



Flight Operations Briefing Notes

Takeoff and Departure Operations

Revisiting the "Stop or Go" Decision

I Introduction

For every flight of any given day, it is necessary for the flight crew to be prepared for a high speed rejected takeoff during the takeoff roll.

The decision on whether or not to perform a rejected takeoff --specifically, on whether or not to STOP or GO-- requires comprehensive flight crew awareness of the many risks involved.

The aim of this Flight Operations Briefing Note is, therefore, to review the STOP or GO decision-making process, and the associated operational and prevention strategies to be applied, in order to limit the risks of taking inappropriate actions and unsafe decisions.

Note:

If the Captain decides to stop a takeoff, at any time during the takeoff roll, this is referred to as a "Rejected Takeoff" (RTO).

II Background Information – Statistical Data

In comparison to the 1960s, the 1990s have demonstrated a 78% decrease in the number of RTO incidents/accidents per 10 million takeoffs. The figures range from 6.3 in the period from 1960 to 1969, down to 1.4 from 1990-1999. This considerable improvement is partly due to the implementation of operational policies, training practices, and industry-developed guidelines (Ref. "Joint Industry/FAA Takeoff Safety Training Aid").

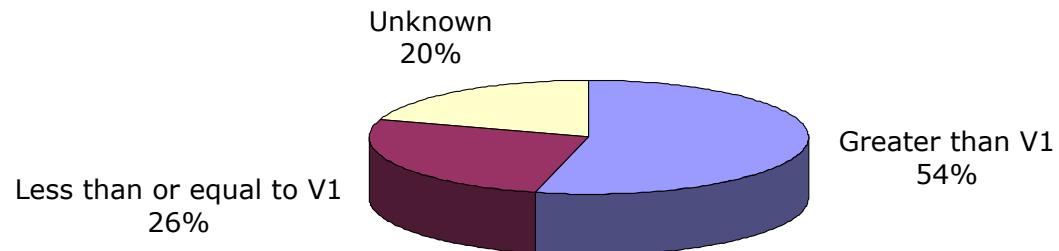
Nonetheless, when flight crewmembers are faced with unusual, unique, or unpredictable situations, there is still a possibility of unduly and/or incorrectly performing high-speed RTOs.

8% of RTOs are performed at high speed (above 100 knots), and 92% are performed at low speed (below 100 knots) (Source: IATA STEADES Safety Trend Analysis - 2002).

Low speed RTOs are simple maneuvers, associated with low risks, and rarely lead to runway excursions or to runway overruns.

High speed RTOs, on the other hand, involve difficult maneuvers, that are associated with high risks due to the amount of energy involved, and the necessity to effectively control aircraft braking and the aircraft trajectory on the runway centerline. Runway overruns or excursions mainly occur during high speed RTOs.

More than half runway overruns or excursions have statistically occurred when the RTOs have been initiated at a speed greater than V1 (**Figure 1**). Thus, the STOP or GO decision has to be made reaching V1; in other words, at the V1 callout **at the latest**. This emphasizes the importance of this callout.



Source: Joint Industry/FAA Takeoff Safety Training Aid

Figure 1

*RTO Overrun Incidents/Accidents Initiation Speed
(Based on 94 RTO Overrun Incidents/Accidents from 1961 to 1999)*

The statistics and experience have shown that, as soon as the aircraft reaches 100 knots, the safest course of action is for the flight crew to continue the takeoff, unless a major failure or a serious situation occurs.

Moreover, experience has shown that if RTOs are performed when the takeoff distance is ASD-limited (Acceleration-Stop Distance), and if the takeoff is rejected at V1, the consequences could be hazardous even if the performance is correctly calculated.

Note:

The Flight Operations Briefing Note **Preventing Runway Excursions and/or Overruns at Takeoff** provides a comprehensive overview of the various factors contributing to the increased risk of performing unsuccessful Rejected Takeoff (RTOs).

Most commonly, when the aircraft is at a speed near to V1, the aircraft rolls at **60 to 80 m per second** and accelerates at **4 to 8 knots per second**. Therefore, a two-second delay in initiating the RTO maneuver will lead to an approximate stopping distance increase of 250 m.

III Operational Standards

Captain's Decision

The decision of whether to STOP or GO, as well as the STOP action, are always performed by the Captain, because this decision and/or action may significantly impact on flight safety. The Captain must, therefore, keep his/her hands on the throttle/thrust levers until the aircraft reaches V1, regardless of whether he/she is PF or PNF.

If a malfunction or problem occurs during the takeoff roll, the Captain will call out "**STOP**", to confirm an RTO decision, and to indicate that he/she now has control of the aircraft. If the Captain calls out "**GO**", this confirms that he/she does not intend to reject the takeoff.

The takeoff roll is divided into a low and high speed segment. If the aircraft speed is less than 100 knots, the aircraft is considered to be in the low speed segment and an RTO decision leads to a low risk maneuver. If the aircraft speed is above 100 knots, the aircraft is considered to be in the high speed segment and an RTO decision may potentially involve more risks. The speed of 100 kt was chosen to help the captain make his/her decision and avoid unnecessary RTOs at high speeds.

Below 100 kt

The Captain will decide whether or not to reject a takeoff, depending on the circumstances. A non-exhaustive list of factors that may trigger this decision is published in the paragraph IV. If a system malfunction is detected (e.g. ECAM caution or warning), when the aircraft is below 100 kt, then the Captain should consider rejecting the takeoff.

Above 100 kt and below V1

The consequence of an RTO maneuver becomes more and more critical as the speed increases. Therefore, only very severe conditions should lead to a STOP decision, when the aircraft is at high speeds.

In the high speed segment, the crew should develop a "**GO**" state of mind. However, the flight crew should never delay a STOP decision, if necessary.

Major failures that may lead to the STOP decision include, but are not limited to:

- Engine or APU fire warnings
- Severe damages
- Sudden loss of engine thrust

- Takeoff configuration warning
- Any malfunction where there is doubt that the aircraft will fly safely.

To minimize the risk of inappropriate decisions to reject a takeoff, the ECAM system inhibits non-relevant warnings and cautions during the high speed regime. Therefore, the Captain must immediately consider all ECAM warnings/cautions that trigger during this segment.

Note:

In order to help the Captain limit the decision-making time, the Airbus Flight Crew Operating Manual (FCOM) lists all of the ECAM warnings and cautions that should result in an RTO decision. However, this list is only provided as a guideline: The decision to STOP or GO remains the Captain's responsibility, and will mainly depend on the aircraft speed at the time that the ECAM warning or caution triggers, or at the time of the encountered problem.

The V1 callout has priority over any other callout. V1 is considered to be the end of the STOP or GO decision-making process. Therefore, at the latest, this decision must be made at V1, so that the Captain can initiate the STOP actions as close to V1 as possible: **V1** is indeed a **decision/action speed**.

Above V1

At V1, the Captain's hand comes off the thrust levers/throttles, and the PF can continue the takeoff even if a malfunction or a problem is then detected, because it may not be possible to stop the aircraft on the remaining runway length.

Note:

The Captain can consider to reject a takeoff when the aircraft is above V1, only in the event that the aircraft is not able to ensure a safe flight.

If a failure occurs when the aircraft speed is above V1, the only actions should involve gear up selection and audio warning cancellation, until:

- The appropriate flight path is stabilized
- The aircraft is at least 400 ft AGL.

The objective is first to stabilize the flight path, and then to initiate the abnormal procedure without excessive delay. A height of 400 ft is recommended, because it is usually equivalent to the time it takes to stabilize the aircraft flight path.

In some emergency conditions (e.g. engine stall, engine fire), as soon as the appropriate flight path is established, the PF may initiate actions before reaching 400 ft AGL.

IV Operational and Human Factors involved in the Stop or Go Decision

The following factors are often linked to the STOP or GO decision-making process:

- Unexpected environmental situations or system malfunctions:
 - Atmospheric conditions: Windshear and microburst, unexpected strong tailwind, crosswind gusts or any external conditions that may significantly affect aircraft lateral control
 - Engine malfunction: Asymmetric thrust, sudden loss of thrust, thrust reverser unlocked and/or unstowed, abnormal slow engine acceleration, takeoff power not set before 80 kt, exceeding engine parameter limit
 - Indicated airspeed discrepancy at 100 kt, or before (if not rising as expected)
 - Aircraft system failure(s) that trigger ECAM messages associated with Master Warning/Caution
 - Traffic conflict / Air Traffic Controller instruction (i.e. takeoff clearance cancelled), particularly on congested airports
 - Undesired presence of aircraft, vehicle and/or pedestrian on the runway (e.g. runway incursion), particularly on congested airports
 - Lack of efficient communication between flight crew (e.g.: untimely power check, improper speed callout, ...)
 - Open window or door
 - Bird strike
 - Broken flight crew-seat latch
 - Significant aircraft directional control problem
 - Unusual noise and/or vibration (e.g.: nose gear vibration, tire burst, engine stall, suspected bomb explosion ...)
 - Aircraft tendency to pitch up
 - Any conditions where there are indications that the aircraft is unsafe or unable to fly
 - ...
- High speed takeoff roll segment factors:
 - Severity of the malfunction
 - Aircraft speed
 - Atmospheric conditions
 - Runway characteristic and conditions
 - Dispatch under MEL and/or CDL that affects acceleration or deceleration capability.

The following factors affect the performance of the STOP or GO decision-making process:

- Limited decision-making time
- Recognition time of unexpected conditions (i.e. unusual or unique situations)
- Failure to understand the nature of problems which may occur during takeoff roll
- Non-adherence to published standard calls (e.g. 80kt/thrust set, 100 kt, V1)
- Flight crew coordination
- Complacency
- Inadequate/incomplete pre-flight briefing.

V Prevention Strategies

The objective is to clearly specify and train the flight crew about the importance of the RTO decision-making process so that, if such an event unexpectedly occurs, the flight crew's reaction in a real-time situation can be as automatic and as accurate as possible.

V.1 Airline's Policies and Procedures

Operators must define and specify the policies, procedures, and required task sharing for an RTO, in addition to defining its low speed and high speed RTO philosophy. The policy should clearly state which flight crewmember has the authority to make the STOP decision, and who has the authority to stop the aircraft.

Accurate PNF standard calls, at predetermined airspeed "gates", helps the Captain to determine when the aircraft transitions from a low speed to a high speed takeoff roll segment (i.e. 100 knots) and to, therefore, be more and more "GO-minded" (**Figure 2**).



Figure 2

Airspeed Gates to Develop the Proper STOP or GO Mindset

Note:

Some Airbus aircraft types are equipped with a V1 auto-callout.

The aim of the "100 knots" callout is:

- To check the coherence of both Captain's airspeed indication and F/O airspeed indication (i.e. both Airspeed Data Computers)
- To indicate that the aircraft is entering the high speed takeoff roll segment.

This further emphasizes the essential support and monitoring role of the PNF during the takeoff roll. The PNF should:

- Perform timely standard callouts
- Monitor thrust parameters
- Monitor speed trend (available on the PFD, depending on the aircraft type)

Note: An unusual speed trend may be an indication of unreliable airspeed or wind shear.

- Detect and/or identify any abnormal conditions.

The Takeoff Briefing, described and detailed in the Flight Operations Briefing Note **Conducting Effective Briefings**, should include a briefing on abnormal takeoff situations, at least for the first flight of the day, or at each flight crew change. This briefing on abnormal takeoff situations should address:

- The respective responsibilities of the PF and PNF during the takeoff roll (e.g. the PNF calls out "power set" below 80 kt, ...)
- The Captain's decision whether to stop or go in the case of failure, and the associated call (i.e. "STOP" or "GO")
- The respective roles of the Captain and First Officer, in the event of a STOP decision (e.g. the Captain takes control of the aircraft, reduces the thrust to idle and controls the thrust reversers, while the First Officer monitors the deceleration...)
- The respective roles of the PF and the PNF, in the event of a GO decision (e.g. in the case of a failure after V1, the Captain will call out "GO", and the PF will continue the takeoff, with no action other than gear up and silencing audio warning(s), until the aircraft reaches 400ft AGL ...).

It is recommended that this briefing be adapted to highlight the aspects specific to each takeoff, because such aspects may influence the Captain's STOP or GO decision, and include:

- Takeoff data (high weight, high V1, ...)
- MEL item affecting stopping capabilities
- Runway conditions (short or contaminated runways)

- Bird activity, suspected windshear (e.g. microburst)
- Tire conditions and brake wear (exterior inspection) ...

V.2 Training

Flight crewmembers must be trained on the following RTO aspects:

- During ground training: The meaning of V1, the reasons for RTOs, the technical understanding of takeoff performance, contaminants, reverse thrust, flap selection and reduced V1, the influence of line-up techniques, and the power setting techniques, ...
- During simulator training: Maximum braking techniques, RTO on a balanced airfield, tire failures, warnings/cautions that may trigger at high speed, timely V1 callout, ...

The joint [industry/FAA Takeoff Safety Training Aid](#) provides an example of a takeoff safety training program, including background data about takeoff safety and guidelines to make better STOP or GO decisions. It is complemented by the [aircraft manufacturer Takeoff Safety Training Aid](#) and the Airbus "[Rejected Takeoff and the Go/Stop Decision](#)" [video](#). It offers flexibility to incorporate lessons into initial, transition, and recurrent training programs, in order to meet the needs of any Operator.

Note:

Performance training should also attempt to improve a flight crewmembers' understanding of the importance of a STOP or GO decision.

Most training programs address RTO decision-making aspects in relation to engine failure at V1 (V1 cut).

It is strongly recommended that recurrent training program, upgrading to Captain course and Line Oriented Flight Training (LOFT) scenarios, also include simulator exercises that require the flight crew to detect and identify abnormal situations that are not the result of a clear and distinct loss of thrust, such as:

- Engine stall accompanied with loud bang (without loss of thrust)
- Tire burst
- Traffic conflicts ("Abort" ATC instruction)
- Engine oil low pressure close to V1.

The following items should be discussed during recurrent training:

- Nose gear vibration, opening of a sliding window, ... should not lead to rejecting a takeoff at high speeds (above 100 kt)

- Tire burst in the V_1 minus 20 kt to V_1 range: Unless debris from the tires have caused serious engine malfunctions, it is far better to get airborne, reduce the fuel load, or proceed for an overweight landing, and land with a full runway length available
- Birdstrike at high speed:
 - If the birdstrike is only suspected, the takeoff should be continued.
 - If the birdstrike is confirmed, but engine bird ingestion is only suspected, the Captain must evaluate other factors:
 - How many engines are affected? (The decision may differ for a 2 or a 4 engine aircraft)
 - Statistically, a continued takeoff followed by an In-Flight Turn Back (IFTB) is a preferred option.

The decision to reject a takeoff may be a good one, if:

- Birdstrike is confirmed
- Engine bird ingestion is probable, and
- Some thrust effects are detected.

Rejecting a takeoff allows the engines to be inspected.

In any case, the takeoff must be interrupted, if a thrust loss is detected before V_1 .

Note:

*The Flight Operations Briefing Note **Birdstrike Threat Awareness** also provides recommendations, in the case of a birdstrike during takeoff roll.*

- Windshear or uneven aircraft acceleration during the takeoff roll:
 - Before V_1 :
 - The Captain should reject the takeoff only if unacceptable airspeed variations occur and the Captain assesses there is sufficient runway length to stop the aircraft
 - If windshear occurs during the takeoff roll, V_1 may be reached later (or sooner) than expected. In this case, the Captain may have to decide if there is sufficient runway length to stop the aircraft, if necessary.

Note:

*The Flight Operations Briefing Note **Windshear Awareness** provides additional details on windshear awareness and avoidance.*

Personal lines-of-defense to prevent runway overruns, and proper techniques to stop the aircraft within the accelerate stop distance are described and discussed in the Flight Operations Briefing Note [Preventing Runway Excursions and/or Overruns at Takeoff](#).

VI Summary of Key Points

- Develop airline policies to define:
 - Who makes the decision to STOP or GO (i.e. [Captain's decision](#))
 - When is a STOP decision recommended depending on the aircraft speed regime and on the type and severity of a malfunction/failure
 - What are the respective flight crew actions and roles in the case of STOP or GO decision during the takeoff roll, and what is the respective task sharing (i.e. [PF-PNF towards Captain-F/O](#) in the case of a STOP decision).
- Include the STOP or GO decision and task sharing, during the takeoff briefing, based on the current conditions and on potential abnormal situations (i.e. to indicate that [each takeoff is unique](#))
- Review and/or practice the conditions that may validate a STOP or GO decision based on the speed, and the type and severity of the malfunction
- Promote and train for an accurate understanding of an aircraft's STOP or GO performance, and outline operational interpretation of V1 (i.e. [V1](#) is a [decision / action speed](#)).

VII Associated Flight Operations Briefing Notes

The following Flight Operations Briefing Notes provide complementary information, and should also be reviewed:

- [Understanding Takeoff Speeds](#)
- [Standard Calls](#)
- [Conducting Effective Briefings](#)
- [Birdstrike Threat Awareness](#)
- [Windshear Awareness](#)
- [Preventing Runway Excursions and/or Overruns at Takeoff](#)

VIII Regulatory References

- FAA AC 120-62 – Takeoff Safety Training Aid: Announcement of Availability
- JAR 25.107 – Takeoff Speeds

IX Airbus References

- A300 & A310/A300-600 Flight Crew Operating Manuals – Supplementary Techniques – Rejected Takeoff
- A318/A319/A320/A321, A330/A340 & A380 FCOM – Abnormal Procedures – Rejected Takeoff
- A318/A319/A320/A321, A330/A340 & A380 Flight Crew Training Manuals – Abnormal Operations - Operating Techniques – Rejected Takeoff
- Airbus Takeoff Safety Training Aid
- Getting to Grips with Aircraft Performance (Brochure)
- Rejected Takeoff and the Go/No-Go Decision (Video)

X Additional Reading Materials

- Joint Industry/FAA Takeoff Safety Training Aid
- Flight Safety Foundation – Publications - Accident Prevention - January 2000

Note:

*This FSF publication is available on the Flight Safety Foundation website:
<http://www.flightsafety.org/home.html>.*

This FOBN is part of a set of Flight Operations Briefing Notes that provide an overview of the applicable standards, flying techniques and best practices, operational and human factors, suggested company prevention strategies and personal lines-of-defense related to major threats and hazards to flight operations safety.

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Airbus Customer Services

Flight Operations Support and Services

1 Rond Point Maurice Bellonte - 31707 BLAGNAC CEDEX FRANCE

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