UNITED KINGDOM

AERONAUTICAL INFORMATION CIRCULAR

AIC 64/2008
(Pink 142)
17 July
Safety

NATS Limited
Aeronautical Information Service
UK Publications Office
NATS Ltd
Heathrow House
Bath Road
Hounslow Middlesex
TW5 9AT
Editorial: 020-8750 3778
Distribution: 0870-8871410 (Tangent Marketing Services Limited)
Content: 01293-573909 (Flight Operations Inspectorate (Training Standards))
Website: www.ais.org.uk

Cancels AIC 52/1999 (Pink 193)

GUIDANCE TO TRAINING CAPTAINS AND TRAINEES - SIMULATION OF ENGINE FAILURE IN AEROPLANES

1 Regulatory Requirements

1.1 This Circular is issued to give guidance to those pilots who may not have had the advantage of formal simulated engine-failure training and as a reminder to Type Rating Instructors (TRI) and Type Rating Examiners (TRE) in order to maintain the highest possible standards of safety.

1.2 The initial type-rating test for pilots requires of them the ability to handle an aeroplane suffering an engine failure during or just after take-off. The majority of engine-out training on large aeroplanes is now carried out in flight simulators. However, there is a continuing need for in-flight training because simulators either are not presently available for the aeroplane type or are not suitably qualified.

1.3 Training Captains conducting this training/testing must have received formal training in this exercise and be in possession of a TRI qualification. To deliver the instruction/checking on an aeroplane (as opposed to a flight simulator) this rating must have included an aeroplane upgrade element and, where appropriate, asymmetric training.

2 General

2.1 Few pilots are likely to face a higher risk than the loss of an engine immediately after take off. This type of emergency occurs at low altitude, at low airspeed, and when engines are already operating at close to maximum power. This is also a time of high workload where after take-off actions, completion of checklists, awareness of weather, departure routes, emergency turn and performance climb are competing for the crew's attention.

2.2 While it remains essential to expose pilots to simulated engine failures after take-off, there have been a number of training incidents where the successful outcome of the training flight was put in doubt. A number of causal factors resulted in incidents; inappropriate thrust reduction below the recommended zero thrust settings and inappropriate rudder input are two such examples.

2.3 It is a regulatory requirement to train pilots in all emergency procedures, and for any such training and checking it is essential to identify and understand all the risks involved and then to mitigate and manage them by establishing appropriate safeguards and procedures.

2.4 It is important to recognise that the level of risk will vary dependent upon the aeroplane type, complexity and performance. Guidance provided by the manufacturer should be followed, but where this is not available the aeroplane operator must develop his own guidance and in so doing seek acceptance of their procedures from the aeroplane manufacturer.

3 Training Program Syllabus

3.1 It is recommended that aeroplane operators produce a comprehensive syllabus of theoretical and practical training specific to aeroplane type. Due consideration should be given to the following items when putting in place a training programme. The list, though not exhaustive, is applicable to the training of new pilots, instructors and examiners and the resulting training programme will, it is hoped, mitigate the latent risks associated with simulated power unit failure:

(a) Qualifications, background, training and recency of trainee pilots including confirmation of understanding and management of aeroplane systems including engine handling, negative torque sensing, auto-feathering systems, emergency checklists and feathering procedures;

(b) Qualifications, background, training and recency of check and training pilots;

(c) Pre-activity briefing;

(d)Policy related to asymmetric training;

(e) The benefit of flight simulators;

(f) Demonstration and practice of asymmetric handling and V1 cut techniques at a safe higher altitude before attempting the exercise at low level;

(g) Intervention training for when things go wrong;

(h) Specified tolerances relating to safe speeds, rate of climb, obstacle clearance, heading, crosswind limits and angle of bank limits which may result in termination of the exercise;

(i) Power restoration techniques and determination of when power should be restored;

(j) Weather limitations and minimum visibility requirements;

(k) Method of simulating engine failure, which should specifically cover the technique to be used and the power to be set to simulate zero thrust. Specific briefings should be given covering the difference between zero thrust and flight idle, if relevant;

(l) Aeroplane and aerodrome performance considerations.

4 Performance Considerations

4.1 Training Captains must only simulate engine failure on take-off in crosswind conditions when they are certain that the speed at which the simulated failure is initiated will, in the prevailing conditions, allow an adequate margin of control. The advice of manufacturers' training departments should be sought before engine failures are simulated in crosswind components greater than 10 kt, and in any case engine failures should never be simulated in crosswind components exceeding 15 kt or on slippery or contaminated runways. Crosswind considerations make it difficult to monitor the trainee's rudder input and to correct any degree of incorrect or inadequate movement.

4.2 Certifications under JAR-25 make no allowance for crosswind components in the calculation of Vmcg, and therefore Training Captains in aircraft so certificated should not simulate engine failure below the greater of:

(a) V1; and

(b) Vmcg incremented by 1 kt per kt of crosswind component (to a maximum of 10 kt).

If (b), is the greater value, V1 should not be increased but the engine failure initiated at the appropriate speed above V1.

4.3 On no occasion should an engine failure before V1 be followed by a continued take-off.

5 Preparation for Flight

5.1 Thorough briefing of all crew members is essential.

5.2 Emphasis should be placed on minimum heights and control speeds (including Vmca), the conduct of drills, the method of simulating engine failure and all aspects of the prevailing weather conditions. The use and effects of systems particularly relevant to asymmetric flight, such as auto-feathering and rudder boost, should be discussed in detail.

5.3 Performance data should be produced to verify runway performance considerations, obstacle clearance, weight and balance, centre of gravity and fly speeds. Crew and aeroplane performance limitations should be determined, as should length of duty day, brake cooling, tyre wear etc.

5.4 Handling expectations should also be discussed as well as common handling errors to be avoided.

5.5 Procedures for handover of control must be clearly discussed as the requirement to take control leaves little room for error and this should be clearly understood by both the trainee and the Training Captain.

5.6 The Training Captain and trainee must share a clear understanding of their roles in the event of a real failure or where the simulated failed engine power cannot be restored.

5.7 Account must be taken of the possible effects on the circuit pattern caused by other traffic, particularly where aeroplanes with widely varying performance characteristics are using the same runway.

5.8 Consideration should be given to carrying a third crew member trained in the role and qualified on type to assist the Training Captain and act as a safety pilot.

5.9 When training is to be conducted away from the aerodrome of departure, pre-flight planning should take into account the need for ready access to a diversion aerodrome. This is particularly important where engine shutdown is to be completed in a twin-engined aeroplane.

5.10 The training flight will often be subject to some non-standard action and procedures. The aeroplane operator should consider the use of training checklists, modified standard operating procedures (SOPs) and load sheets, resulting in specific training material being required when conducting certain training flights.

6 Rejected Take-Off (RTO) Training in Aeroplanes

6.1 When a flight simulator is not available for a specific aeroplane type, crews must receive RTO training in the aeroplane within the bounds of reasonable safety.

6.2 The content of CAA Forms SRG1158 'MPA Type Rating, Skill Test and Proficiency Check Schedule - Examiner's Record' and SRG1157 'SPA, Skill Test and Proficiency Check Schedule - Examiner's Record' varies depending on aircraft type; many of these forms contain a test requiring RTO following a simulated engine failure. In the past this has often been accomplished by retarding one of the power levers, after which the candidate's ability to bring the aeroplane to a standstill on the runway with adequate directional control is assessed. On a number of occasions aeroplanes have run off the marked runway areas; this is a particular hazard when the Training Captain is unable to exercise full control over the nose wheel steering if the exercise is mishandled. Therefore, where RTO is required to be practised in an aeroplane, the exercise is initiated by an appropriate emergency call, eg 'Stop Stop', and no asymmetric power reduction should be selected. The Authority will accept this method as the means of satisfying the CAA Forms SRG1158 and SRG1157 rejected take-off requirement only for tests conducted in aeroplanes.

Note: AIC 24/2006 (Pink 94) 'Rejected Take-off (RTO) - Performance Class A Aeroplanes' provides more detailed guidance on RTO considerations.

7 Recommended Techniques for Simulating Engine Failure on Take-off

7.1 Turbo-jet and Turbo-fan Engines

7.1.1 The Flight Manual Vmcg is established on the basis of an instantaneous fuel cut occurring and when the procedure is practised in a flight simulator that method should be adopted. However, when practised in an aeroplane, good airmanship requires smooth handling of all controls and the power/thrust lever(s) should be retarded at a rate commensurate with the engine's deceleration behaviour. It may then be advisable, with certain engines, to position the power lever slightly forward of 'idle' in order to reduce spool up time if subsequent acceleration of the engine becomes required.

7.2 Turbo-prop Engines

7.2.1 The simulation of engine failure by use of power levers can introduce particular handling and performance problems. The primary concern arises from the fact that a turbo-prop engine which has been throttled back to flight idle will produce very much more drag than an engine which has failed and auto-feathered. A further problem is that any automatic feathering or drag limiting devices fitted are usually made inoperative when the power lever is closed. In consequence, if an engine which has been throttled back to a simulate failure suffers a real failure it may go to a very high drag 'windmilling' condition, remaining unfeathered unless correct feathering action is taken by the crew. Furthermore, because the engine is in a low power condition, failure may not be noticed until after severe handling difficulties have arisen.

7.2.2 There will also be a reduction in performance that may well lead to decay in airspeed and an inability to maintain adequate clearance over obstacles. Any such loss in airspeed can of course contribute to the loss of directional control.

7.2.3 These potential problems can best be avoided by appropriate methods of simulating engine failure. Training Captains must continue to monitor the power to ensure that zero thrust settings are maintained. Advice from engine or aeroplane manufacturers specific to type should always be sought and followed, but where this is lacking the following general advice is likely to be appropriate:

'The power lever should be retarded smoothly towards a pre-determined torque setting approximating to zero thrust. This torque setting should be maintained during the remainder of the take-off and initial climb; if it falls due to a suspected malfunction the power lever should be realigned with that of the operative engine'.

7.3 Piston Engines

7.3.1 Generally, the power lever may initially be moved smoothly to the closed position; the mixture control or Idle Cut-Off should not be used to simulate engine failure. Reference to the engine manufacturer's recommendations should clarify the technique in particular cases. When the trainee has identified the 'failed' engine and completed his 'touch only' feathering drill the power lever should be advanced to the zero thrust position.

7.3.2 Training Captains should be familiar with the advice in AIC 100/2005 (Pink 90) 'Propeller Feathering on Twin Piston Engined Aircraft' before simulating engine failure in aeroplanes in this category.

7.4 Minimum Heights

7.4.1 In aeroplanes which are not certificated as transport category aeroplanes (JAR/FAR 25) or as commuter category aeroplanes (SFAR 23), the engine failure shall not be simulated until reaching a minimum height of 500 ft above runway end. In aeroplanes having the same performance as a transport category aeroplane regarding take-off mass and density altitude, the instructor may simulate the engine failure shortly after reaching V2.

7.4.2 For multi-engined single-pilot aeroplanes it is recommended that engine failure shall not be simulated until reaching a minimum height of 300 ft above ground level (agl).

7.4.3 For all other aeroplanes, consideration should be given to simulating the engine failure in a manner appropriate to type (eg where gear retraction may induce excessive drag during the retraction cycle, simulation of the engine failure should be delayed until the gear is fully retracted). Where aeroplane performance is critical then delay the simulation of the engine failure until a stable and safe flight profile has been established.

8 In-Flight Procedures

8.1 Engine failures above the minimum heights at paragraph 7.4 should be simulated only by reducing power and never by complete shutdown of the engine until recommended minimum heights at paragraph 9.4 have been achieved. The best method of simulation by power reduction will vary from one class of aeroplane to another.

8.2 Immediately before failure is simulated, the Training Captain must position his feet so that he can prevent any incorrect rudder application by the trainee. During and after the simulation he must be particularly vigilant in monitoring airspeed, heading, pitch and roll, rudder position and yaw indication. He must also carefully monitor engine instruments especially on those types of aeroplanes in which a genuine failure of the idling engine would produce an abnormal hazard. He must ensure that any recommended bank angle is correctly applied and after ensuring safe initial rudder application he should monitor the trainee's rudder input by resting his feet lightly on the rudder pedals. He should bring to the trainee's attention any tendency for flight parameters to move significantly from their target values.

8.3 The Training Captain must never allow the trainee to retain control if, due to an incorrect technique such as an exaggerated nose-up attitude, the airspeed is reducing towards minimum control speed. Only at a height that is known to be safe in relation to the control characteristics of the aircraft should the Training Captain demonstrate, or permit the occurrence of, an actual loss of directional control to the extent that it is necessary to increase airspeed or reduce power in order to regain control.

8.4 When power failure is simulated during take-off, the speed should always be at or above V1 or take-off safety speed (TOSS) and the Training Captain should assume control if there is any indication that action by the trainee is leading to a reduction below these speeds. If either a reduction of power or height loss is necessary for the retention of control the Training Captain must consider whether he simulated failure at too low a speed or whether he took over control too late.

9 Actual Engine Shutdown

9.1 For the majority of pilots an actual engine failure or premeditated shutdown is a rare event. It is particularly important, therefore, that aeroplane operators allocate adequate time for refresher training in the relevant drills and procedures. Ideally this training should take place in conjunction with the recurrent check and Training Captains should emphasise the need to complete drills calmly and methodically and stress the importance of acting without haste. Where appropriate, the autopilot should be engaged. It should be remembered that during certification tests a reasonable allowance is made for pilot reaction time and that incomplete and over-hasty drills are known to have been the cause of a significant number of accidents and incidents. The importance of the methodical completion of drills cannot be overemphasised.

9.2 Whenever refresher training involving shutdown is carried out in an aeroplane in flight, Training Captains must be aware of the time required to restart an engine in the event of an actual failure of a second engine during an engine shutdown demonstration. In addition, consideration should be given to where the engine shutdown actually occurs, taking into account distance from the aerodrome in the event of an unsuccessful re-start and drift down capabilities to a suitable aerodrome.

9.3 Practice engine shutdown for training purposes should only be carried out if icing conditions can be avoided throughout the exercise.

9.4 Recommended Minimum Safe Heights for Complete Shutdown of Power Plants for Training Purposes

Piston or Turbo-prop engined aeroplanes with Maximum Total Weight Authorised (MTWA) not exceeding 5700 kg (exception; Dove - 4000 ft)	3000 ft agl
Triple piston-engined or four engined aeroplanes	4000 ft agl
(a) Twin piston or turbo-prop engined aerplanes with MTWA exceeding 5700 kg	5000 ft agl
(b) Triple turbo-jet or turbo-fan engined aeroplanes	
Twin turbo-jet or turbo-fan engined aeroplanes	8000 ft agl

Note 1: It is recognised that, for certain aircraft types, the CAA Check Flight Schedules require engine shutdown for performance measurement at lower heights than those tabulated above. Such flight tests are conducted by appropriately qualified pilots. The heights tabulated above are considered to provide minimum safety margins for pilot training and testing.

Note 2: Since different types of aeroplanes have widely differing characteristics, the advice of the Authority should be sought if there is any doubt about the safety of methods and procedures to be adopted for any particular type/variant.

10 In-flight Precautionary Power Reduction: Propeller-driven Aeroplanes

10.1 An abnormal condition affecting a power plant of a multi-engined propeller aeroplane may lead to the Commander deciding not to shut down the affected engine but to make a precautionary power reduction. In this event a torque or manifold pressure value equal to or greater than the zero thrust setting for the speed and altitude should be set. Any lower power setting would result in degradation in both handling and performance that may cause the aeroplane not to meet its certification standard; for example during a go-around or drift down.

10.2 Pilots should be given specific operational guidance in this context during conversion and recurrent training and provided with zero thrust setting data which takes account of variations in speed and altitude. Specific operational guidance should also be given regarding temperature and configuration if known to be significant for a particular aeroplane type.

11 Touch-and-Go Landings

11.1 Practice asymmetric landings in twin-engined aeroplanes should always be to a full stop. It is inadvisable to touch-and-go because additional factors, particularly resetting displaced rudder trim, flaps, engine spool-up times and runway length considerations, could result in a significantly increased ground roll and would be extremely hazardous to the subsequent take-off if overlooked.

11.2 Touch-and-go landings demand a particularly high level of crew co-ordination and the briefing should include precise details of the action to be taken by the trainee and Training Captain respectively in relation to the initiation of drills and the setting of power levers, flaps, airbrakes, reverse thrust and other controls.

11.3 Touch-and-go landings provide valuable approach and landing training but are often unrepresentative of normal take-offs (non-standard power lever handling, no V1, Airspeed Indicator (ASI) bugs not set to take-off speeds etc.). For these reasons, Training Captains are strongly recommended not to conduct simulated engine failure exercises during touch-and-go take-offs. Such training should be confined to standing start take-offs for which performance data has been properly calculated and the crew have been suitably briefed.

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

Published by NATS on behalf of the CAA. Printed and distributed by Tangent Marketing Services Limited, Cheltenham, Glos. GL52 2DG.