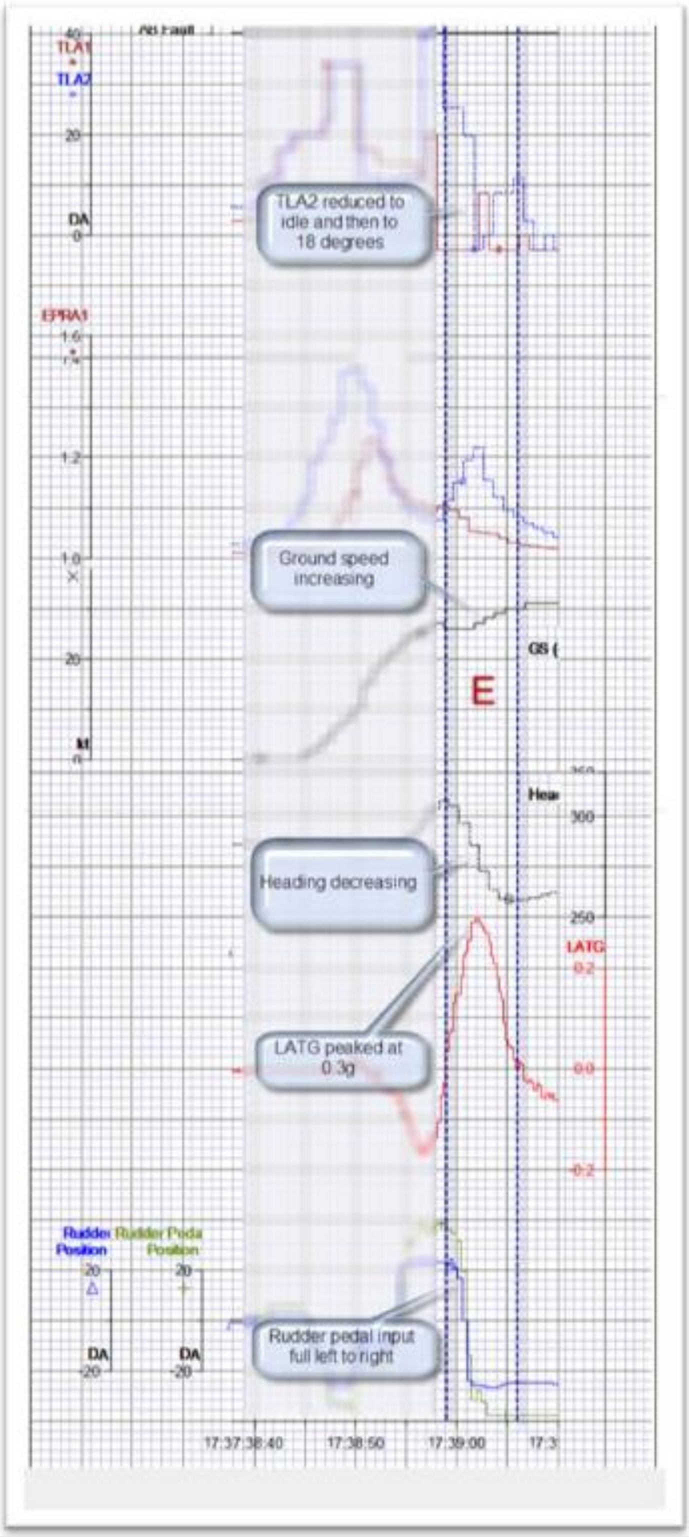


D. TRAJECTORY - PHASE 2

17:38:51 UTC:
At 15kt (GS), thrust levers were reduced to 14.0° for TLA1 and 11.2° for TLA2; rudder pedal orders were reduced to -14.8° (to the right). Heading started to increase (A/C started to veer to the right) and LATG started to decrease.

- EPRA1 was 1.23 and started to decrease ;
- EPRA2 was 1.34 and started to decrease
- N2A1 was 90.9% and started to decrease;
- N2A2 was 92.9% and started to decrease

Comment:
When the rudder pedal input to the right was reduced, the aircraft veered to the right.



17:38:54 UTC: At 22kt (GS) increasing, while A/C was turning to the right, a left rudder pedal order was applied up to +38.9°.

17:38:56 UTC: At 26kt (GS), TLA2 was pushed up to 42.2° (close to TOGA notch) and TLA1 was pulled to IDLE notch. LATG reached a minimum of 0.17G then started to increase.

17:38:58 UTC: At 26kt (GS), heading reached a maximum of 306.9° then started to decrease. Both brake pedals were applied up to around 40° during 4s

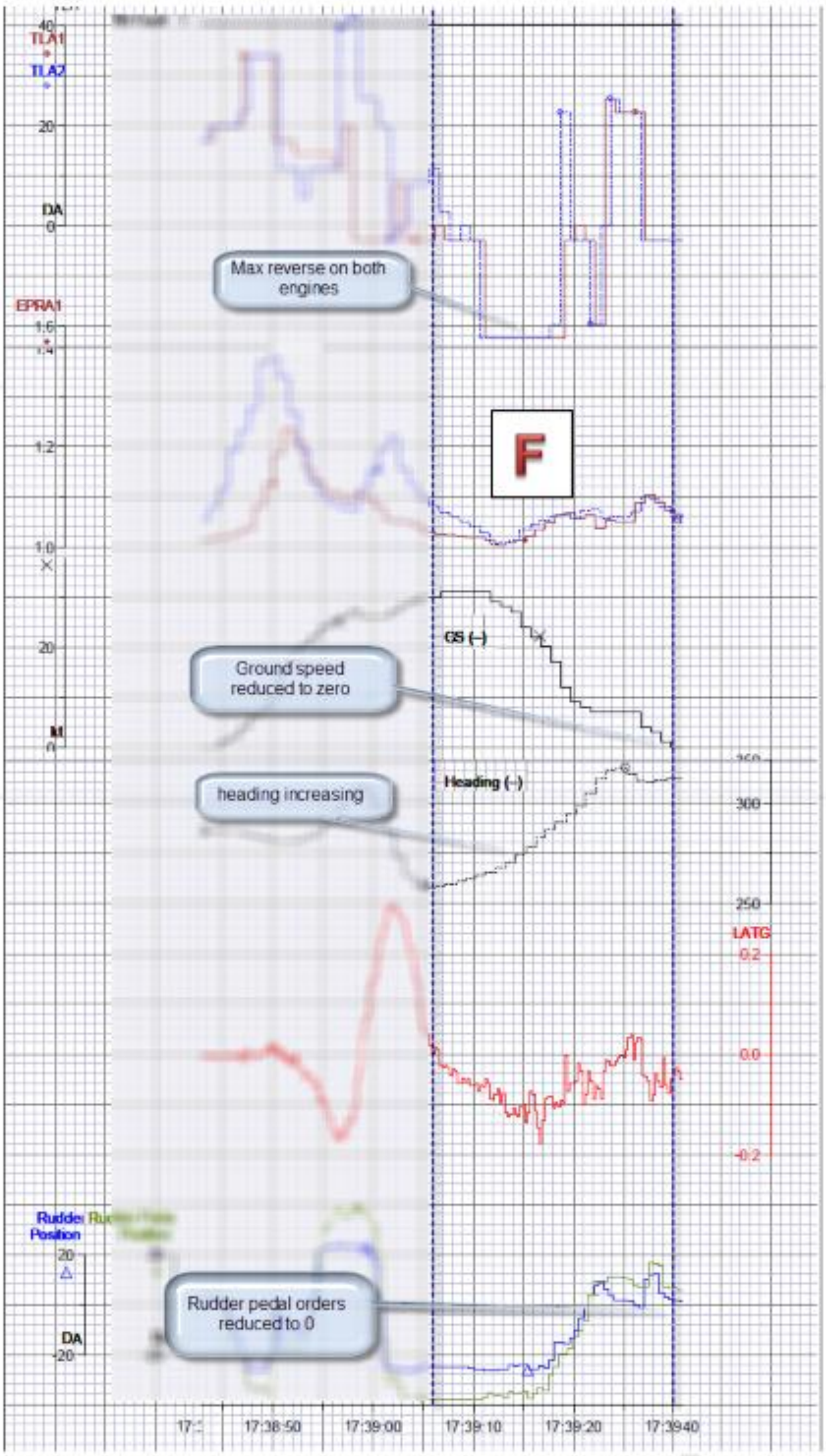
Comment: A thrust dissymmetry leads to a yawing moment towards the engine with the lowest thrust; in addition, rudder pedal deflection resulted in moving the NWS to the left. As heading was recorded decreasing, these 2 effects resulted in a left yawing moment.

E. TRAJECTORY – PHASE 3

17:39:01 UTC: At 26kt (GS),

- LOC reached a minimum value of -21.5 µA (right side of the runway)
- Heading was 285.8° decreasing
- EPRA1 was at 1.05 while EPRA2 was at 1.22 (results of actions performed on TLA2 within the last 5s)
- LATG reached a maximum of +0.30G
- TLA2 was pulled to IDLE notch within 6s. A right rudder pedal input was applied to -37.2°. Rudder surface deflected down to -24.8°.

F. TRAJECTORY – PHASE 4



17:39:06 UTC: At 30kt (GS), heading reached a minimum of 258.4° then started to increase again; LOC reduced to ~as at +20µA (left side of the runway).

17:39:10 UTC: At a maximum of 31kt (GS), both thrust levers were pulled on MAX REV notch

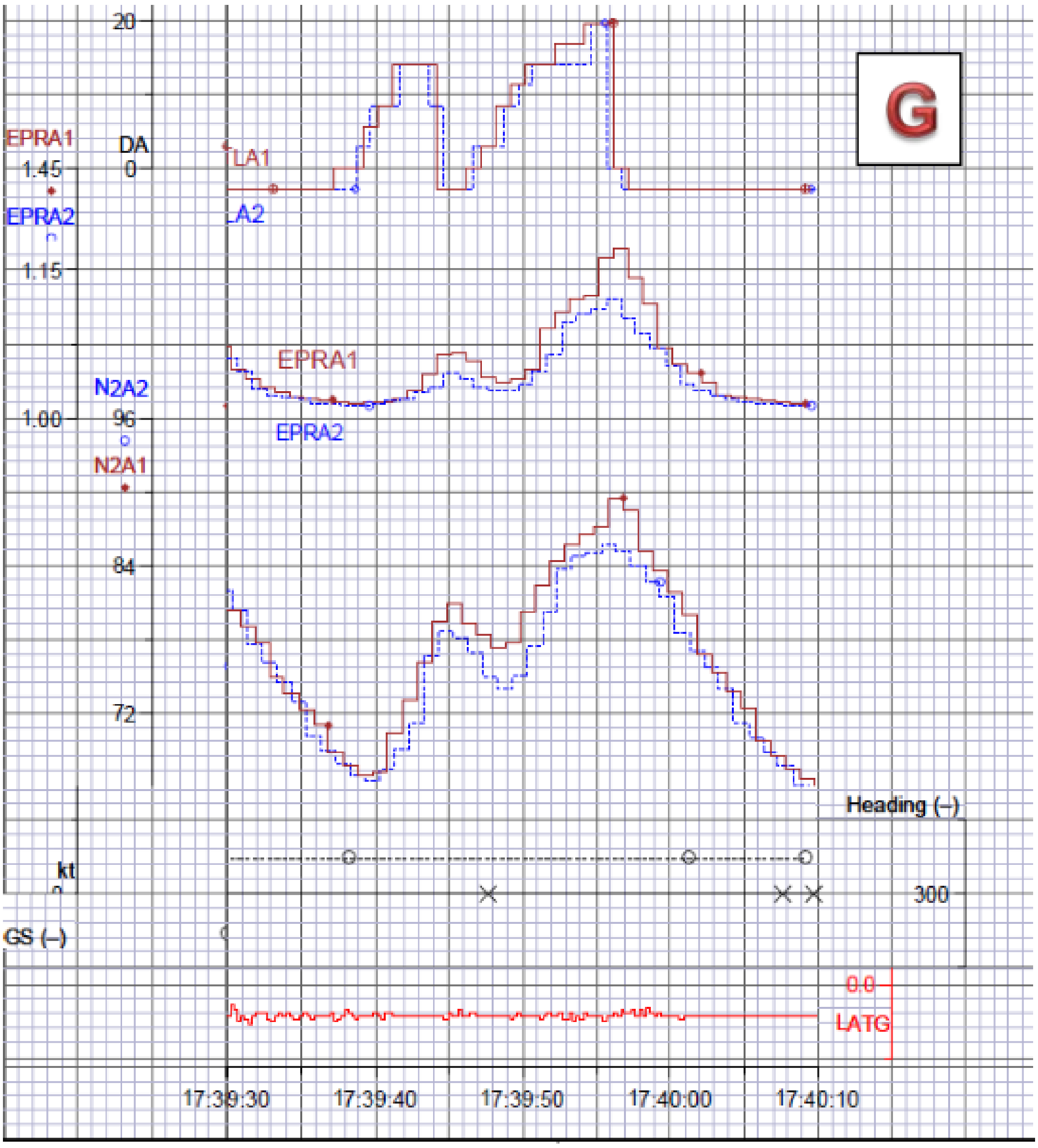
17:39:18 UTC: LOC reached a maximum recorded value of 95.3 µA. Then at 12kt (GS), TLA2 was briefly pushed to 22.5° then both trust levers were set on IDLE notch ; LOC was at +90 µA. Rudder pedal order was progressively released to 0°

17:39:28 UTC: At 3kt (GS), both brake pedals were applied up to around 50°

17:39:29 UTC: A/C was stopped; LOC was at around +61 µA

G. FINAL PHASE

Following the aircraft coming to a standstill off the runway edge, 2 thrust applications are made, with TLAs advanced to 14° first and then to 20°, with EPRA1 reaching 1.16. There was no movement in aircraft speed which remained at zero, and the heading remained static.



1.12 Wreckage and Impact Information:

There was sign of Manual braking just before excursion from the RWY and TWY C_1.

After custody release of incident site, the aircraft was towed to parking area. The Technician of Atrak Air made remedial actions on the aircraft. Then they started the engines and the aircraft was transferred to the hanger without any abnormal behaviors on the landing gears.

1.13 Medical and Pathological Information:

The research about crew and their medical documentation in CAO.IRI did not show any illegal behaviors or medical problems.

1.14 Fire:

No fire occurred for the aircraft.

1.15 Survival Aspects:

No injuries were reported.

1.16 Tests and Research:

As the pilot of incident flight has reported an unusual performance of nose landing gear during take-off. A fast test taxi and operational check according to Aircraft Maintenance manual was conducted by a technician and pilot from the I.R.I civil aviation organization. The result showed no abnormality with regard to nose landing gear and steering system.

1.17 Organizational and Management Information:

ATRAK Air is an Iranian airline that operates A320 fleet consisting of 3 A320-231 airplane (only 2 of them are operative)**.**

1.18 Additional Information:

None

1.19 Useful or Effective Investigation Techniques:

Not applicable.

2. ANALYSIS:

2.1 GENERAL:

The pilots were properly certificated and qualified under IRI Civil Aviation Organization regulations. No evidence indicated any medical or behavioral conditions that might have adversely affected their performance during the Incident flight. There was no evidence of flight crew fatigue.

The accident airplane was properly certificated and was equipped, maintained, in accordance with industry practices.

No evidence indicated any failure of the airplane's powerplants, structures, or systems that would have affected the airplane's operation during this incident.

The flight was cleared to hold short on RWY 29L and stand by for Take-off Clearance. Just the pilot heard the Take-off clearance by the tower, he set the engine power to maximum continues take off power (FLEX) and begun rolling. Meanwhile the copilot was calling back to the tower and could not to observe on engine performance. We should refer to standard Takeoff procedure and related SOP to analyze the behaviors of the crew:

2.2 **TAKEOFF PROCEDURES:**

It is recommended a FLEX power takeoff be performed whenever conditions permit. Advance the throttles and allow the engines to stabilize at approximately 1.05 EPR (50% N1) prior to advancing the throttles to the FLEX or TO/GA detent.

When engines are set to take-off thrust without stabilization, due to different initial engine conditions, different engine spool up and thrust power may be created in the first short time period, so engine stabilization is necessary before advancing thrust levers to take-off thrust. When the throttles are advanced to FLEX or TO/GA (FLEX) at takeoff, the auto throttle is armed.

- Maintain directional control throughout the takeoff roll by using the rudder to keep the airplane on the runway centerline. Do not use the nose wheel steering tiller during the takeoff roll.

During take-off roll, the following procedures should apply by the pilot:

Thrust Stabilization:

<u>FCOM</u>

Ident.: PRO-NOR-SOP-12-A-00011560.0011001 / 23 JUN 15
Applicable to: MSN 0393

<u>THRUST SETTING</u>

THRUST LEVERS..50 % N1 (1.05 EPR)

The DFDR shows that the TLAs were advanced to ~19 decree, where there was a brief pause for 2-3 seconds, and then to MCT/FLEX (33 decree). During the pause the engines had not stabilized at 1.05 EPR and were actually EPRA1 = 1.03 while EPRA2 = 1.24.

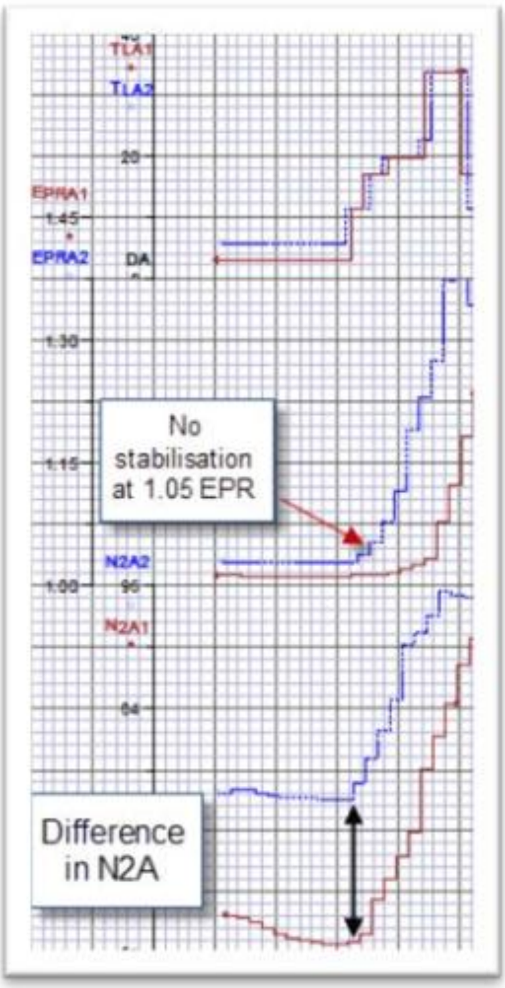
Take-off thrust application is described in FCTM NO-050 and requires thrust application and stabilization at 1.05 EPR. This equates to a TLA of 9.5 to 10 degrees – depending on bleed configuration and atmospheric conditions.

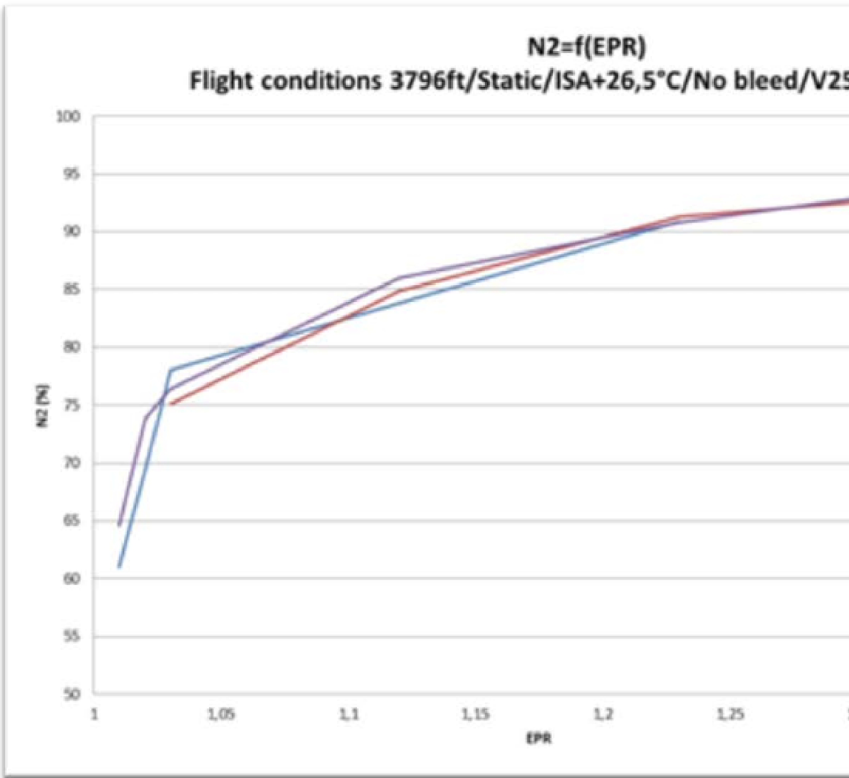
As engine stabilization was not achieved prior to advancing the throttles to MCT/FLEX, it led to the aircraft to start rolling and veer to the left due to the thrust asymmetry.

2.3 ENGINEERING ANALYSIS & SIMULATIONS

2.3.1 Engine Spool Up:

Following the asymmetric engine spool up, to ensure that there was no engine related issues, an analysis of engine behavior during the event was completed. the graph below presents the N2 vs EPR for both engines compared to the Airbus stabilized model.





Considering the sampling, the use of the stabilized model in transient phase and the engine to engine variability, both engines are consistent with the model, showing no abnormal behavior.

The EPR delta between the engines during the take-off roll is due to the longer acceleration of engine 1, which is normal due to its lower initial N2 level.

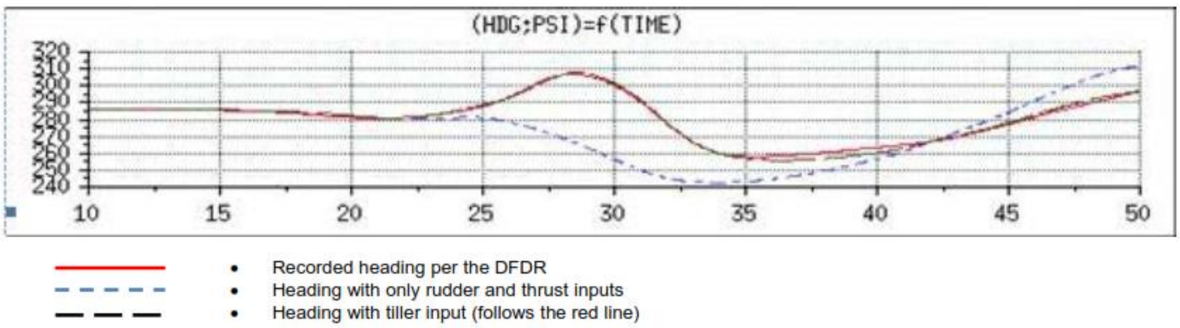
There is a pause for 2-3 seconds at ~20° TLA before they were increased to MCT/FLEX (33°). During the pause, there was no engine stabilization and TLAs were advanced to FLEX, further increasing the thrust asymmetry.

2.3.2 Rudder & Nose wheel Steering

During the event at 17:38:45, the aircraft started to veer to the left. A rudder pedal input to the right steered the nose-wheel 6° to the right. This had limited effect on the aircraft trajectory, due to the asymmetric engine thrust overcoming the nose wheel angle. The reported noise and vibration at this point would high likely be a result of the wheels started to drag on the runway, being off line to the axis of aircraft movement, driven by the thrust asymmetry. The aircraft then veers to the right, with the heading increasing.

The counteraction of the initial veer to the left results in a change to the aircraft direction. The nose wheel steering using the rudder pedals is limited to 6° in either direction and by this time, the rudder pedal order had reduced.

An engineering simulation was performed to simulate the trajectory with the rudder inputs, symmetrical braking and engine power levels as recorded on the DFDR. The Airbus simulation of the aircraft trajectory is shown below.



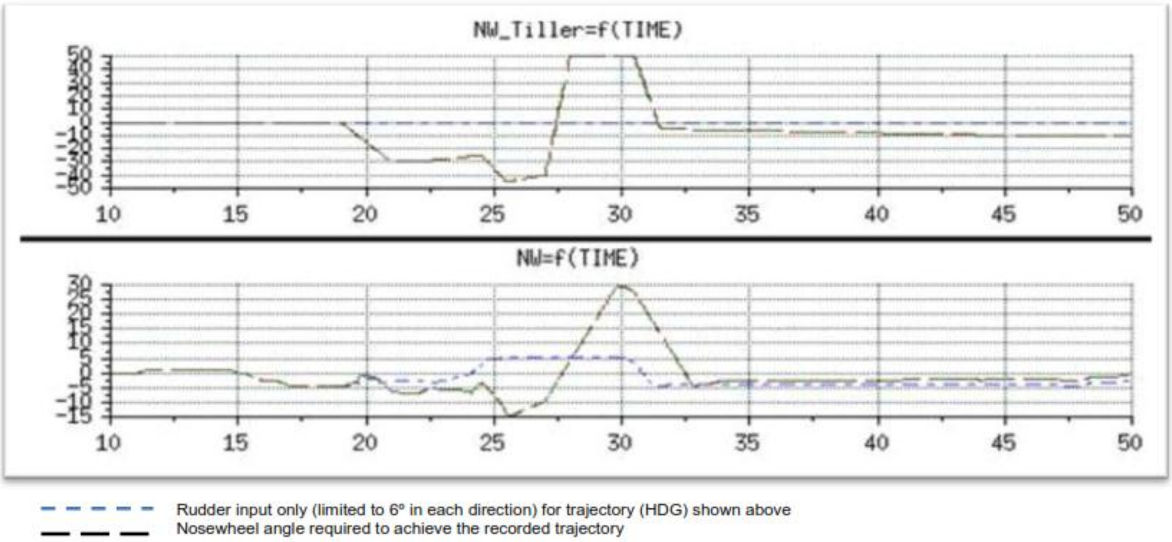
The trajectory shown with the blue dashed line is a simulation performed at Airbus using only the rudder pedal inputs and the engine thrust as recorded in the DFDR.

It can be seen above that the actual recorded trajectory is not possible using only the rudder and thrust inputs.

The actual trajectory of the event, shown in red, shows the aircraft veer to the left slightly, sharply to the right and finally, sharply to the left. There is a slow rotation towards the right, by which time the aircraft had exited the runway.

The next simulation was performed to recreate the actual trajectory. The same rudder pedal and engine inputs were used, however to achieve the actual trajectory the nose-wheel and tiller were required. Below is the result of the NW tiller and steering inputs required to achieve the recorded trajectory.

<u>Nose wheel and tiller angles vs time</u>

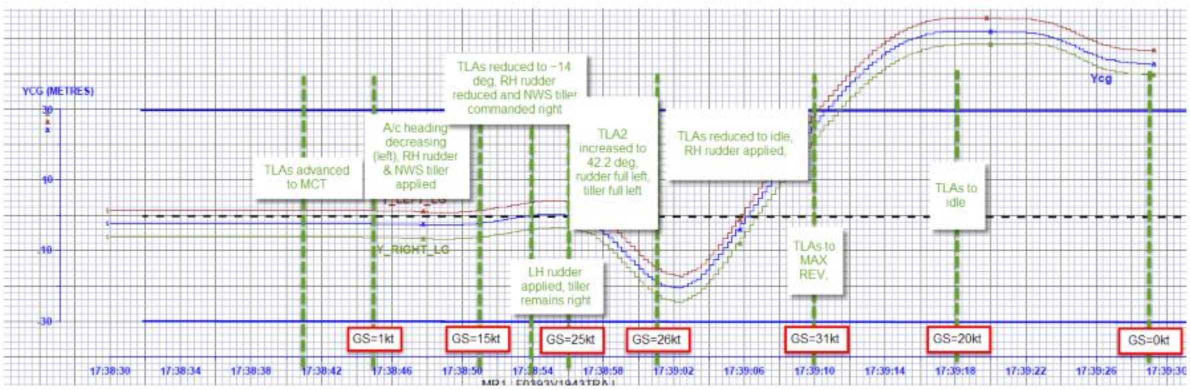


The above simulation was performed using the Airbus engineering models.

The objective of the simulation was to determine whether the tiller was used, and ascertain the nose wheel steering functionality during the event. The simulation concludes:

- That the actual trajectory is only possible with the use of the NW tiller deflection of the nose-wheel steering is commanded, firstly to the left and then to the right.

<u>Aircraft Trajectory vs Time.</u>



2.4 Directional Control:

FCOM

A318/A319/A320/A321 FLIGHT CREW OPERATING MANUAL	PROCEDURES NORMAL PROCEDURES STANDARD OPERATING PROCEDURES - TAKEOFF

DIRECTIONAL CONTROL.. USE RUDDER

At 130 kt (wheel speed), the connection between nosewheel steering and the rudder pedals is removed. Therefore, in strong crosswinds, more rudder input will be required at this point to prevent the aircraft from turning into the wind.

FCTM

The PF should use pedals to keep the aircraft straight. The nosewheel steering authority decreases at a pre-determined rate as the groundspeed increases (no more efficiency at 130 kt) and the rudder becomes more effective. The use the tiller is not recommended during takeoff roll, because of its high efficiency, which might lead to aircraft overreaction.

ATR A318/A319/A320/A321 FLEET NO-050 P 2/10

FCTM ← A to B → 22 MAR 16

2.5 DIRECTIONAL RECOVERY:

Regaining directional control following divergence from the trajectory is described in the FCTM under "LOW SPEED ENGINE FAILURE "bellowed:

LOW SPEED ENGINE FAILURE

Ident.: AO-020-00005612.0001001 / 27 JUN 12
Applicable to: ALL

If an engine failure occurs at low speed, the resultant yaw may be significant, leading to rapid displacement from the runway centreline.

To regain or maintain directional control on the runway, it is necessary:
- To immediately reduce both thrust levers to IDLE, which will reduce the thrust asymmetry caused by the failed engine
- To select both reversers irrespective of which engine has failed
- To use rudder pedal for directional control, supplemented by symmetrical or differential braking if needed.

The steering hand-wheels may be used when taxi is reached.

<u>Note:</u> *1. If rudder pedal input and differential braking are needed, apply both on the same side*
2. Below 72 kts, the ground spoilers will not deploy and the auto brake will not activate.

The suitable decision which can be made by the Pilot flying is aborting take off and control the aircraft to prevent RWY excursion. In this section of this incident, the pilot decided to use the nose wheel steering tiller and asymmetric thrust power to control directional of the aircraft. This dangerous decision had leaded to increase speed of the aircraft and reduce crew capability to control the aircraft and prevent RWY Excursion.

2.6 AIRCRAFT RECOVERY:

The DFDR data shows that 2 engine power applications once the aircraft had come to a standstill off the runway on soft ground.

This may induce damage to the airframe, to the engine, and possibly result in injuries:

- The NLG may collapse under excessive loads,
- Engines may ingest significant amount of debris,
- These debris may in sequence impact and damage the airframe, provoke fuel or hydraulic leaks, with associated risks.

The Aircraft Recovery Manual provides appropriate procedures for safely returning the aircraft back to the runway.

3. CONCLUSIONS:

3.1 Findings:

- The pilots were properly certificated and qualified for this flight.
- Evidences did not indicate any medical or behavioral conditions that might have adversely affected to the incident.
- The airplane was properly certificated and was equipped, maintained, in accordance with industry practices.
- No evidence indicated any failure of the airplane's powerplants, structures, or systems that would have affected the airplane's performance during incident.
- The pilots had adequate briefing on the related check list before rolling take off.
- The static take off has been happened during this occurrence.
- The power of engine engines was set to take off (FLEX or TO/GA) mode without initial stabilization on two engines.
- The non-flying pilot had not concentration on engine parameters while reading back of ATC clearance.
- The aircraft veered to the left due to difference of thrust power on the engines by late spool up of engine #2.
- Both pilots had disagreement to stop the aircraft and abort take-off

- The pilot flying used the nose wheel steering tiller and engine asymmetric thrust to have directional control on the aircraft which increased the speed of the aircraft.
- The abnormal noise and vibration on nose landing gear would high likely be a result of the wheels started to drag on the runway, being off line to the axis of aircraft movement, driven by the thrust asymmetry. The aircraft then veers to the right, with the heading increasing.
- The pilot used engine Thrust reverser and baking action so late and in the critical distance of runway edge, so runway excursion was not prevented.
- The Atrak Airlines did not provide its pilots with clear and consistent guidance and training regarding company policies and procedures for engine stabilization during take-off according to its SOP.
- When the incident was happened, the operation of the airport was stopped due to the single runway operation of Mehrabad Airport.

3.2 Probable Cause:

The IRI CAO Aircraft incident Investigation Board determines that the probable cause of this accident was the pilot failure to set engine power to take off power without initial stabilization on both engine parameters and also timely manner to safely aborting take-off and stop the aircraft after rolling, which resulted in a runway excursion. This failure occurred because the pilots' lack of attention with the aircraft FCOM.

3.3 contributive factors:

- Failure of the airline to provide its pilots with clear and consistent guidance and training regarding company policies and procedures related to engine stabilization before take-off roll and SOP review.
- Lack of cockpit management (CRM) for task sharing and decision making.

4. SAFETY RECOMMENDATIONS:

As a result of this investigation, the Aircraft Accident Investigation Board makes the following recommendations to the IRI Civil Aviation Organization:

- ✓ Require all operators to provide clear guidance and training to pilots regarding company policy for engine Stabilization before take-off and concerned supervision on engine data by non-flying pilot.
- ✓ Follow up on evaluation of Atrak Airlines training section to provide CRM and SOP ground course pilots.
- ✓ Concentrate on Atrak Airlines to perform extra flight data monitoring of fleets.

Also As a result of the Atrak Air incident investigation, the Safety Board issues the following safety recommendations to the Airbus Company:

- ❖ Send safety note to the Airbus operators based on findings of this report and to warn pilots to prevent such same occurrences.

5. Attachments.

TAKEOFF

Applicable to: ALL

Ident.: PRO-NOR-SOP-12-A-00011559.0001001 / 28 JUL 14

The below procedure is the standard takeoff procedure. However, rolling takeoff is permitted.

TAKEOFF.. ANNOUNCE

Ident.: PRO-NOR-SOP-12-A-00011560.0011001 / 23 JUN 15

THRUST SETTING

THRUST LEVERS..50 % N1 (1.05 EPR)

- **If the crosswind is at or below 20 kt and there is no tailwind:**

  To counter the nose-up effect of setting engine takeoff thrust, apply half forward sidestick until the airspeed reaches 80 kt. Release the sidestick gradually to reach neutral at 100 kt.

  BRAKES...RELEASE
  THRUST LEVERS.. FLX or TOGA

  Once the thrust levers are set to FLX or TOGA detent, the Captain keeps his hand on the thrust levers until the aircraft reaches V1.

- **In case of tailwind, or if crosswind is greater than 20 kt:**

  The PF applies full forward sidestick.

  BRAKES...RELEASE
  THRUST LEVERS.. FLX or TOGA

  - *The PF increases thrust progressively to reach takeoff thrust by 40 kt ground speed, while maintaining sidestick full forward up to 80 kt. Release the sidestick gradually to reach neutral at 100 kt.*
  - *Once the thrust levers are set to FLX or TOGA detent, the Captain keeps his hand on the thrust levers until the aircraft reaches V1.*

Note: 1. *ENG SD page replaces WHEEL SD page on the ECAM lower display*
2. *The FADEC includes a keep-out zone, which is designed to avoid steady state operation inside a N1 range between 60 % and 74 % due to fan flutter phenomenon. This can result in discontinuous EPR increase during thrust setting (Refer to DSC-70-20 Functions).*

DIRECTIONAL CONTROL.. USE RUDDER

At 130 kt (wheel speed), the connection between nosewheel steering and the rudder pedals is removed. Therefore, in strong crosswinds, more rudder input will be required at this point to prevent the aircraft from turning into the wind.

CHRONO..START
PFD /ND..MONITOR

1. *Check the FMA on the PFD . The following modes are displayed: FLX (or TOGA) /SRS /RWY (or BLANK) / A/THR (in blue).*

   Note: *If an ILS that corresponds to the departure runway is tuned, RWY mode appears. If not, no lateral mode appears until the aircraft lifts off.*

2. *Check the FMS position on the ND (aircraft on runway centerline).*

FMA.. ANNOUNCE

Ident.: PRO-NOR-SOP-12-A-00011561.0002001 / 04 MAR 14

BELOW 80 KT

TAKEOFF EPR..CHECK

Check that the actual EPR of the individual engines has reached the EPR rating limit, before the aircraft reaches 80 kt. Check EGT.

THRUST SET..ANNOUNCE
PFD and ENG indications..MONITOR

Scan airspeed, EPR , and EGT throughout the takeoff.

Ident.: PRO-NOR-SOP-12-A-00011562.0001001 / 13 AUG 10

REACHING 100 KT

ONE HUNDRED KNOTS.. ANNOUNCE

- *The PF crosschecks and confirms the speed indicated on the PFD*
- *Below 100 kt the Captain may decide to abort the takeoff, depending on the circumstances*
- *Above 100 kt, rejecting the takeoff is a more serious matter.*

Ident.: PRO-NOR-SOP-12-A-00011563.0001001 / 13 AUG 10

AT V1

V1..ANNOUNCE

Ident.: PRO-NOR-SOP-12-A-00011564.0001001 / 13 AUG 10

AT VR

ROTATION ....ORDER

ROTATION....................................PERFORM

- *At VR, initiate the rotation to achieve a continuous rotation with a rate of about 3 °/s, towards a pitch attitude 15 ° (12.5 °, one engine is failed)*
- *Minimize the lateral inputs on ground and during the rotation, to avoid spoiler extension*
- *In strong crosswind conditions, small lateral stick inputs may be used, if necessary, to aim at maintaining wings level*
- *After lift-off, follow the SRS pitch command bar.*

CAUTION	If a tailstrike occurs, avoid flying at an altitude requiring a pressurized cabin, and return to the originating airport for damage assessment.

Ident.: PRO-NOR-SOP-12-A-00011565.0001001 / 04 MAR 14

WHEN POSITIVE CLIMB

POSITIVE CLIMB....................................ANNOUNCE
L/G UP....................................ORDER
L/G....................................SELECT UP
AP....................................AS RQRD

Above 100 ft AGL , AP 1 or 2 may be engaged.

Ident.: PRO-NOR-SOP-12-A-00011566.0001001 / 28 JUL 15

AT THRUST REDUCTION ALTITUDE

THRUST LEVERS....................................CL

Move the thrust levers to the CL detent, when the flashing CLB prompt appears on the FMA .
A/THR is now active.
In manual flight, the pilot must anticipate the change in pitch attitude in order to prevent the speed from decaying when thrust is reduced.

PACK 1 and 2 (if applicable)....................................ON

Select PACK 1 on after CLB thrust reduction.
Select PACK 2, at least 10 s after PACK 1 is selected on, for passenger comfort.

Note: 1. *Selecting pack on before reducing takeoff thrust would result in an EGT increase.*
2. *If packs are not switched on after the takeoff phase, an ECAM caution will be triggered.*

Ident.: PRO-NOR-SOP-12-A-00011567.0001001 / 04 MAR 14

AT ACCELERATION ALTITUDE

Check the target speed change from V2 + 10 to the first CLB speed (either preselected or managed).

Note: 1. *When THR RED and ACC ALT are equal, the FMA will change from MAN FLX/SRS /--- to CLB /CLB/---.*
2. *If FCU -selected altitude is equal to or close to the acceleration altitude, then the FMA will switch from SRS to ALT*.*

Ident.: PRO-NOR-SOP-12-A-00011568.0001001 / 23 JUN 15

ABOVE ACCELERATION ALTITUDE (OR ONCE IN CLIMB PHASE)

The following procedure ensures that the aircraft is effectively accelerating toward climb speed.

- **At F speed:**

  Note: *For takeoff in CONF 1 + F, "F" speed does not appear.*

  FLAPS 1 .... ORDER
  FLAPS 1 .... SELECT

- **At S speed:**

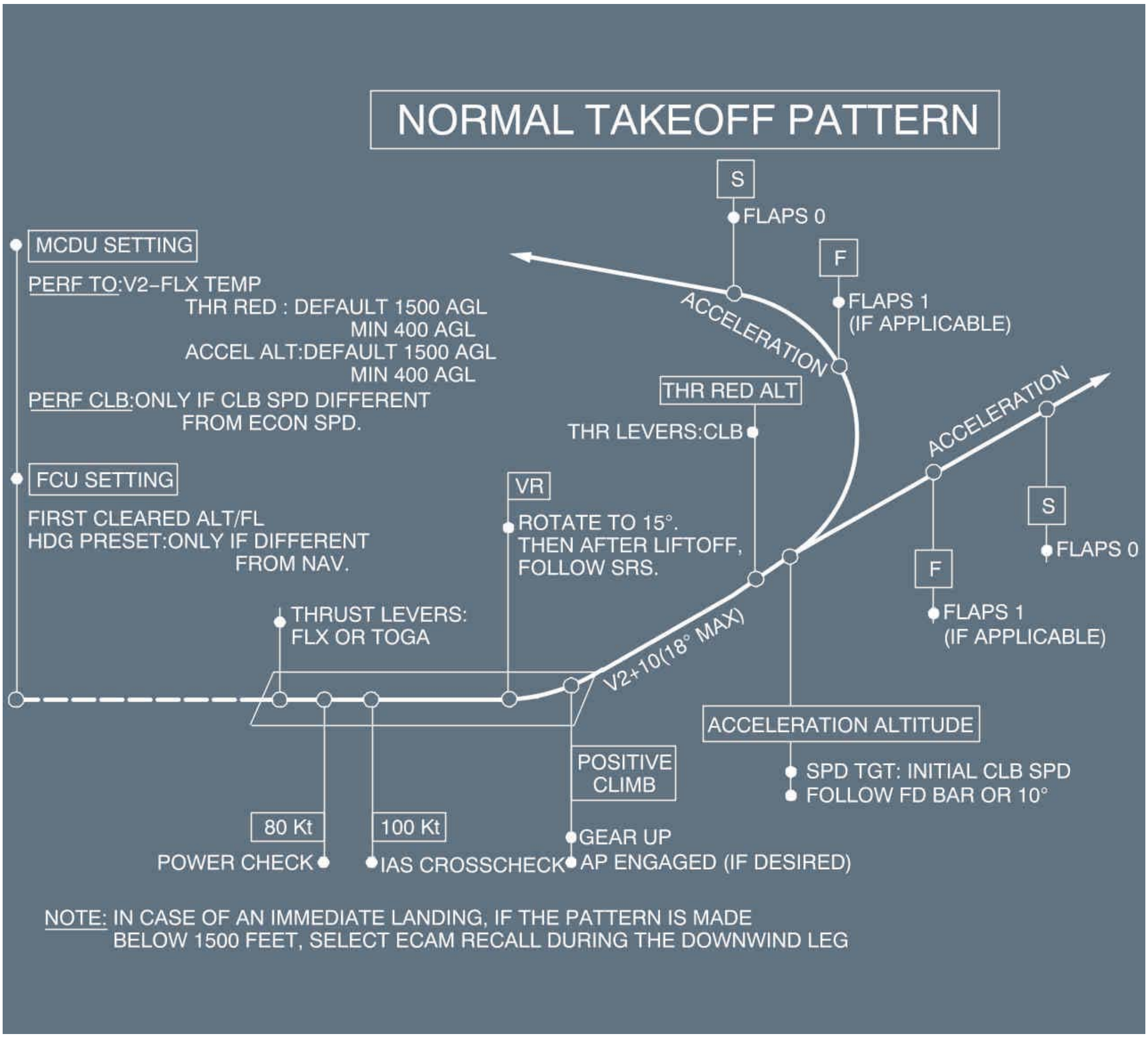
  FLAPS 0 .... ORDER
  FLAPS 0 .... SELECT
  GND SPLRS .... DISARM
  NOSE sw .... OFF
  RWY TURN OFF sw .... OFF
  OTHER EXTERIOR LIGHTS .... AS RQRD
  The flight crew can maintain the LAND LIGHTS selector set to ON, according to airline policy or regulatory recommendations.

Note: *The CRUISE SD page replaces the ENG SD page.*

Ident.: PRO-NOR-SOP-12-A-00011569.0001001 / 21 MAR 17

1 DERATED CLB OPS .... Refer to FCOM/PRO/NOR/SUP/ENG section

Ident.: PRO-NOR-SOP-12-A-00011570.0001001 / 18 DEC 12



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THRUST SETTING

Ident.: PR-NP-SOP-120-00018791.0002001 / 20 MAR 17
Applicable to: ALL

The Thrust Setting procedure ensures that all engines will accelerate similarly. If not properly applied, this may lead to asymmetrical thrust increase, and, consequently, to severe directional control problem.
The Electronic Engine Control (EEC) computer prevents the engine stabilizing between an approximate range of 60 to 74 % N1, in order to protect against fan flutter. This range is called the Keep-Out-Zone, and the flight crew may notice a non-linear thrust response to thrust lever movement. If one lever is moved out of the Keep-Out-Zone before the other, a very slow movement of the levers may lead to asymmetric engine acceleration.
If the thrust levers are not set to the proper take-off detent, e.g. FLX instead of TOGA , an alert triggers on the ECAM.

TAKEOFF ROLL

Ident.: PR-NP-SOP-120-00018792.0001001 / 20 MAR 17
Applicable to: ALL

Once the thrust is set, the PF announces the indications on the FMA . The PM must check that the thrust is set by 80 kt and must announce "Thrust Set".
The Captain must keep his hand on the thrust levers when the thrust levers are set to TOGA /FLX notch and until V1.
On a normal takeoff, to counteract the pitch up moment during thrust application, the PF should apply half forward (full forward in cross wind case) sidestick at the start of the takeoff roll until reaching 80 kt. At this point, the input should be gradually reduced to be zero by 100 kt.
The PF should use pedals to keep the aircraft straight. The nosewheel steering authority decreases at a pre-determined rate as the groundspeed increases (no more efficiency at 130 kt) and the rudder becomes more effective. The use the tiller is not recommended during takeoff roll, because of its high efficiency, which might lead to aircraft overreaction.
For crosswind takeoffs, routine use of into wind aileron is not necessary. In strong crosswind conditions, small lateral stick input may be used to maintain wings level, if deemed necessary due to into wind wing reaction, but avoid using large deflections, resulting in excessive spoiler deployment which increase the aircraft tendency to turn into the wind (due to high weight on wheels on the spoiler extended side), reduces lift and increases drag. Spoiler deflection becomes significant with more than a third sidestick deflection.

In the event of unexpected lateral disturbance during takeoff roll, the flight crew should use the rudder as for counteracting any lateral disturbance. Indeed, excessive rudder input may increase

ENGINE FAILURE - GENERAL

Ident.: PR-AEP-ENG-00016338.0001001 / 20 MAR 17
Applicable to: ALL

An engine flameout can be due to many reasons, for example:
- Fuel starvation
- Encounter with volcanic ash, sand or dust clouds
- Heavy rain, hail, or icing
- Bird strike
- Engine stall
- Engine control system malfunction.

An engine flameout may trigger an ECAM alert.
The flight crew can detect an engine flameout without damage by a rapid decrease of EPR /N1 , N2 , N3 ◁ , EGT and FF.

The flight crew can suspect engine damage, if the flight crew observes two or more of the following symptoms:
- Rapid increase of the EGT above the red line
- Important mismatch of the rotor speeds, or absence of rotation
- Significant increase of aircraft vibrations, or buffeting, or both vibrations and buffeting
- Hydraulic system loss
- Repeated, or not controllable engine stalls.

ENGINE FAILURE AT LOW SPEED (ON GROUND)

Ident.: PR-AEP-ENG-00018095.0001001 / 20 MAR 17
Applicable to: ALL

If an engine failure occurs at low speed, the resultant yaw may be significant, leading to rapid displacement from the runway centreline.

To regain or maintain directional control on the runway, it is necessary:
- To immediately reduce both thrust levers to IDLE, which will reduce the thrust asymmetry caused by the failed engine
- To select both reversers irrespective of which engine has failed
- To use rudder pedal for directional control, supplemented by symmetrical or differential braking if needed.

The steering hand-wheels may be used when taxi is reached.

<u>Note:</u> *1. If rudder pedal input and differential braking are needed, apply both on the same side*
2. Below 72 kts, the ground spoilers will not deploy and the auto brake will not activate.

The crew will elect the landing configuration according to the "maximum weight for go-around in CONF 3" table provided both in QRH and in FCOM:

- If aircraft weight is below the maximum weight for go-around in CONF 3, landing will be performed CONF full (and go-around CONF 3) as it is the preferred configuration for optimized landing performance
- If aircraft weight is above the maximum weight for go-around in CONF 3, landing will be performed CONF 3 (and go-around CONF 1+F). The CONF 1+F meets the approach climb gradient requirement in all cases (high weights, high altitude and temperature).

If a go-around CONF 1+F is carried out following an approach CONF 3, VLS CONF 1+F may be higher than VLS CONF 3 +5 kt. The recommendation in such a case is to follow SRS orders which will accelerate the aircraft up to the displayed VLS . It should be noted, however, that VLS CONF 1+F equates to 1.23 VS1G whereas the minimum go-around speed required by regulations is 1.13 VS1G. This requirement is always satisfied.
The crew should be aware that the transition from -3 ° flight path angle to go around climb gradient requires a lot of energy and therefore some altitude loss.
Taking into account the runway landing distance available, the use of brakes should be modulated to avoid very hot brakes and the risk of tire deflation.
When the aircraft weight exceeds the maximum landing weight, structural considerations impose the ability to touch down at 360 ft/min without damage. This means that no maintenance inspection is required if vertical speed is below 360 ft/min. If vertical speed exceeds 360 ft/min at touch down, a maintenance inspection is required.

REJECTED TAKEOFF

Ident.: PR-AEP-MISC-C-00016357.0001001 / 20 MAR 17
Applicable to: ALL

FACTORS AFFECTING THE REJECTED TAKEOFF (RTO)

Experience has shown that a rejected takeoff can be hazardous, even if correct procedures are followed.

Some factors that can detract from a successful rejected takeoff are as follows:
- Tire damage
- Brakes worn or not working correctly
- Brakes not being fully applied
- Error in gross weight determination
- Incorrect performance calculations
- Incorrect runway line-up technique
- Initial brake temperature

- Delay in initiating the stopping procedure
- Runway friction coefficient lower than expected.

Thorough pre-flight preparation and a conscientious exterior inspection can eliminate the effect of some of these factors.
During the taxi-out, the takeoff briefing should be confirmed. Any change to the planned conditions requires the crew to re-calculate the takeoff data. In this case, the crew should not be pressurised into accepting a takeoff clearance before being fully ready. Similarly, the crew should not accept an intersection takeoff until the takeoff performance has been checked.
The line-up technique is very important. The pilot should use the over steer technique to minimize field length loss and consequently, to maximize the acceleration-stop distance available.

Ident.: PR-AEP-MISC-C-00016358.0001001 / 20 MAR 17
Applicable to: ALL

DECISION MAKING

A rejected takeoff is a potentially hazardous manoeuvre and the time for decision making is limited. It is not possible to list all the factors that could lead to the decision to reject the takeoff. However, in order to help the Captain to make a decision, the ECAM inhibits the warnings that are not essential from 80 kt to 1 500 ft (or 2 min after lift-off, whichever occurs first). Therefore, any warning received during this period must be considered as significant.

SPEED CONSIDERATIONS

To assist in the decision making process, the takeoff is divided into low and high speeds regimes, with 100 kt being chosen as the dividing line. The speed of 100 kt is not critical but was chosen in order to help the Captain make the decision and to avoid unnecessary stops from high speed.

- **Below 100 kt:**
  The decision to reject the takeoff may be taken at the Captain's discretion, depending on the circumstances.
  The Captain should seriously consider discontinuing the takeoff, if any ECAM warning/caution is activated.
- **Above 100 kt, and below V1:**

  Rejecting the takeoff at these speeds is a more serious matter, particularly on slippery runways. It could lead to a hazardous situation, if the speed is approaching V1. At these speeds, the Captain should be "go-minded" and very few situations should lead to the decision to reject the takeoff:
  1. Fire warning, or severe damage
  2. Sudden loss of engine thrust
  3. Malfunctions or conditions that give unambiguous indications that the aircraft will not fly safely

4. Any red ECAM warning
5. Any amber ECAM caution listed bellow:

   - F/CTL SIDESTICK FAULT
   - ENG FAIL
   - ENG REVERSER FAULT
   - ENG REVERSE UNLOCKED
   - ENG 1(2) THR LEVER FAULT

Exceeding the EGT red line or nose gear vibration should not result in the decision to reject takeoff above 100 kt.
In case of tire failure between V1 minus 20 kt and V1, unless debris from the tires has caused serious engine anomalies, it is far better to get airborne, reduce the fuel load, and land with a full runway length available.
The V1 call has precedence over any other call.

- **Above V1:**
  Takeoff must be continued, because it may not be possible to stop the aircraft on the remaining runway.

DECISION CALLOUTS

The decision to reject the takeoff and the stop action is the responsibility of the Captain and must be made prior to V1 speed. It is therefore recommended that the Captain keeps his hand on the thrust levers until the aircraft reaches V1, whether he is Pilot Flying (PF) or Pilot Monitoring (PM).

- If a malfunction occurs before V1, for which the Captain does not intend to reject the takeoff, he will announce his intention by calling "GO".
- If a decision is made to reject the takeoff, the Captain calls "STOP". This call both confirms the decision to reject the takeoff and also states that the Captain now has control. It is the only time that hand-over of control is not accompanied by the phrase "I have control".

Ident.: PR-AEP-MISC-C-00016359.0002001 / 20 MAR 17
Criteria: 31-1334, SA
Applicable to: MSN 0373

RTO TECHNIQUE

Should a RTO procedure is initiated, the following task sharing will be applied.

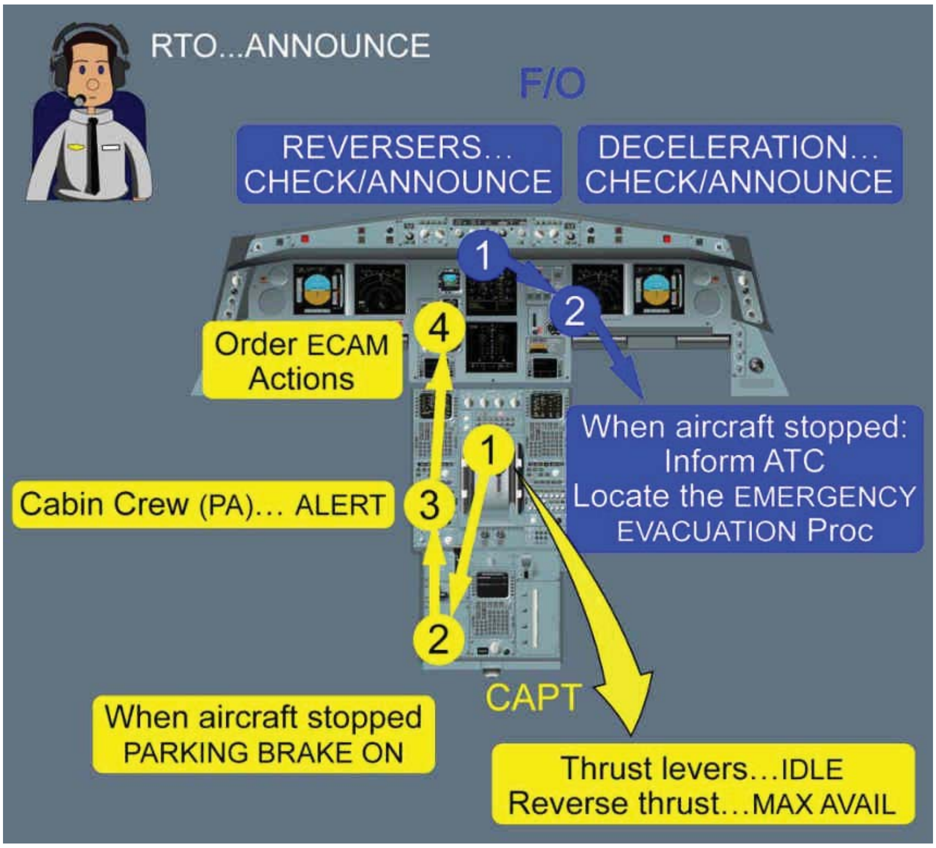
CAPT	F/O
"STOP".................................ANNOUNCE	
Simultaneously:	
THRUST LEVERS...........................IDLE	
REVERSE THRUST..............MAX AVAIL.	REVERSERS........CHECK/ANNOUNCE (1)
	DECELERATION...CHECK/ANNOUNCE (2)
	ANY AUDIO....................................CANCEL
Aircraft stopped	
Consider positioning the aircraft to keep any possible fire away from the fuselage.	
REVERSERS...........................STOWED	ATC...NOTIFY
PARKING BRAKE...............................ON	EMER EVAC Procedure (QRH).......LOCATE
CABIN CREW..............................ALERT	
ECAM ACTIONS.........................ORDER	ECAM ACTIONS.........................PERFORM
The aircraft should remain stationary while the crew evaluates the situation.	

(1) : Full reverse may be used until coming to a complete stop. But, if there is enough runway available at the end of the deceleration, it is preferable to reduce reverse thrust when passing 70 kt

(2) : - Announcing the deceleration means that the deceleration is felt by the crew, and confirmed by the Vc trend on the PFD. The deceleration may also be confirmed by the DECEL light (if the autobrake is on). However, this light only comes on when the actual deceleration is 80 % of the selected rate, it is not an indicator of the proper autobrake operation. For instance, the DECEL light might not appear on a contaminated runway, with the autobrake working properly, due to the effect of the antiskid.
- If a rejected takeoff is initiated and MAX auto brake decelerates the aircraft, the captain will avoid pressing the pedals (which might be a reflex action).
- If the autobrake is inoperative or if the takeoff is rejected prior to 72 kt (autobrake not active and no deployment of spoilers), the captain simultaneously reduces thrust and applies maximum pressure on both pedals. The aircraft will stop in the minimum distance, only if the brake pedals are maintained fully pressed until the aircraft comes to a stop.
- If the brake response does not seem appropriate for the runway condition, FULL manual braking should be applied and maintained. If IN DOUBT, TAKE OVER MANUALLY.
- If normal braking is inoperative, immediately apply the Loss of Braking procedure (*Refer to FCOM/PRO-ABN-BRAKES [MEM] LOSS OF BRAKING*)

After a rejected takeoff, if the aircraft comes to a complete stop using autobrake MAX, release brakes prior to taxi by disarming spoilers.
Do not attempt to vacate the runway, until it is absolutely clear that an evacuation is not necessary and that it is safe to do so.

RTO FLOW PATTERN



Ident.: PR-AEP-MISC-C-00016359.0001001 / 20 MAR 17
Criteria: SA
Applicable to: MSN 0314, 0393

RTO TECHNIQUE

Should a RTO procedure is initiated, the following task sharing will be applied.

CAPT	F/O
"STOP"..................................ANNOUNCE Simultaneously: THRUST LEVERS..............................IDLE REVERSE THRUST...............MAX AVAIL.	REVERSERS........CHECK/ANNOUNCE (1) DECELERATION...CHECK/ANNOUNCE (2) ANY AUDIO....................................CANCEL
Aircraft stopped Consider positioning the aircraft to keep any possible fire away from the fuselage. REVERSERS............................STOWED PARKING BRAKE................................ON CABIN CREW...............................ALERT ECAM ACTIONS..........................ORDER	ATC..NOTIFY EMER EVAC Procedure (QRH).......LOCATE ECAM ACTIONS...................PERFORM (3)
The aircraft should remain stationary while the crew evaluates the situation.	

(1) : Full reverse may be used until coming to a complete stop. But, if there is enough runway available at the end of the deceleration, it is preferable to reduce reverse thrust when passing 70 kt

(2) : - Announcing the deceleration means that the deceleration is felt by the crew, and confirmed by the Vc trend on the PFD. The deceleration may also be confirmed by the DECEL light (if the autobrake is on). However, this light only comes on when the actual deceleration is 80 % of the selected rate, it is not an indicator of the proper autobrake operation. For instance, the DECEL light might not appear on a contaminated runway, with the autobrake working properly, due to the effect of the antiskid.
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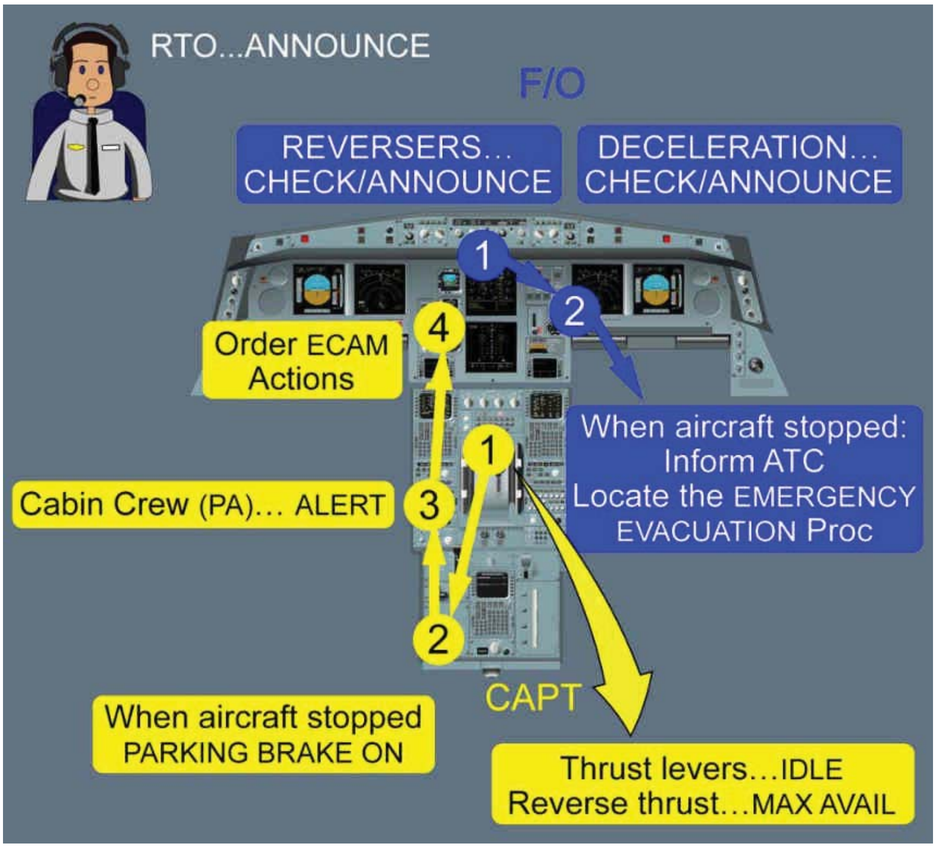
- If the brake response does not seem appropriate for the runway condition, FULL manual braking should be applied and maintained. If IN DOUBT, TAKE OVER MANUALLY.
- If normal braking is inoperative, immediately apply the Loss of Braking procedure (*Refer to FCOM/PRO-ABN-BRAKES [MEM] LOSS OF BRAKING*)

(3) : If takeoff has been rejected due to an engine fire, the ECAM actions will be completed until shutting down the remaining engines.

After a rejected takeoff, if the aircraft comes to a complete stop using autobrake MAX, release brakes prior to taxi by disarming spoilers.

Do not attempt to vacate the runway, until it is absolutely clear that an evacuation is not necessary and that it is safe to do so.

RTO FLOW PATTERN



Ident.: PR-AEP-MISC-C-00020585.0001001 / 20 MAR 17
Applicable to: ALL

TAKEOFF FOLLOWING RTO

Depending on the technical condition of the aircraft and the reason for the RTO (e.g. ATC instruction), the flight crew may consider a new takeoff attempt subsequent to the RTO.

In this case, the flight crew should:
- Reset both FD s and set FCU
- Restart Standard Operating Procedures from the AFTER START checklist.

STALL RECOVERY

Applicable to: ALL

Ident.: PR-AEP-MISC-D-00016361.0001001 / 20 MAR 17

DEFINITION OF THE STALL

The stall is a condition in aerodynamics where the Angle of Attack (AOA) increases beyond a point such that the lift begins to decrease.