1. PURPOSE. This advisory circular (AC) announces the availability of a joint industry/Federal Aviation Administration (FAA) Takeoff Safety Training Aid to help air carriers and pilots increase safety during the takeoff phase of flight.

a. The FAA recommends early consideration of the information contained in the aid and use of the material, as appropriate, for training aircrews. This AC also highlights certain key items, concepts, and definitions that each air carrier or operator should address in their respective operational procedures and crew qualification programs.

b. This circular applies to Federal Aviation Regulations (FAR) Part 121 operators. However, many of the principles, concepts, and procedures described apply to operations under FAR Parts 91, 129, and 135 for certain aircraft, and are recommended for use by those operators when applicable.

2. BACKGROUND. Takeoff accidents resulting from improper rejected takeoff (RTO) decisions and procedures are significant contributors to worldwide commercial aviation accident statistics. For those takeoffs that are rejected, and for takeoffs made under certain environmental conditions and with certain system failures, risks could be reduced by a higher level of flightcrew knowledge and by the use of improved procedures. Due to the risks and the accident statistics associated with takeoffs, a joint FAA/industry team studied what actions might be taken to increase takeoff safety. These studies included simulation trials and in-depth analysis of takeoff accidents and incidents. To present the findings of this group, a comprehensive training aid for operators and pilots of transport aircraft was prepared.

a. The goal of the Takeoff Safety Training Aid is to minimize, to the greatest extent practical, the probability of RTO-related accidents and incidents by:

(1) Improving the ability of pilots to take advantage of opportunities to maximize takeoff performance margins;

training aid;

(ii) Pilot Guide to Takeoff Safety: This section summarizes key RTO information for flightcrews. It includes an analysis of past RTO overrun accidents and incidents, and a discussion of information pilots should know in order to make better "Go/No Go" decisions. This section is intended for personal reading by all jet transport airplane pilots;

(iii) Example Takeoff Safety Training Program: This section provides ground and simulator training modules with a guide for implementing the simulator training; and

(iv) Takeoff Safety-Background Data: This section is an expansion of the Pilot Guide with selected and related supporting data provided by Appendix. This section targets instructors and training program developers.

b. This AC announces the general availability of the Takeoff Safety Training Aid. Additional related materials that support this aid (videos, model specific performance data, pictures, briefing materials, etc.) may be available from the manufacturers. This circular endorses the industry-developed training aid and the associated materials developed by each manufacturer in support of reducing the number of RTO overrun accidents and incidents.

3. HOW TO OBTAIN COPIES. For a fee, the Takeoff Safety Training Aid may be obtained by the general public from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161, (703) 487-4650. The NTIS reference number for the Takeoff Safety Training Aid is PB93780013.

a. Some aircraft manufacturers have developed supporting instructional materials which may be available through their customer service and training departments.

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4. RELATED FEDERAL AVIATION REGULATIONS (FAR) SECTIONS.

a. Part 121, Subpart E - Approval of Routes: Domestic and Flag Air Carriers. Section 121.97.

b. Part 121, Subpart F - Approval of Areas and Routes for Supplemental Air Carriers and Commercial Operators. Section 121.117.

c. Part 121, Subpart G - Manual Requirements. Section 121.135.

g. Part 121, Subpart O - Crewmember Qualifications. Sections 121.433, 121.441, 121.443, and 121.445.

h. Part 121, Appendices E, F, and H.

5. RELATED READING MATERIAL.

a. AC 91-6A, Water, Slush, and Snow on the Runway.

b. AC 120-40B, Airplane Simulator Qualification.

c. AC 120-51A, Crew Resource Management.

6. DEFINITIONS. Certain definitions are needed to explain the concepts discussed in this training aid. Some of the definitions used are taken from the FAR's or other references, and some are defined in the training aid. Where appropriate, the training aid definitions have been written from the point of view of the pilot and may clarify or expand on the regulatory definition to the extent necessary to assure appropriate flightcrew action.

a. V_1. The speed selected for each takeoff, based upon approved performance data and specified conditions, which represents:

(1) The maximum speed by which a rejected takeoff must be initiated to assure that a safe stop can be completed within the remaining runway, or runway and stopway;

(2) The minimum speed which assures that a takeoff can be safely completed within the remaining runway, or runway and clearway, after failure of the most critical engine at a designated speed; and

Note 2: Reference performance conditions for determining V_1 may not necessarily account for all variables possibly affecting a takeoff, such as runway surface friction, failures other than a critical powerplant, etc.

b. Minimum V_1. The minimum permissible V_1 speed for the reference conditions from which the takeoff can be safely completed from a given runway, or runway and clearway, after the critical engine has failed at the designated speed.

c. Maximum V_1. That maximum permissible V_1 speed for the reference conditions at which a rejected takeoff can be initiated and the airplane stopped within the remaining runway, or runway and stopway.

d. Reduced V_1. A V_1 less than the maximum V_1 or the normal V_1, but more than the minimum V_1, selected to reduce the RTO stopping distance required.

Note: V_1 speeds based on wet or slippery conditions are reduced V_1's to adjust the RTO stopping distance for the degraded stopping capability associated with the conditions. Reducing V_1 for a dry runway takeoff, when conditions permit, will provide additional stopping margin in the event of an RTO. In either case, the reduced V_1 must be determined to also assure the continued takeoff criteria are met (i.e., screen height, obstacle clearance, and V_{MCG}).

e. V_R. Rotation speed.

f. V_{LOF}. Lift-off speed.

g. V_2. Minimum takeoff safety speed.

h. Screen Height. The height of an imaginary screen which the airplane would just clear at the end of the runway, or runway and clearway, in an unbanked attitude with the landing gear extended.

start of the takeoff to the point where the airplane reaches the prescribed screen height above the takeoff surface with the critical engine having failed at the designated speed.

k. Accelerate-Stop Distance. The horizontal distance from the start of the takeoff to the point where the airplane is stopped in the runway or runway and stopway, when the stop is initiated at V_1 and completed using the approved procedures and specified conditions.

l. Balanced Field Length. The runway length (or runway plus clearway and/or stopway) where, for the takeoff weight, the engine-out accelerate-go distance equals the accelerate-stop distance.

m. Critical Field Length. The minimum runway length (or runway plus clearway and/or stopway) required for a specific takeoff weight. This distance may be the longer of the balanced field length, 115% of the all engine takeoff distance, or established by other limitations such as maintaining V_1 to be less than or equal to V_R.

n. Derated Takeoff Thrust. A takeoff thrust level less than the maximum takeoff thrust approved for an airplane/engine for which a separate and specific set of data which complies with all of the requirements of FAR Part 25 exists. When operating with a derated takeoff thrust, the thrust setting parameter used to establish thrush for takeoff is presented in the AFM and is considered an operating limit for that takeoff.

o. Reduced Takeoff Thrust. A takeoff thrust level less than the maximum (or derated) takeoff thrust. The takeoff performance and thrust settings are established by approved simple methods, such as adjustments or corrections to the takeoff performance and thrust settings defined for the maximum thrust (or derated) performance and thrust settings. When operating with a reduced takeoff thrust, the thrust setting parameter used to establish thrust for takeoff is not considered an operating limit; the

q. Stopway. An area beyond the end of the runway, at least as wide as the runway and centered along the extended center line of the runway, able to support the airplane during a rejected takeoff without causing structural damage to the airplane, and designated by the authorities for use in decelerating the airplane during a rejected takeoff.

r. Rejected Takeoff. A takeoff that is discontinued after takeoff thrust is set and initiation of the takeoff roll has begun.

7. USE OF THE TAKEOFF SAFETY TRAINING AID. Operators should use this training aid in development or modification of their various training and crew qualification programs. This information may also be helpful for other applications or assessments related to takeoff safety as shown in item (b) below.

a. Maintaining or Improving Airman Knowledge and Skills. Training aid information should be used for:

(1) Training program preparation or revisions, including upgrade, initial, transition, differences, recurrent, or requalification programs;

(2) Incorporation in Advanced Qualification Program curriculum segments;

(3) Incorporation in crew resource management or line oriented flight training;

(4) Briefing of check airmen to address pertinent items during various checks and evaluations, including annual proficiency check/proficiency training events, operational experience, line checks, and route checks;

(5) Incorporation of takeoff scenarios in airmen training, certification, recurrency, and proficiency evaluation activities;

(6) Training of other airmen such as dispatchers; and

procedures to ensure that the latest validated information is being provided to flightcrews;

(3) To assist in reviewing dispatch policies to ensure that the latest validated information, procedures, and policies are being used;

(4) To assist in reviewing an operator's performance engineering methods and programs to ensure that the latest validated information, procedures, and policies are being used (e.g., clutter correction methods and appropriate line up distance assumptions);

(5) To assist in reviewing an operator's maintenance practices to ensure that the latest validated information, procedures, and policies are being used (brake wear policies, minimum equipment list use, etc.);

(6) To assist in reviewing various operator manuals to ensure that the latest validated information, procedures, and policies are being used;

(7) To assist in planning for the most desirable safety options to be selected when making decisions about acquisition of new aircraft or modification of existing aircraft (availability or capability of auto brake systems, reverse thrust, anti skid, auto spoilers, flight manual data appendices, etc.);

(8) To assist in planning for the purchase, lease, or modification of simulators and training devices to provide the most desirable options (appropriate simulator response for RTO's, realistic visual representation of critical scenarios, incorporation of relevant systems such as auto brakes, etc.); and

(9) To assist in formulation of airline special emphasis or seasonal programs.

event of failures;

(2) Potential effects of improper procedures during an RTO;

(3) Guidelines on rejecting or not rejecting a takeoff in the low and high speed regimes;

(4) Assigned crewmember duties, use of comprehensive briefings, and proper crew coordination;

(5) Appropriate selection of runway, flap settings, thrust levels, and V speeds relative to takeoff conditions (gross weight, runway contaminants, etc.);

(6) Proper use of "reduced V_1" policies if used; and

(7) The increased stopping distance required on slippery or contaminated runways.

b. Flight Training and Checking. Flight training programs and airmen evaluations, to the extent appropriate, using an approved simulator should ensure appropriate crew skill in applying the items listed in (a) above. Simulator scenarios should include the following conditions and procedures:

(1) Use of critical weights for a specified runway (e.g., critical field length/balanced field length).

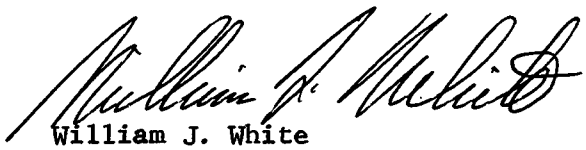
(2) Demonstration of the increased stopping distance required on slippery or contaminated runways.

(3) Demonstration of the proper and appropriate crew responses for engine failure, tire failure, nuisance alerts, and critical failures that affect the ability to safely continue the takeoff in both the high and low speed regimes.

c. Crew Resource Management (CRM). The topics of ground training and scenarios suggested for flight training and checking, as shown above, including specific behaviors associated

characteristics. Planning for new, leased, or modified simulators or training devices should also consider those guidelines to ensure that future devices will have the necessary capability to satisfy takeoff safety training objectives.

10. OTHER FACTORS AFFECTING TAKEOFF SAFETY. Other factors affecting takeoff safety such as deicing precautions, winter operations, windshear, engine-out takeoff obstacle clearance criteria, and other topics are addressed by other references and are not repeated in the takeoff safety training aid. To ensure a comprehensive air carrier program, other references listed in paragraph 4 of this AC should be consulted.



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