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Title 14—AERONAUTICS AND SPACE

Chapter I—Federal Aviation Agency

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PART 121—CERTIFICATION AND OPERATIONS: AIR CARRIERS AND COMMERCIAL OPERATORS OF LARGE AIRCRAFT

Landing Performance Operating Limitations for Turbojet Powered Transport Category Airplanes

The purpose of this amendment to Part 121 of the Federal Aviation Regulations is to increase for turbojet powered airplanes the required runway length for landing, at alternate airports at all times, and at destination airports whenever weather reports and forecasts indicate that the runways will be wet or slippery at the estimated time of arrival.

This amendment is based on a notice of proposed rule making (Notice 63-28) issued on July 15, 1963, and published in the FEDERAL REGISTER on July 25, 1963 (28 F.R. 7565). Notice 63-28 also proposed to increase the accelerate-stop distance for turbojet powered airplanes. This proposal is being withdrawn for the reasons set forth below.

The Agency received numerous comments, both favorable and unfavorable, addressed to both of the major proposals contained in Notice 63-28. In view of the wide divergency of the comments received, the Agency held a public hearing on June 23, 1964. As stated in the notice of public hearing (29 F.R. 5640), the hearing was held to give interested persons further opportunity to express their views, and in addition, the Agency solicited specific recommendations as to the criteria or procedures that could be used in establishing adequate accelerate-stop and landing distances for each type and model turbojet powered airplane.

The basis for the Agency's original proposal and the significant comments, both favorable and unfavorable, received by the Agency, before, at, and after, the public hearing are hereafter summarized and discussed.

Accelerate-stop distance. The Agency's proposal to add an additional margin of 800 feet to the accelerate-stop distance was based on the following:

(1) The existing accelerate-stop distance is considered to result in the absolute minimum level of safety.

(2) There are no built-in safety margins to account for normal operational variations other than 50 percent headwind and 150 percent tailwind accountability.

(3) Airline pilots cannot reproduce during normal operations the accelerate-

stop distance determined during type certification.

(4) There are no arbitrary factors applied to the accelerate-stop distance to account for operational variations; i.e., pilot technique, runway surface conditions, etc.

(5) In airline operations, airplanes are operated at times with tires and brakes that do not provide maximum braking action.

(6) If an engine failure occurs at V_1 speed during airline operations, there is a time period during which the pilot decides whether to abort or continue the takeoff and also a reaction time to initiate braking.

(7) The effective runway length required for accelerate-stop distance can be exactly equal to the runway length. No allowance need be made for the runway consumed in positioning the airplane.

Based on the preceding, the Agency proposed to add 800 feet to the normal accelerate-stop distance for turbojet airplanes, 600 feet to provide a 3-second decision time to the pilot and 200 feet to account for runway used in positioning the airplane.

Synopsis of comments opposed to proposed increase in accelerate-stop distance. (1) Airport taxi aprons are normally located so as to allow airplane positioning on the runway edge. However, where airport layout precludes such positioning "effective runway length" should be redefined rather than arbitrarily add a 200-foot increase that would penalize airports at which there is no problem.

(2) There are safety margins not recognized in the notice such as reverse thrust, low probability of engine failure at V_1 speed, and time delays imposed during type certification.

(3) There is no basis for increasing accelerate-stop distances for turbojet airplanes only, when the reciprocating engine powered airplane is statistically more likely to experience an engine failure and aborted takeoff.

(4) Type certification performance in an aborted takeoff is repeatable if the specified procedures are followed. Furthermore, a decision time is inappropriate since the pilot's decision is already made depending upon whether the airplane's actual speed is below or above V_1 . Once V_1 is reached, the pilot no longer will consider aborting, and until it is reached, he will automatically abort if an engine fails.

(5) The type certification accelerate-stop distance is based on: (a) acceleration to V_1 ; (b) complete power loss on one engine at this exact point; (c) pilot reaction time; and (d) full braking on a dry runway. The very basis for de-

termining accelerate-stop distance has a built-in conservatism that provides an adequate safety margin for normal operations. This is true for several reasons: In practice, if an engine fails before V_1 is reached, more distance is available for stopping; if after, the pilot's decision to takeoff has already been made.

(6) Several comments from foreign manufacturers and operators stated that even if an increase was justified for some turbojet airplanes type certificated in the United States, such an increase should not apply to those airplanes type certificated in a foreign country whose type certification process contained additional safety factors (such as additional decision time) not considered in U.S. type certification process.

Synopsis of comments in favor of proposed increase in accelerate-stop distance. Several comments that favored the proposed 800-foot increase in accelerate-stop distance agreed with the Agency based on the justification contained in the notice. Several qualified favorable comments were received that agreed that for some airplanes at some airports there could be a safety problem. These commentators favored an approach directed at the specific problem situations rather than an arbitrary 800-foot increase that would affect all turbojet operations.

Conclusion. After reviewing all of the comments received relating to the proposed increase in accelerate-stop distance, the Agency believes that it does not at this time have sufficient facts to justify the proposed increase.

The Agency agrees that the proposed 200-foot increase to account for positioning the airplane on the runway is not justified in all cases and would therefore penalize operations in which there is no problem. The Agency believes that a better approach to solve this problem where it does exist would be to redefine effective runway length so as to account for any runway lost due to positioning. However, this approach would affect the takeoff distance and takeoff run as well as the accelerate-stop distance and would therefore be outside the scope of Notice 63-28. The Agency also agrees that there are additional safety margins built into the accelerate-stop distance determined during type certification not considered in Notice 63-28. Since these additional built-in factors were listed above, they need not be repeated. Furthermore, the Agency finds that there have been no overrun aborted takeoffs experienced in air carrier operations with a turbojet powered airplane on a dry runway. Thus, if the present accelerate-stop distance is inadequate in some cases, it would appear that any in-

(As published in the Federal Register /30 F.R. 8568/ on July 7, 1965)

crease should be based on runway conditions and not applied arbitrarily to all operations.

In view of the above, the Agency has decided to withdraw the proposed increase in accelerate-stop distance contained in Notice 63-28. The Agency will continue to study the adequacy of the present accelerate-stop distance requirements with particular attention to the effect of adverse runway conditions. If it finds that the present accelerate-stop distance is inadequate under certain conditions, the Agency will consider more particular regulatory action that would not arbitrarily penalize operations in which there is now no safety problem.

Landing distance limitations. The Agency's proposal to increase the required landing runway lengths for turbojet airplanes as stated in Notice 63-28 was based primarily on the following:

(1) A survey completed by the Agency indicated that some of the major airlines operating turbojet equipment already apply some correction factor for landing on slippery or wet runways.

(2) FAA policy for approval of turbojet operations with 200-1/2 landing minimums requires that runway lengths be increased by 1,000 feet or 15 percent, whichever is greater.

(3) In actual operations, the landing technique differs from that on which the type certification landing distance is based, i.e., in operations the airplane usually touches down at a greater distance from the runway threshold and at a higher touchdown speed.

(4) The effectiveness of the braking systems is substantially reduced on wet or icy runways.

(5) That, as a result of the factors discussed in Item 3 a substantial portion of the 40 percent runway margin that is presumably available for adverse conditions is used up in normal operations on dry runways leaving an inadequate margin for operations in adverse conditions, such as wet or slippery runways.

Based on the preceding, the Agency proposed to increase the required runway length at the destination airport by 20 percent whenever the weather reports or forecasts indicated that at the estimated time of arrival wet or slippery runways could be expected.

Synopsis of comments opposed to proposed increase in landing distance. (1) The use of actual landing data obtained on runways where there is a substantial excess runway length over that required by the regulations is not a proper basis for concluding that the type certification landing conditions cannot be met. Pilots in normal operations will frequently use as much runway as they have available, and, therefore, the fact that the actual landing involves a longer touchdown distance at a higher speed than that used during type certification is not relevant unless the landing is made on a runway where the length is critical.

(2) Additional factors that are not considered in the type certification process, such as reverse thrust, together with the presently required margin, compensate for the fact that operational landings differ from type certification determinations.

(3) The accident/incident record does not justify an increase in landing distance runway lengths since that record would not have been changed had the proposed landing requirements been effective before the accidents.

(4) The proposed increase in landing distance would cause an economic burden that would far outweigh any increase in safety that might be achieved. The burden from reducing landing weights to meet the proposed 20 percent increase in required runway length was estimated to be in excess of 18 million dollars per year for the affected airlines, on an actual load factor basis.

(5) Only a few of the airlines apply additional margins similar to those proposed in Notice 63-28 and these usually apply to specific airports and are used at the discretion of the pilot in command.

Synopsis of comments in favor of proposed increase in landing distance. Basically, the favorable comments agreed in substance with the Agency's reasons for proposing an increase in the required landing distance for wet or slippery runways. Particular attention was given to the fact that pilots did not feel that they could duplicate the type certification landing distances in normal operations. The history of overrun, underrun, missed approach, cross wind, and wind shear, and other terminal area accidents indicates that longer runways are necessary. The Air Line Pilots Association stated that while it supported the proposed increase as an interim measure it felt that an increase of 40 percent over existing runway requirements is actually needed to cover slippery runway conditions encountered in actual operations.

Discussion. The Agency has thoroughly examined all of the comments and detailed data submitted in connection with the proposed increase in landing distances for wet or slippery runways. On the basis of this review, the Agency believes that many of the persons who commented on the notice misunderstood much of the basis for the Agency's determination that additional runway length was necessary for landings on wet or slippery runways. This belief is based on the numerous comments critical of the use to which the Agency was putting the operational data evaluated in Flight Standards Service Release No. 470 and also critical of the basis set forth in the notice upon which the Agency concluded that an equivalent of 1,300 feet should be added to the required landing runway lengths. In view of this possible misunderstanding, the Agency believes that further discussion of the basis for its original proposal is warranted.

The photostereoscopic data accumulated on 183 daylight turbojet landing operations of scheduled air carriers reported in Flight Standards Service Release No. 470 were used by the Agency basically to determine information concerning the airborne portion of the average operational landing. This data revealed that the mean threshold speed was 1.39V_s (round to 1.4V_s for the purpose of this preamble) (type certification 1.3V_s), mean touchdown distance 1,514 feet

(type certification 1,000 feet), and mean touchdown speed 1.3V_s (Type certification 1.2V_s). The Agency realizes that, as pointed out in many of the comments, a large portion of the 183 landings studied in obtaining this data were made at airports at which there was substantial additional runway to that required to meet the present landing distance requirements. The Agency also recognizes that, to some extent, pilots will use as much runway as they have available. However, the Agency found that there was little difference in the mean values of threshold speed, touchdown distance, and touchdown speed between runways with excess length as compared with those that might be termed critical. Furthermore, the relevance of the mean values stated above is supported by the data obtained by the United Kingdom in similar studies.¹

Touchdown distance and touchdown speed are controlling factors affecting the total landing distance whether the runway is wet or dry. However, landing on wet or slippery runways is more critical because braking effectiveness is reduced. For example, for a typical turbojet powered airplane landing at a weight of 155,000 pounds using the type certification technique (threshold speed 1.3V_s, at 50 feet above threshold, touchdown speed 1.2V_s, and touchdown distance 1,000 feet), the type certification distance from threshold to stop is about 3,300 feet and the present operationally required runway length is 5,500 feet. Thus a margin of about 2,200 feet is presumably available to cover variations in landing techniques and runway conditions. However, when the mean touchdown speeds (1.3V_s instead of 1.2V_s, and mean touchdown distances (1,500 feet instead of 1,000 feet) found to occur in actual operations on dry runways are considered, this margin drops to about 1,300 feet. When the effect of wet or slippery runways on braking effectiveness is considered, the Agency finds that this remaining margin completely disappears for some airplane types. Thus, the Agency concludes that the present landing distance requirements provide barely enough margin over the average type certification technique landing to account for the mean airline technique and wet or slippery runway landing conditions. When probable deviations from the mean operational landing are considered, the Agency finds that no margin remains when the runway is wet or slippery and that in fact if the runway length available was equal to the present requirements an overrun would likely occur. The Aerospace Industries Association submitted data based on type certification landing techniques on wet runways to which the effect of 50 and 100 percent reverse thrust was applied that would appear to

¹"Analysis of Operational Landing Statistics of Turbine-Engine Airplanes"; ICAO Paper AIR C-WP/195, May 21, 1962.

"Photographic Measurements of Landings at London Airport," ICAO Paper AIR C-WP/163, Feb. 21, 1962.

"Photographic Measurements of Landings at Prestwick Airport," ICAO Paper AIR C-WP/187, Apr. 16 and July 10, 1962.

refute the above stated conclusions. However, when the AIA data are corrected to account for average operational landing techniques, the above stated conclusions are confirmed.

It is for the above stated reasons that the Agency feels that operations with turbojet powered airplanes into airports with wet or slippery runways, that do not have any excess length over that required under the present rules, are of sufficient potential danger to warrant a requirement for additional runway under adverse conditions (or compensating reduction in weight).

While the Agency did not in Notice 63-28 base its original proposal on the accident/incident record of turbojet airplanes, many of the comments received were addressed to this record. The Agency recognizes that in each of the 10 incidents (1960-64) that involved overruns with turbojet airplanes there were so many contributing factors that no firm conclusions can be drawn therefrom. However, the Agency believes it is relevant that nine of the ten overruns occurred on wet or slippery runways. These incidents also indicate that where operational conditions into wet or slippery runways vary to any substantial degree from the average conditions, there is a strong likelihood that an overrun will occur unless the runway length is substantially in excess of that required by the present regulations. The Agency believes that the fact that there have been so few such overruns as compared to the total number of airline landings is attributable to a large degree to the fact that most of the airports into which the large turbine engine powered airplanes have been operating have runways that are substantially longer (partially due to takeoff distance requirements for long range operations) than the minimums required by the regulations for landing. For example, a typical runway length required under the present regulations for landing a fully loaded turbojet airplane is about 6,800 feet. Of the top 80 airports, based on the frequency of air carrier operations, approximately 50 have at least one runway available in excess of 7,800 feet.² Thus, even if the average operation into these airports was with a fully loaded airplane, there would be substantial excess runway over that required by the regulations. Most of the overruns have occurred on runways that were substantially (7 to 30 percent longer than required. This enabled the airplane to go off the end or the sides of the runway at a lower speed, thereby minimizing the potential damage. There have been no fatalities in turbojet overruns on wet runways, but one case resulted in serious injuries.

However, in the future, the number of turbojet airline operations into smaller cities with smaller (i.e., short range) airports is expected to increase, and unless the Agency takes regulatory action, it believes that the margins of safety which presently exist outside the requirements of the regulations will frequently disappear.

² FAA Air Traffic Activity, fiscal year 1964; Table 7, pp. 51-53.

Conclusion. Based on the above, the Agency concludes that an increase in the runway length required for landing on a wet or slippery runway is justified. From its study of the accident/incident record and the operational data, the Agency believes that an increase of 15 percent over the runway length required by the present regulations is adequate to cover those runway conditions that may frequently be expected and also reasonable variations in landing techniques. The Agency recognizes that to require runway length increases of the magnitude that would be necessary to prevent overruns when all the possible adverse conditions and extreme operating techniques are accumulated would be to impose economic burdens that have no relationship to the increased safety obtained. The Agency believes that compliance with the normal operating rules, such as sections 91.9, 121.551, and 121.553, is the proper means of preventing such incidents. The Agency believes that the economic burdens imposed by the increase adopted by this amendment are commensurate with the additional safety achieved thereby. These economic aspects will be discussed more fully hereafter.

Alternative operational method. Many of the comments received indicated that, in view of the advanced braking systems installed on many of the newer airplanes together with reverse thrust (not considered during type certification), any arbitrary increase would impose unjustified burdens on operations with some airplanes that are fully capable of landing even on wet or slippery runways within less than a 15-percent increase in the present required runway lengths. The Agency recognizes the validity of this comment and this amendment therefore provides an alternative whereby a particular type and model airplane may be approved for operations involving wet or slippery runways into airports with less than 115 percent of the normal required runway length upon obtaining approval from the Administrator. An advisory circular is being issued with this amendment that sets forth an acceptable means of compliance whereby this approval can be obtained. Basically, this advisory circular sets out criteria that require demonstration landings on wet or slippery runways at what the Agency considers normal operating conditions and giving credit for partial reverse thrust when available. To the average landing distance indicated by such demonstrations, an additional 15 percent margin is added to cover conditions that vary somewhat from the average. If the resulting figure is less than that which otherwise would be required by this amendment, it will be approved providing that in no event will the margin imposed by the present rule be decreased.

At the public hearing, the Air Transport Association of America proposed that a 10-percent increase in required landing runway length be made applicable to only the 707-120 type airplanes. The Agency considered this proposal, but it is not being adopted because the Agency believes that a 10-percent increase is not adequate for this type (with the original brake and thrust reversing systems) and that an increase for other

types is also justified. Since many airplanes have been or may be altered with respect to brake and reversing systems, this rule permits all of these factors to be taken into account under the alternate operational method.

Economic aspects. The Agency recognizes that, notwithstanding the duty resting upon air carriers to perform their services with the highest possible degree of safety, the economic burden added by any new safety requirement is relevant to the justification for that requirement.

Many of the comments received contained economic data indicating the burden that the proposed rule would place on individual operations and on overall air carrier operations. The Agency found that much of the economic data submitted was difficult to evaluate, and even more difficult to cumulate if a total operational cost was to be determined. This resulted from the fact that some calculations were based on actual loads while others were based on assumed 100 percent loads. The Agency now believes that the economic burden imposed by this rule, when effective, is commensurate with the additional safety that will be provided. The Agency further believes that there are four possible ways in which the objectives sought by this regulation may be achieved. These are—

(1) Comply with the 115-percent requirement for wet or slippery runways making any necessary payload reductions.

(2) Utilize the alternate operational method to obtain approval for operations into airports with less margin than required by (1) above.

(3) Increase the length of runways at those airports into which operations would otherwise be substantially affected by this amendment.

(4) Install improved antiskid systems and/or automatic spoilers that would make it easier to make the necessary showing under (1) or (2) above.

The Agency believes that none of the above alternatives will place an undue economic burden on those affected by this regulation for operations with the present turbine engine powered fleet. A study of landing weight penalties at a number of critical airports indicated that a 15-percent increase in required runway length would result in about one-half the total penalty associated with the 20-percent increase proposed in Notice 63-28. Furthermore, the most likely solution is a combination of the above alternatives depending upon the economic and operational feasibility of each. Thus, as airports, brake systems, and thrust reversing systems are improved, any weight penalties imposed by this rule will decrease further. Furthermore, while it is impossible to estimate accurately an annual dollar savings from prevented overshoots, the Agency believes that such savings will be an offsetting factor to any economic burden resulting from this amendment.

For future operations for such airplanes as the B-727, DC-9, and BAC 1-11, the Agency realizes that it is more difficult to estimate the effect of this regulation since these airplanes are specifically designed for operation into airports with shorter runways than those

being used by the present fleet. The Agency does have some data for the B-727 that would indicate that a showing can be made under the proposed operational method such that that airplane would not require any significant increase in runway length for wet or slippery conditions over that required by the present regulations. If a similar showing can be made with the DC-9 and BAC 1-11, this regulation would not impose any burden on operation of these aircraft. If such a showing cannot be made under the operational method for these aircraft for operations into wet or slippery runways, the 115-percent requirement must be met.

Critical airports. Much of the estimated economic burden of the proposed landing distance increase was indicated to be due to operations into six airports with critical length runways. These are Kansas City (Municipal), Newark, Dallas, Cleveland (Hopkins), Detroit (Willow Run), and Atlanta. Since the issue of the notice, several of these most critical situations have been alleviated. The ILS runway at Atlanta has now been extended to 8,800 feet. The ILS at Cleveland (Hopkins) has now been moved to the 9,000-foot runway. At Detroit (Willow Run) the longest runway is still the 7,521-foot runway, but Detroit is also served by Wayne Airport whose longest runway is 10,500 feet. At Kansas City Municipal Airport the longest runway is still the 7,000-foot runway, but the new Mid-continent Airport has a 9,000-foot runway that could presumably be used once the terminal building is constructed. At Newark the longest runway is still the 7,000-foot runway which would be adequate for all but the largest airplanes when heavily loaded which presumably could use John F. Kennedy International Airport. Accordingly, the Agency does not believe that this rule will cause a substantial economic burden even at those airports which can be termed the most critical for operation with large, heavily loaded turbojet airplanes.

Alternate airport requirements. Notice 63-28 proposed to increase the alternate airport landing distance requirements to provide a 40-percent runway margin beyond the type certification landing distance for all turbojet powered airplanes rather than the present 30-percent margin. The Agency's basis

for this proposal was substantially the same as that for increasing the destination airport landing distance requirements. However, since operations into alternate airports are fairly infrequent, the Agency did not believe that it was worthwhile to propose this increase on the basis of the condition of the runway. While few comments were directly addressed to the proposed alternate airport landing distance increase, the Agency has assumed that most of the comments received were applicable alike to the alternate airport proposal. The Agency believes that, for the reasons stated above relating to destination airports and those stated in the notice, the proposed increase in the alternate airport landing distance requirement should be adopted and should apply to all turbojet landings thereat. Section 121.197 is being amended accordingly, and a paragraph (e) is being added to § 121.195 consistent with the change to § 121.197.

Low weather minimum criteria. Notice 63-28 mentioned the relevance of the FAA policy (reflected in Advisory Circular 120-4) for approval of turbojet operations with 200-½ minimums. This advisory circular permits operations with landing minimums of 200-½ at certain approved airports provided additional operational requirements are met. One of these additional requirements is that there be 15 percent or 1,000 feet (whichever is greater) additional runway over that required by the present regulation. These operations are not affected since the 15-percent increase (for turbojet powered airplanes) in runway lengths for wet or slippery runways required by this amendment is not in addition to the 15-percent required for operations into approved airports with low minimums. However, the Agency is studying the effect of the combination of wet or slippery runway conditions and low weather minimums to determine whether the required 15 percent increase is adequate for such operations.

To allow time for affected persons to prepare and issue revised runway landing weight limitations and if possible to take steps toward alleviating possible payload penalties, this amendment is to become effective six months after the date of adoption.

In consideration of the foregoing, Part 121 of the Federal Aviation Regulations is amended, effective January 15, 1966, as

follows:

a. Paragraph (b) of § 121.195 is amended by striking the words "paragraph (c)" and inserting the words "paragraphs (c), (d), or (e)" in place thereof.

b. Paragraph (c) of § 121.195 is amended by striking out the first word "An" and inserting the words "A turbo-propeller powered" in place thereof.

c. Section 121.195 is amended by adding the following new paragraphs (d) and (e) at the end thereof:

§ 121.195 Transport category airplanes: turbine engine powered: landing limitations: destination airports.

(d) Unless, based on a showing of actual operating landing techniques on wet runways, a shorter landing distance (but never less than that required by paragraph (b) of this section) has been approved for a specific type and model airplane and included in the airplane flight manual, no person may takeoff a turbojet powered airplane when the appropriate weather reports and forecasts, or a combination thereof, indicate that the runways at the destination airport may be wet or slippery at the estimated time of arrival unless the effective runway length at the destination airport is at least 115 percent of the runway length required under paragraph (b) of this section.

(e) A turbojet powered airplane that would be prohibited from being taken off because it could not meet the requirements of paragraph (b)(2) of this section may be taken off if an alternate airport is specified that meets all the requirements of paragraph (b) of this section.

§ 121.197 [Amended]

d. Section 121.197 is amended by inserting the words "for turbopropeller powered airplanes and 60 percent of the effective length of the runway for turbojet powered airplanes," immediately after the words "length of the runway".

(Secs. 313(a), 601, 603, and 604, Federal Aviation Act of 1958 (49 U.S.C. 1354, 1421, 1423, and 1424))

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N. E. HALABY,
Administrator.