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Editorial: 020-8745 3457

Distribution: 0870-8871410 (Tangent Marketing Services Limited)

Content: 01293-573473 (Flight Operations Inspectorate (Training Standards))

Website: www.ais.org.uk

Cancels AIC 141/1998 (Pink 182)

REJECTED TAKE-OFF (RTO) - PERFORMANCE CLASS A AEROPLANES**1 Introduction**

1.1 A rejected take-off can be a highly critical manoeuvre. It is therefore essential that the decision to either reject or continue a take-off, and any subsequent actions following a decision to reject the take-off, are carried out correctly. This Circular provides guidance to crews and operators concerning rejected take-offs in Performance Class A aeroplanes.

2 Decision Speed - (V_1)

2.1 The decision speed (V_1) is the highest speed by which the pilot should have made the mental decision to reject the take-off in the event of a relevant failure. Safety margins, in the form of delay times or extra distance on either side of V_1 , are built into the accelerated-stop distances published in performance data issued in compliance with JAR-OPS 1 and the Air Navigation (General) Regulations.

These margins address two considerations.

- (a) A Recognition Delay Prior to V_1 . A pilot can only be expected to have made a rejected decision by V_1 in response to a failure that has occurred a suitable time before V_1 for him to have recognised it. The accelerated distance presumes an engine failure to occur at a speed, V_{EF} , before V_1 and the distance allows for the lower acceleration between that point and V_1 .
- (b) Reaction Delays After V_1 . Allowance is made for taking the necessary actions to initiate the deceleration. In terms of time, such delays are typically $1\frac{1}{2}$ to 2 seconds. It is important to understand that this is not a margin to allow for a decision to stop beyond the V_1 call out. It is a safety margin to allow for the delays that inevitably occur in taking the various control actions (closing throttles, applying brakes, selecting ground spoilers, selecting reverse) even after the decision to stop has been made. This margin is in addition to the control activation times demonstrated for certification by a test crew responding to a premeditated test condition. However, the margin is no greater than might reasonably be anticipated for a well trained and alert crew, taking into account the rare and unexpected nature of the event in operational service.

2.1.1 Thus, considerations of pilot recognition of a failure and reaction in response to that recognition are allowed for. However, **V_1 must be respected as the latest speed by which a decision to stop must have been taken to assure a stopping capability within the distance available on a limiting runway.**

2.2 The published accelerated-stop distance makes no allowance for a decision to stop from beyond V_1 . It follows, therefore, that such a late decision presumes a judgement that a failure, or combination of failures, has occurred such that getting airborne would pose a greater risk than overrunning the end of the runway. On anything close to a limiting runway, the overrun is liable to occur with the aeroplane still travelling at significant speed and to impose a significant risk to the aeroplane and its occupants.

2.3 Some margins are provided in the continued take-off performance in the event of a decision to continue the take-off with an engine failure below V_1 but these could be eroded to such an extent that the aeroplane may not be able to lift off by the end of the runway and/or to clear obstacles once airborne. This is particularly so when using a 'wet' V_1 . 'Wet' V_1 accounts for the reduced stopping capability on a wet runway, but it also reduces the margins in the continued take-off performance compared to the dry runway situation. Handling problems may also be encountered, due to infringing V_{MCG} , if a decision to continue is taken from an arbitrarily reduced decision speed.

3 Runway Line-up Distance

3.1 JAR-OPS 1.490(c)(6) requires that the loss of runway length due to alignment of the aeroplane prior to take-off be accounted for in determining take-off performance. JAR-OPS also provides useful explanatory material to show how the line-up distance can be calculated. It is not always possible to get an aeroplane fully aligned with the runway centre-line before reaching the start of the declared runway length available for take-off. It is recommended to operators, who have not yet completed the transition to JAR-OPS, to make suitable corrections to the take-off run/distance available when calculating the regulated take-off weight (RTOW) where this is a factor. If this is not done the take-off run will be commenced with less distance available than indicated on the airfield charts, with a consequent erosion of the intended safety margins. The distance lost will vary with the particular runway/taxiway geometry, aeroplane geometry and ground steering characteristics.

4 Training for RTO

4.1 The RTO training that a pilot receives should include guidance on:

- (a) recognition of factors that will be critical during take-off, evaluated over a range of operating conditions and aeroplane configurations;
- (b) the effect of wet runways; how the selection of a 'wet' V_1 can influence RTOW and its subsequent effect on aeroplane performance after V_1 ;
- (c) which failures or malfunctions should result in a RTO and how the pilot can recognise such malfunctions;
- (d) the need for vigilance on every take-off and to be alert for the unexpected;
- (e) the need to initiate all stopping devices without delay in the sequence and according to the procedure specified in the Aircraft Flight Manual;
- (f) the use of immediate maximum wheel braking effort, including the use and monitoring of automatic brakes if fitted;
- (g) the initiation of RTO after V_1 only when the aeroplane is considered incapable of safe flight;
- (h) when to continue a take-off following a failure below V_1 ;
- (i) the dangerous consequences of the commander changing his mind once V_1 is passed;
- (j) the need for both pilots to have seats and rudder pedals adjusted to ensure that maximum brake pressure can be applied;
- (k) the standard procedure for monitoring speed during the take-off run;
- (l) factors that adversely affect the stopping distance:
 - (i) worn or hot brakes and burst tyres;
 - (ii) lowered runway surface friction;
- (m) information to pilots about the conditions upon which the flight manual stopping performance is calculated and information about those factors which adversely affect the aeroplane's stopping performance;
- (n) emphasis on crew co-ordination during a RTO particularly when a transfer of control from first officer to captain is required;
- (o) consideration of the factors influencing the commander's decision for the choice of handling pilot if a runway is limited or contaminated;
- (p) the advantages of using as much runway as is available and the effect of using less than the full runway length when lining up for take-off;
- (q) the positioning of the aeroplane when it comes to a halt in relation to the surface wind direction and fire service access, particularly following a RTO as a result of a fire warning;
- (r) the factors to be taken into consideration when deciding whether to order an evacuation of the aeroplane following a RTO;
- (s) the need for a systematic approach to carrying out the check list following a RTO and the need to avoid rushing drills.

5 Simulator Training

5.1 Where a dedicated simulator is available RTO training should include:

- (a) a variety of situations that do not always associate a RTO with an engine failure or fire, and a RTO at a speed close to V_1 on a runway that has a performance limiting Take-off Run Available (TORA);
- (b) RTO practice using the aeroplane's maximised braking capability to:
 - (i) experience the aeroplane's stopping performance following a high speed RTO,
 - (ii) be familiar with the necessary responses to warnings or cautions in the high speed regime,
 - (iii) experience the effect of the aeroplane's maximum stopping performance during a balanced field length RTO at V_1 ;
- (c) the necessity for clear and unambiguous calls, eg ' V_1 ' or 'STOP' and the unequivocal understanding of who may make them;
- (d) a demonstration of the advantages of using RTO auto-brakes, if fitted, to obtain immediate maximum braking effort.

6 Aircraft Types without Flight Simulators

6.1 When a flight simulator is not available for RTO training, crews should be trained using other training devices, discussion and, in the aircraft, touch drills only.

This Circular is issued for information, guidance and necessary action.