UNITED STATES

ENVIRONMENTAL PROTECTION AGENCY

RECOMMENDED

NOTICE OF PROPOSED RULE MAKING
ON
TWO - SEGMENT ILS NOISE ABATEMENT APPROACH
FOR TURBOJET ENGINE - POWERED AIRPLANES

22 AUGUST 1975

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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

[14 CFR Part 91]

[Docket No. ; Notice No. 75-]

TWO-SEGMENT ILS NOISE ABATEMENT APPROACH FOR TURBOJET ENGINE-POWERED AIRPLANES

Notice of Proposed Rulemaking

In accordance with a recommendation by the Administrator of the Environmental Protection Agency, the Federal Aviation Administration is considering an amendment to Section 91.87 of the Federal Aviation Regulations which would provide noise relief to communities in the vicinity of airports by prescribing a two-segment Instrument Landing System (ILS) approach for civil turbojet engine-powered airplanes.

This proposed rule is one of three rules recommended by the EPA for the control of noise during the approach and landing of turbojet engine-powered airplanes. The two remaining rules recommended by EPA involve the use of reduced flap setting procedures and a two-segment visual approach under specifically defined visual weather conditions which are more restrictive than VFR. The latter rule, if promulgated, could be made effective in the near future, applying to airports equipped with colocated ILS and Distance Measuring Equipment (DME) ground facilities, as it does not require any additional airborne equipment. If the two-segment ILS approach rule discussed herein is promulgated and implemented - including the necessary airborne glide-slope computer installations on all affected aircraft -it would supersede the two-segment visual approach rule, since it would require the use of a two-segment approach under both VFR and IFR conditions.

In addition to recommending the promulgation of three proposed regulations, the EPA has recommended certain non-regulatory actions by the FAA, concerning evaluation of an increased approach glide angle and reduced use of reverse thrust after landing. These recommendations, with background information, are included in each NPRM, so that each is complete in itself, independent of the others.

Interested persons are invited to participate in the subject rule making process by submitting such written data, views, or arguments as they may desire. Communications should identify the regulatory docket or notice number and be submitted in duplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket, GC-24, 800 Independence Avenue, S.W., Washington, D.C. 20590, and Environmental Protection Agency, Office of Noise Control Programs, AW-571, Attention: Docket No. 75-13, 401 M Street, S.W., Washington, D.C. 20460. All communications received on or before will be considered by the FAA Administrator before taking action on the proposed rule. The concepts contained in this notice may be changed in the light of comments received. All comments submitted will be available, both before and after the closing date for comments, in the Rules Docket for examination by interested persons.

Under the requirements of Section 7(a) of the Noise Control Act of 1972 (Pub. L. 92-574, 86 Stat. 1234) the Administrator of the Environmental Protection Agency conducted a study of aircraft and airport noise and submitted a report thereon to the Congress. (Report on Aircraft/Airport Noise, Senate Committee on Public Works, Serial No. 93-8, Aug. 1973, Reference 16). Under Section 611 of the Federal Aviation Act, as amended by the Noise Control Act of 1972, the Administrator of the EPA also is required, not earlier than the date of submission of his report to the Congress, to submit to the Federal Aviation Administration proposed regulations to provide such control and abatement of aircraft noise and sonic boom (including control and abatement through the exercise of any of the FAA's regulatory authority over air commerce or transportation or over aircraft or airport operations) as the Administrator of the EPA determines is necessary to protect the public health and welfare. In accordance with the foregoing requirement, the EPA published in the Federal Register on February 19, 1974, (39 F.R. 6142) a "Notice of Public Comment Period" containing a synopsis of the following rules it is considering in its efforts to achieve a satisfactory level of aircraft noise control and abatement for the protection of the public health and welfare. The proposed rules and the type of control which each rule would implement are as follows:

<u>Flight procedures noise control.</u>

(1) Takeoff procedures.

(2) Approach procedures.

(3) Minimum altitudes.

<u>Source noise control.</u>

(4) Retrofit/fleet noise level.

(5) Supersonic civil aircraft noise.

(6) Modifications to Part 36 of the Federal Aviation Regulations.

(7) Propeller driven small airplanes.

(8) Short haul aircraft.

Airport operations noise control.

(9) Airport goals, mechanisms and procedures by which noise exposure of communities around airports can be limited to levels consistent with public health and welfare requirements.

This proposed rule is identified as the two-segment ILS noise abatement approach portion of item (2) above.

References

In the development of this proposed rule the EPA evaluated several pertinent studies made by Federal agencies and private persons. Those studies are listed herein for the information of all interested persons and are available for examination at the FAA Rules Docket Office, GC-24, 800 Independence Avenue, S.W., Washington, D.C. 20590, or Environmental Protection Agency, Office of Noise Control Programs, Crystal Mall No. 2, 1921 Jefferson Davis Highway, Arlington, VA 20460. Copies of those studies prepared by Government Agencies are also for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(1) "Operational Noise Abatement Procedures Designed to Limit the Amount of Disturbance Caused by Aircraft Taking Off, In Flight, or Landings", International Conference on the Reduction of Noise and Disturbance Caused by Civil Aircraft, London, November, 1966.

(2) "Note on Effect of Thrust and Altitude on Noise in Steep Approaches", NASA, LWP-283, September 14, 1966.

(3) "Flight Investigations of Methods for Implementing Noise Abatement Landing Approaches", "Progress of NASA Research Relating to Noise Alleviation of Large Subsonic Jet Aircraft", NASA SP-189, October 8-10, 1968.

(4) "Flight and Simulation Investigation of Methods for Implementing Noise Abatement Landing Approaches", NASA TN D-5781, May 1970.

(5) "Noise Measurement for a Three-Engine Turbo-Fan Transport Airplane During Climbout and Landing Approach Operations", NASA TN D-6137, May 1971.

(6) "Measurement and Analysis of Noise from Four Aircraft During Approach and Departure Operations (727, KC-135, 707-320B, and DC-9)", FAA Report FAA-RD-71-84, September 1971.

(7) "Preliminary Results on Two-Segment Noise Abatement Studies", NASA TM X-62, 098, September 22, 1971.

(8) "Noise Reductions Achieved on a 720-023B Aircraft Using a Two-Segment Approach", NASA CR-14417, December 1971.

(9) "Flight Evaluation of Two-Segment Approaches for Jet Transport Noise Abatement", American Airlines NASA Contractor Report, prepared under Contract No. NAS 2-6501, June 1973.

(10) "Aircraft Noise Reduction Technology", a report by the National Aeronautics and Space Administration to the Environmental Protection Agency for the Aircraft/Airport Noise Study, March 30, 1973.

(11) D.G. Denery, et al, "Status Report on NASA Two-Segment Approach Program", Paper 750594, presented at the SAE Air Transportation Meeting, Hartford, Conn., May 6-8, 1975.

(12) "Initial Flight and Simulator Evaluation of a Head-Up Display for Standard and Noise Abatement Visual Approaches", NASA, TM X-62, 187, February 1973.

(13) "NBAA Noise Abatement Program", National Business Aircraft Association, Report SR 67-12, June 1967.

(14) "Effects of Aircraft Operations on Community Noise", The Boeing Company, Commercial Airplane Group, June 1971.

(15) "A Comparison of Aircraft Approach Angles at Los Angeles and San Diego International Airports", City of Inglewood, California, June 1972.

(16) "Report on Aircraft/Airport Noise", Report of the Administrator of the Environmental Protection Agency in Compliance with Public Law 92-574, Senate Committee on Public Works, Serial No. 93-8, August 1973.

(17) "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", EPA Technical Document 550/9-74-004, March 1974.

(18) C. Bartel, L.C. Sutherland and L. Simpson, "Airport Noise Reduction Forecast", DOT Report DOT-TST-75-3, October 1974.

(19) J.E. Wesler, "Airport Noise Abatement - How Effective Can It Be?", Sound and Vibration, February 1975, pp. 16-21.

(20) R. H. Peterson and R. F. Burke, "Studies of Methods for Reducing Community Noise Around Airports", Nielsen Engineering and Research, Inc., Report NEAR TR 73, prepared under contract no. NAS2-8190 for NASA/Ames, August 1974.

(21) G.D. Adams, "Let-Down Guidance System", FAA Report No. FAA-RD-70-6, April 1970.

(22) Joseph D. Blatt, letter to Steven Starley, Office of Noise Abatement and Control, Environmental Protection Agency, March 31, 1975.

(23) "Field Evaluation of 3000 Ft-Glideslope Intercept Program," Report No. FAA AT-72-1, March 1972.

(24) "Noise Measurement Evaluation of Takeoff and Approach, Profiles Optimized for Noise Abatement", NASA TN D-6244, March 1971.

(25) "Recommended Steps for Noise Abatement Approach", Informal Paper Submitted to EPA by ATA, received March 5, 1973.

(26) "Operations Analysis Including Monitoring, Enforcement, Safety, and Cost," Report of Task Group 2, EPA NTID 73.3, 27 July 1973.

(27) "Approach and Landing Procedures for Noise Control", EPA Project Report, 1 July 1975.

Regulatory History

Advance Notice of Proposed Rule Making (ANPRM) 74-12 (39 FR 11193), issued by the FAA on March 20, 1974, proposed regulations that would require aircraft landing at specified airports to use a two-segment ILS approach in order to reduce the noise impact on persons or property underlying the approach path. The proposed regulations would apply to all civil turbojet engine-powered airplanes conducting an ILS approach to over 100 ILS equipped runways located at 58 major airports in the U.S. The 55 airports, listed by state, that were identified in ANPRM 74-12 as being under consideration for implementation of the two-segment ILS noise abatement approach are repeated herein for the information of all interested persons.

Arizona [Sky Harbor (Phoenix), Tucson International];

California [Fresno Air Terminal, Hollywood-Burbank, Lindberg Field (San Diego), Long Beach, Los Angeles International, Oakland International, Ontario International, Orange County (Santa Ana), San Jose Municipal, San Francisco International];

Colorado [Stapleton International (Denver)];

Connecticut [Bradley International (Windsor Locks)];

Florida [Miami International, Tampa International];

Georgia [Atlanta Hartsfield International];

Illinois [Chicago-Midway, Chicago-O'Hare International];

Iowa [Des Moines Municipal];

Kentucky-Ohio [Greater Cincinnati, Standiford Field (Louisville)];

Louisiana [New Orleans International];

Maine [Bangor International, Portland International];

Massachusetts [Barnstable Municipal (Hyannis), Logan International (Boston)];

Michigan [Detroit-Wayne County Metropolitan];

Minnesota [Minneapolis-St. Paul International];

Missouri [Lambert International (St. Louis)];

Nebraska [Eppley Airfield (Omaha)];

New Jersey [Atlantic City, Mercer County (Trenton), Morristown Municipal, Newark];

New York [Albany County, J.F. Kennedy International (New York), La Guardia (New York), Stewart (Newburgh), Westchester County (White Plains)];

Ohio [Cleveland-Hopkins International, Dayton Municipal, Port Columbus International];

Oklahoma [Tulsa International, Will Rogers World (Oklahoma City)];

Pennsylvania [Philadelphia International];

Rhode Island [T.F. Green (Providence)];

Texas [Dallas-Ft. Worth Regional, Houston Intercontinental, San Antonio International];

Vermont [Burlington International];

Virginia [Dulles International (D. C.), Washington National (D. C.)];

Washington [Lewiston Nez Perce, Seattle-Tacoma International]; and

Wisconsin [Madison Municipal]

As in the case of other noise reduction proposals the comments received from persons residing in the vicinity of the airports concerned generally favored the proposal. The comments received from the American Association of Airport Executives (AAAE) also favored the proposal as an effective means of reducing the impact of flight operations in the approach area. In the opinion of one major West Coast airport operator the proposal would, if adopted, result in a very great cost benefit for the entire aviation industry. The operator stated that at his airport alone the potential liability for noise is in excess of $3 billion and that a reduction of the 90 EPNdB impact area in each approach zone from 18 square miles to 3.7 square miles is a very dramatic and helpful improvement that could be of great significance in that liability. It should be pointed out here that this estimate of the improvement obtainable with two-segment approach is over-optimistic; a 30 to 60% reduction in the 90 EPNdB impact area is more reasonable.

Conversely, the aircraft operators were generally opposed to the two-segment ILS approach. The Airline Pilots Association (ALPA and IFALPA), speaking for its members, stated that the two-segment ILS approach is not acceptable to the pilot community and as proposed, it leaves many questions still unresolved. As an optional method of reducing noise the pilot associations suggest quieter airplanes and retrofit. The Air Transport Association (ATA), on the other hand, speaking for its air carrier members, believes the benefits of a two-segment approach are overstated and the costs understated. Moreover, it believes the two-segment ILS approach is not yet adequately proved in service to introduce as a mandatory procedure.

The National Business Aircraft Association (NBAA), speaking on behalf of its members who use aircraft in the conduct of their business, stated that the two-segment ILS approach under IFR was not warranted at this time on the combined grounds of possible degradation of safety, small noise reduction potential, and high cost. The Aircraft Owners and Pilots Association (AOPA) were also opposed to the use of a two-segment approach and raised the issue of safety in regard to wake turbulence.

Introduction and Basis

Notwithstanding the foregoing comments in opposition to the two-segment ILS approach, the EPA believes that the use of a two-segment ILS approach for civil turbojet engine-powered airplanes can provide significant noise abatement within existing technology and pilot capability without degradation of safety. Since the FAA has not taken additional rule making action in regard to ANPRM 74-12, the EPA has submitted this recommended notice of proposed rule making for the consideration of the FAA Administrator under the mandates of Section 611 of the Federal Aviation Act of 1958 as amended. It is published herein for the information and comments of all interested persons. In the preparation of those comments it is to be noted that the EPA has also submitted separate noise reduction proposals for a two-segment ILS approach under visual conditions and for the use of reduced flap settings during the approach and landing. Both of these proposals apply to civil turbojet engine-powered airplanes and may be issued in separate rule making actions by the FAA under the provisions of section 611 of the Federal Aviation Act.

As stated in the previous notice (ANPRM 74-12), the two-segment ILS approach rule would require an ILS approach and landing to be conducted at those airports designated above. The approach would consist of a two-part descent with the upper segment glide angle flown at 5 to 6 degrees, depending on the type of aircraft, and with the second segment being flown using the existing ILS glide slope angle. Transition between upper and lower segments would be accomplished far enough from touchdown to allow stabilized conditions by 700 feet height above airport (HAA). Normally, the transition would begin approximately three nautical miles from runway threshold and be completed by two nautical miles from threshold. The regulation would allow a stable, controlled approach down to the Category I weather minimums in the standard instrument approach procedures issued under Part 97 of the Federal Aviation Regulations. The regulation would apply to all civil turbojet airplanes.

The two-segment noise abatement approach technique has been under development over the past several years and has progressed from the engineering and development phase to operational evaluation under actual operating conditions in the national airspace system. Several variations of the two-segment approach have been examined and one airline has adopted a two-segment approach procedure under visual conditions with conventional cockpit instrumentation.

The National Aeronautics and Space Administration (NASA) and FAA began research work on steep single-segment and two-segment approaches early in the 1960's. It appears that, of the various approach procedures studied, the two-segment approach holds the most promise for significant noise relief without impairment of safety, especially for turbojet engine-powered airplanes.

In 1966, the FAA installed an experimental dual ILS glide path system at Dulles Airport that provided guidance for a two-segment approach. The first and second segment approach angles were 5.5 and 2.5 degrees, respectively. The transition point from the first to the second segment occurred at approximately 1140 ft altitude (827 ft HAA) and 3.1 nautical miles from threshold (827 ft / 3.1 nm). With the use of these approach procedures, as reported in Reference (1), a noise reduction of 10 dB (overall sound pressure level) was observed at a distance of 26,000 feet (4.3 nm) from the runway threshold.

As shown in the NASA study reported in Reference (2), the noise reduction due to steeper approaches is caused by two factors, the increased altitudes and the reduced power setting. For the four engine turbojet airplane used in that study, increasing the glide slope angle from 3 to 6 degrees reduced the overall sound pressure level under the flight track by 11.5 to 13.5 dB, of which approximately 7 dB was due to thrust reduction, the remainder being due to increased altitude.

NASA studies [References (3) and (4)] were also conducted to determine the requirements that would enable pilots to fly two-segment approach profiles with the precision common to conventional instrument landing approaches, without an increase in pilot workload. The approach profiles were evaluated by 11 pilots using a research four-engine turbojet powered airplane which had a flight director modified for two-segment approaches, an autothrottle, and both longitudinal and lateral directional stability augmentation. The studies concluded that a two-segment approach could be flown in the modified airplane with the same precision as a conventional one-segment instrument landing approach without a significant increase in pilot workload in the nearly ideal conditions of the tests.

The NASA tests reported in Reference (5) used a B-727 three-engine aircraft to fly 6/3 degrees two-segment approaches with transition starting at 1115 ft/3.4 nm and completed by 722 ft/2.6 nm. Test results for these approaches indicated a noise reduction of 6 EPNdB at 3 nm and 10 EPNdB at 4.5 nm from threshold.

The FAA tests reported in Reference (6) studied nine approach noise abatement procedures for four different types of aircraft (B-727, KC-135, B-707-320B, and DC-9). The weather conditions for the tests varied considerably, a situation typical of actual line operations and, therefore, considerable scatter was evident in the data. Nevertheless, the report concluded that a "two-segment approach can achieve significant reductions in noise along the ground". Both procedures used an initial intercept height of 3000 feet HAA and full flaps. The results of these tests also indicated a noise reduction averaging 10 to 14 EPNdB at 5 to 7 nautical miles from the runway threshold achieved by the use of the two-segment approach.

The studies reported in References (7) through (9) were conducted by NASA with American Airlines and Hydrospace Research Corporation as contractors. In these studies, two-segment approaches (6/2.5 degrees with transition at 400 ft / 1.5 nm) were evaluated during 75 hours of flight in a B-720 four engine turbojet powered aircraft. A total of 28 pilots [2 project pilots and 26 guest pilots representing air carriers, FAA, ALPA, Allied Pilots Association (APA) and NASA] flew 234 two-segment approaches and 34 normal ILS approaches. All the tests were made during the daytime and in calm visual conditions.

The results of the tests were then presented to advisory committees, composed of individuals representing the airlines, airframe manufacturers, avionics suppliers, ATA, ALPA, and the Government, who agreed that the two-segment approach appeared operationally feasible, but warranted additional evaluation under representative operational conditions in other types of aircraft. The committees recommended that one of the aircraft should be a B-727 because that type of aircraft accounts for the largest number of arrivals and departures and is used by more air carriers than any other type of aircraft. The committee also recommended that another type of aircraft to be used in the tests should be a long-range type of aircraft such as the DC-8 or B-707 in order to extend the applicability to the data, as those aircraft differ significantly from the B-727 type of aircraft and have a larger noise footprint. In accordance with recommendations of the advisory committee, on-line flight evaluations were conducted with B-727 and DC-8 airplanes by United Airlines under contract to NASA, Reference (10).

The results of the UAL investigation and tests under this NASA contract were discussed at a recent status reporting session held by NASA (Reference 11). The key points presented are summarized below:

- Two-Segment avionics have been developed and certified for airline use
- These avionics make use of contemporary ground navigational aids

- Crew procedures have been developed to be nearly identical to to those in use by the air carriers
- Procedures and equipment are being evaluated under a wide variety of operational conditions:

    Usable under VFR & IFR conditions

    Compatible with ATC (based on 727 tests)

    Normal ILS approach should be used during icing or in extreme tail winds
- Noise reduction has been measured
- System costs have been estimated
- Adaptability to the entire fleet has been shown

The UAL researchers indicated that some problems and uncertainties remained unresolved. However, most of the factors identified as problems reside largely in the fact that two-segment approach has not been in widespread use, and they would be resolved as the necessary hardware and techniques were introduced into the air-carrier system.

The NASA tests reported in Reference (12) evaluated thirty-three approaches with a B-747 aircraft equipped with a cockpit "head-up" display Visual Approach Monitor (VAM) to aid the pilot in transitioning to a normal glide path from either a higher or a lower position. When compared with a standard 3 degrees approach, noise measurements made during those approaches again indicated considerable noise reductions. The reductions ranged from 6 EPNdB at 1 nm (from runway threshold) to 11 EPNdB at 5 nm for a 6/3 degree approach with transition at 660 ft/2.1 nm. Since a 6 degrees upper segment with 25 degrees flaps was slightly too steep for the 747 aircraft, use of 30 degree flaps and/or 5 degrees upper segment was recommended for future tests.

In addition to the studies conducted by NASA, EPA and the FAA, it is to be noted that air carriers, aircraft manufacturers and aeronautical associations have made studies regarding the feasibility of the two-segment approach, and in some cases, air carriers are using such approaches. For example, in a report dated 12 June 1967, the National Business Aircraft Association (NBAA) recommended the use of two-segment approaches in VFR weather conditions [Reference (13) listed above]. The Boeing Company in a report issued in June, 1971, Reference (14), investigated the reduction of noise by the use of the two-segment approach. For a 6/3 degrees approach with transition at 1000 ft/3 nm, the Boeing report predicted a noise reduction ranging from 5.5 EPNdB at 3.5 nm to 9.5 EPNdB at 6 nm from threshold for its B-727 aircraft. Using electronic guidance and a transition (250 ft HAA) closer to the airport, the report also predicted a noise reduction ranging from 5.2 EPNdB at 1 nm to 13 EPNdB at 6 nm.

In 1967, National Airlines began using a two-segment approach at Miami International Airport with weather minimums of 3000 feet ceiling (above ground) and five nautical miles visibility. In 1972, Pacific Southwest Airlines started to use a visual two-segment approach at airports used by that airline in California. In the same year, Air California also started to use a visual two-segment decelerating approach with B-737 type aircraft. The two-segment approach is also used by aircraft as large as a DC-8 at the San Diego International Airport. Most of the approaches at this airport are made over high terrain to the east of the runway which necessitates a steep approach. This approach may be either a 4.5 degrees single-segment [a non-standard Visual Approach Slope Indicator (VASI) at this angle provides a visual reference], or a two-segment approach with close-in transition, i.e., closer than 1 nm from runway threshold [Reference (15), above].

Health and Welfare Considerations

The EPA Report to Congress on Aircraft and Airport Noise (Reference 16) indicated that large numbers of persons are subjected to levels of cumulative noise exposure due to aircraft operations which have a potential for producing a permanent impairment of hearing, interference with speech, and the generation of annoyance. That report estimated that in 1972, 16 million persons in the United States were subjected, due to aircraft operations, to a Day-Night Average Sound Level of 60 dB or greater. The Day-Night Average Sound Level, Ldn is the measure used by the EPA to express quantitatively the cumulative noise exposure of a population.

Information presented in the Report to Congress (Reference 16) further indicated that, based on available data in the scientific literature, at Ldn values of 60 dB there is about a 2.5 percent occurrence of speech interference and about 23 percent of the exposed population is highly annoyed. Further, the EPA "Levels Document" (Reference 17) specifically identified two long-term average levels of noise exposure which should not be exceeded in order to protect the public health and welfare with an adequate margin of safety:

- A Day-Night Level (Ldn) no greater than 55 dB, to protect against annoyance (including interference with speech communication);
- An Equivalent Noise Level (Leq) no greater than 70 dB, to protect against significant adverse effects on hearing.

As pointed out in EPA's "Levels Document" the phrase "health and welfare" is taken to mean "complete physical, mental and social well-being and not merely the absence of disease and infirmity". It is clear from the foregoing data that noise due to aircraft operations represents a significant hazard to the health and welfare of millions of persons.

As set forth in the Report to Congress, the EPA has determined that, in order to protect the public health and welfare from aircraft noise, it is necessary that regulations be proposed to the FAA, for promulgation, in the eight subject areas of aircraft noise control listed earlier in this preamble.

The intent of those aircraft noise regulations is to produce a substantial reduction in the number of persons subjected to cumulative noiselevels that are considered hazardous to their health and welfare, i.e., in the terms outlined in the foregoing paragraphs, to Ldn values of 55 dB or greater. Although theoretically it might be considered desirable to reduce the day-night level due to aircraft noise to less than 55 dB for all persons, this is an unrealistic goal. As reported in the Levels Document, Reference 17, some 62 million persons in the United States are estimated to be exposed to Ldn 60 or greater due simply to vehicular traffic noise, and some 75 percent of the urban population are estimated to be exposed to ambient sound levels averaging Ldn 55 or greater. Present technology does not provide the capability of reducing cumulative noise due to aircraft operations to Ldn 55 for all persons without essentially destroying the national air-carrier system, with all its attendant benefits to the public health and welfare. And even if aircraft noise were completely eliminated, many millions of persons still would be subjected to cumulative noise in excess of Ldn 55 due to other sources, mainly motor vehicles. Consequently, the EPA has a more modest and realistic goal, namely, to achieve the maximum reduction of cumulative noise due to aircraft operations that is technologically feasible to obtain without exorbitant costs. This is a position consistent with the requirements under the Noise Control Act that EPA, as well as the FAA, must meet in developing and promulgating noise control regulations which are within their respective areas of responsibility.

The EPA believes that the succeeding paragraphs quantify the environmental noise impact associated with aircraft and airport operations. This is done for both a defined baseline situation and for hypothetical situations in which it is assumed that one or more of the proposed aircraft noise regulations has been implemented. Comparison of the various sets of figures provides reasonable estimates of the noise reduction benefits to be gained by implementation of the various regulatory proposals for the control of aircraft noise.

Assessment of Noise Impact due to Aircraft Operations

This section deals with the health and welfare effects of environmental noise in terms of noise impact assessment which is a methodology for quantifying the extensiveness and severity of noise impact by a single number. An explanation of Noise Impact Methodology has been presented in various EPA publications, including Reference 27. In brief, this methodology comprises the following steps, for each specified environmental noise situation.

1. Determine (or estimate) the number of persons [P(i)] exposed to various ranges of Day-Night Equivalent Sound Level (Ldn) (e.g., 8.5 million persons between Ldn 60 and 65; 4.1 million between Ldn 65 and 70, etc.)

2. Assign to each Ldn range a Fractional Impact value [FI(i)] appropriate to the criterion under consideration. For purposes of this analysis, Ldn 55 is considered to represent a zero impact [FI =0], and Ldn 75 an impact of 1.0 [FI = 1.0]. For Ldn 60-65, FI(1) is 0.375; for Ldn 65-70 FI(2) is 0.625; for Ldn 70-75, FI(3) is 0.875; etc.

3. For each range of Ldn values, determine the Noise Impact Contribution as the product of number of persons exposed and fractional impact, or

$$NI(i) = [FI(i)] \times [P(i)]$$

4. Calculate the Equivalent Noise Impact, ENI, as the sum of the individual Noise Impact contributions, or

$$ENI = \Sigma (i) [FI(i)] [P(i)]$$

This quantity may be interpreted as the equivalent number of persons "fully impacted" by the noise in the given situation. For residential land use affected by noise, the ENI value is the equivalent number of persons exposed to Ldn 75.

To obtain an estimate of the noise impact reduction resulting from some action, such as implementation of aircraft noise regulation, one would estimate the ENI values for the baseline condition and for the condition existing as a result of the action taken. The result could be expressed as a change in absolute value, or as a ratio, of the baseline Equivalent Noise Impact.

1. Baseline Noise Impact - Aircraft Operations

For this analysis, the baseline year of 1972 is used, mainly because the best available analyses of aircraft environmental noise have been premised on a 1972 baseline (References 18-20). Since the Noise Control Act was enacted into law in 1972, this baseline seems quite appropriate.

Of the three references listed, Reference 18, "Aircraft Noise Reduction Forecast", also known as the DOT "23-Airport Study", is the most widely known. It provides the basic data and point of departure for the others. In terms of the individual elements of EPA's proposed regulatory package, Reference 19, which extended the analysis of Reference 18 to cover additional options of noise reduction, seems most nearly oriented towards evaluation of the effects of the various options considered. Consequently, the calculations and results presented in this section are based largely on the data of Reference 19, with key data points confirmed by Reference 18. This latter report adduced that the 23 airports studied accommodated approximately half of the operations nationally of air-carrier jet aircraft. In terms of total impact, however, independent analyses by EPA and its consultants indicated that the population impacted by the operations to and from the 23 airports represented about 63% of the national impacted population. The results presented herein are based on that premise.

On the basis of the information discussed in the previous paragraphs, the EPA has estimated that for the 1972 baseline condition, the national population exposed to Ldn 65 or greater is 7,925,000 persons, and to Ldn 75 or greater is 792,000 persons. This corresponds to an Equivalent Noise Impact (ENI) (considering the population exposed to Ldn 65 or greater) of approximately 5,800,000 persons. By extrapolating the population data, a rough estimate can be obtained of the baseline population exposed to Ldn 60 or greater. This rough estimate is about 25,000,000 persons; the corresponding ENI, considering the population exposed to Ldn 60 or greater, is about 12,000,000 persons.

2. Noise Impact - Projected Fleet of the late 1970's, with several Noise Control Options Applied

Summarized below are the estimates of the effects of several of the noise control options that would be undertaken if the regulations package proposed by EPA were promulgated and implemented. The results, for the late 1970's, are given in terms of Reduction in numbers of persons exposed to Day-Night Equivalent Levels of 65 or greater, and 75 or greater, respectively, and corresponding changes in Noise

Impact, taking into account the change in air-carrier fleet mix and number of operations projected for that period.

The conditions considered are the following:

- 1978 Baseline Fleet (this reflects the introduction of new, less noisy aircraft that meet or better FAR 36 noise limits, and the phasing out of old, noisier aircraft.)
- Two-Segment Approach
- Noise Abatement Takeoff
- Quiet Nacelle (QN) also referred to as Sound Absorption Material (SAM) Retrofit

The estimated data on numbers of people affected in various Ldn ranges, and the corresponding changes in Noise Impact, are tabulated below.

- 1978 Baseline Fleet (relative to 1972 Baseline):
  - Population exposed to Ldn 65 or greater reduced by 2,520,000.
  - Population exposed to Ldn 75 or greater reduced by 287,000.
  - Severity and extensiveness of impact reduced by 33.6 percent.
- Two-segment approach (relative to 1978 Baseline):
  - Population exposed to Ldn 65 or greater reduced by 570,000.
  - Population exposed to Ldn 75 or greater reduced by 54,000.
  - Severity and extensiveness of impact reduced by 10.4 percent.

- Noise Abatement Takeoff (relative to 1978 Baseline):
  - Population exposed to Ldn 65 or greater reduced by 1,050,000.
  - Population exposed to Ldn 75 or greater reduced by 102,000.
  - Severity and extensiveness of impact reduced by 19.1 percent.
- Quiet Nacelle Retrofit (relative to 1978 Baseline):
  - Population exposed to Ldn 65 or greater reduced by 1,600,000.
  - Population exposed to Ldn 75 or greater reduced by 283,000.
  - Severity and extensiveness of impact reduced by 32.3 percent.

Although not all of the EPA proposed regulations for control of aircraft noise can be quantified directly in terms of the reduction in Equivalent Noise Impact, it is apparent from the foregoing discussion that a serious noise impact now exists, and prompt action is necessary to protect the public health and welfare. It also is apparent that, although the expected evolution of the fleet will reduce the noise impact significantly, implementation and promulgation of aircraft noise regulations is a necessary and important part of the action that needs to be taken, and will yield substantial benefits in reducing the number of persons seriously impacted by noise.

Cost Considerations

A two-segment ILS approach as proposed in the ANPRM 74-12 and in this notice would require an electronic equipment retrofit for all U.S. and foreign aircraft using the 58 airports in the United States having a noise sensitive area within 3 to 8 miles from the runways under the approach path. On the basis that the equipment required is a glide slope computer such as that used in the tests, the cost to be borne by the operator of the airplane has been estimated in ANPRM 74-12 and by NASA to be between $35,000 and $37,000 per airplane, including labor, interface equipment and wiring modifications, parts and spares. The corresponding total cost for the approximately 2000 airplanes of the U.S. air-carrier fleet would be about $70 million.

There are alternative means by which two-segment approach capability can be obtained, and these alternatives have a direct bearing on how much of the cost of the capability can be charged to noise abatement. One such alternative is to utilize electronic systems which include the glide slope computer function even though the system was not designed for the purpose of noise abatement. A second alternative is to utilize a single purpose system designed specifically for noise abatement. Finally, although it would offer no near term relief, another alternative should address incorporation of the two - segment approach capability into future aircraft guidance and air traffic control systems. In the interests of brevity, the three alternative methods of achieving a two-segment approach capability will be referred to as the multi-purpose system, single purpose system, and future system.

A multi-purpose system which includes necessary glide slope computer function does exist (Reference 11) since the FAA Western Region issued a Supplemental Type Certificate (STC SA2865WE dated June 7, 1974) which permits in-service use of the ANS-70A area navigation (RNAV) system to fly two-segment approaches. The cost implications for noise abatement which derive from the availability of an RNAV system that includes the glide slope computer function are not clear, e.g., if the RNAV system were installed for area navigation, then the incremental cost for two - segment approach capability would be modest. Even if the system were purchased because two-segment approaches are required and the RNAV capability is a desirable rather than a required item, only a portion of the system cost should be charged off against noise abatement, since it does not appear reasonable that a full-function RNAV system would be purchased only for its two-segment approach capability. Whereas it may be difficult to apportion the costs of a two-segment approach capable RNAV system to both noise abatement and air navigation, no such problem exists for the single-purpose system. Single purpose systems have been built and demonstrated by both the FAA and NASA.

In 1970, the National Aviation Facilities Experimental Center (NAFEC) of the FAA designed and demonstrated a "Let Down Guidance System" for two-segment approaches (Reference 21). The NAFEC unit is a small airborne analog computer which converts distance and barometric altitude inputs into vertical guidance signals which are presented on a conventional crosspointer instrument. In Reference

22, it is estimated that the current cost of an Airborne Glide Slope Computer of the NAFEC type would be between \$2,000 and \$5,000, assuming that the aircraft is equipped with DME and a satisfactory altimeter system. The actual cost of the installed system, within the range indicated here, would depend upon the sophistication desired and the number of units as well as the kind and amount of interface hardware and engineering required.

The previously-mentioned NASA estimate of \$37,000 (Reference 11) concerned a two-segment approach system which was based on the NAFEC type of airborne computer but which incorporates the attributes necessary for certification for use in air-carrier aircraft. This estimate was based upon certain assumptions as to number of units manufactured and existing instrumentation on board the aircraft. A detailed review of the NASA estimates indicates some possible conservatism in the cost-influencing assumptions with respect to the need for new DME, cost-quantity relations, spares allowance, and installation labor. With different assumptions, the cost estimate could be significantly lower.

With respect to future systems such as the Microwave Landing System (MLS), a two-segment approach capability essentially exists within the current system design concepts. If the MLS were fully developed with an explicit two-segment approach capability, the costs chargeable against noise abatement would undoubtedly be considerably lower than those discussed here for ILS/DME systems.

In the case of air carrier aircraft, the time required to complete the installation of all needed guidance equipment, concurrent with scheduled aircraft down-time, is estimated to be approximately 3 to 4 years for a normal schedule, and approximately 2-1/2 to 3 years for an accelerated schedule.

In respect to the ground facilities needed for the two-segment approach, it is anticipated as stated in ANPRM 74-12 that the cost of installing Distance Measuring Equipment (DME) would be approximately $50,000 each or a total of $5 million for the 100 DME installations located at the 58 airports having noise sensitive areas. However, the proposed DME installations would provide increased air navigational capabilities over and above that needed for noise abatement, and the DME costs should be apportioned among the several uses of the facility.

In the use of the two-segment approach it is anticipated that there would be a change in the operational costs for the aircraft involved. As previously explained, steeper approach procedures reduce the noise exposure area due to their inherently higher approach altitudes and required lower power settings. Economically, these lower power settings in the approach phase of a flight directly translate into fuel savings. On the other hand, higher approach altitudes may induce higher operational costs due to the effects of longer flight paths on--

(a) The decreased practical capacity of an airport;

(b) The increased delay times resulting from the dynamics of flight control at an airport; and

(c) The increased maneuver distances associated with the geometry of two-segment approaches.

It is estimated that the minimum increase, due to the above factors, for a 3000 ft glide slope intercept procedure, is roughly $8.55 per flight [Reference 23, above]. However, countering that cost increase is reduced fuel consumption due to the lower power settings. For example, that fuel saving is estimated to be about 380 pounds (or some 58 gallons) per landing for a B-727 aircraft when compared to a conventional approach. On a per landing basis, saving 58 gallons of fuel at 25 cents per gallon translates into an operational cost savings of $14.50. This saving will continue to increase in accordance with the increase in cost of aviation fuel. Since per landing savings exceed the potential induced costs, adoption of the proposed procedures is economically reasonable in respect to the operators of the airplane to which the procedures would apply.

If a consistent intercept point for the visual two-segment approach is desired, it is necessary to have DME colocated with the ILS (ILS/DME). This proposed alteration to the Air Traffic Control (ATC) system will take time and money to implement. Of the over 100 ILS equipped runways to which this rule would apply, only seven now have colocated DME. It is estimated that it will cost approximately $50,000 per installation and the total cost to the FAA would be approximately 5 million dollars.

Thrust Reversers

The EPA Report to the Congress in respect to aircraft noise (Reference 16) observed, among other things, that thrust reverse noise on landing contributes to noise annoyance at some airports. This noise depends on the amount of the reverse power applied and varies over an extremely wide range, from idle thrust (no appreciable thrust reversal) to almost takeoff power. On the average, thrust reverse noise is approximately 10 EPNdB lower than takeoff noise. The effect of thrust reverse noise on cumulative noise exposure (e.g., Ldn) is often negligible because of its lower level and short duration compared to sideline takeoff noise.

One unpleasant characteristic of thrust reverse noise, however, is its sharp application, making it especially annoying, particularly at night. During that time, takeoff noise is louder at most locations in the community, but the sound builds up gradually. But, in the case of thrust reversal there may be a "startle" effect associated with the noise which becomes a problem when there are people living in the vicinity of an operational runway.

Thrust reversal is used on landing to slow the aircraft at high speeds since the high kinetic energy of the aircraft can cause excessive heating and wear of the wheel brakes at such speeds. As the airplane slows down, the relative effectiveness of the brakes increases while that of the reverse thrust decreases; below about 60 knots, the reverse thrust has very little effect compared to the brakes. However, the use of thrust reversal generally is not necessary even at high speeds for transport category aircraft. Such aircraft have a certificated runway length in which they can safely land and stop without the use of thrust reversers and in all cases that distance is considerably shorter than the runway length available at the airports used by those aircraft. In general, the use or non-use of thrust reversal for a particular landing is situation-dependent and from a safety standpoint it may be desirable to deploy thrust reversers on some relatively short runways. However, when landing on a long, dry runway, with no airtraffic control urgency, the thrust reverse noise is more detrimental to the public welfare than the additional ground taxi noise that results from the non-use of thrust reversers.

In accordance with the recommendations of the EPA Aircraft/Airport Noise Study Task Group Two Report (Reference 26), it is proposed that the FAA prepare and issue an Advisory Circular which would discuss the appropriate use of thrust reversal and which would encourage pilots to minimize the use of thrust reverse where it does not adversely affect the safety of the landing. The fact that reduced flap settings result in slightly increased landing speeds should also be taken into consideration in that circular.

4-Degree Glide Angle

As pointed out earlier, the EPA is submitting two proposals for rulemaking concerned with noise abatement approach procedures, in addition to the rule discussed herein. Another method of abating approach noise which could provide much of the noise-reduction benefit of the two-segment approach while avoiding some of the costs and complications is the use of a single-segment approach using a glide angle of 4 degrees, instead of the conventional 3 degrees or less.

Conceptually, introduction of a 4 degree glide angle ILS approach would be simple, requiring no change in airborne avionics nor in the basic approach and landing technique now in use. It could be accomplished by a mechanical adjustment of the ground-based ILS glide slope transmitter from a 3-degree to a 4-degree angular orientation above horizontal and appropriate relocation of the marker beacons. For visual approach guidance, the Visual Approach Slope Indicators (VASI) would also have to be modified for the new glide angle, which may involve substantial repositioning of the light bars.

Although a small number of airports now have approach glide path angles greater than 3 degrees, there has not been a thorough systematic program of development testing and in-service evaluation to establish the practical acceptability for all or most airports of a 4 degrees glide angle approach. Consequently, it is not proposed herein to initiate rulemaking regarding such an approach. However, the EPA strongly recommends that appropriate studies be initiated to determine both the practical benefits to be gained and the effects, if any, on airplane operation and safety as well as pilot reaction, of a 4 degrees glide angle approach.

Exceptions

Under the provisions of this proposal, each person operating an aircraft to which the rule applies is expressly given final authority and responsibility for the safe operation of his airplane. Therefore, if he determines in the interest of safety that an approved instrument approach procedure other than a two-segment ILS approach should be used for a particular approach and landing, he may use the other procedure upon notice thereof to Air Traffic Control (ATC). The authority for alternative procedures is presently provided under the noise abatement runway system requirements of §91.87(g) and would be equally appropriate for the two-segment noise abatement procedure requirements proposed herein.

Noise abatement procedure criteria

If the two-segment ILS approach is made mandatory, it is proposed to use the criteria set forth below for the use of such facilities. Accordingly, comments in regard to those criteria or other criteria deemed necessary or desirable for the use of a two-segment ILS approach may also be submitted by any interested person.

Entry at 3000 ft/6 nm

(1) 6/3 degrees, transition at 930 ft/2.7 nm

(2) 5/3 degrees, transition at 400 ft/1.1 nm

Entry at 3000 ft/7 nm

(1) 6/3 degrees, transition at 1570 ft/4.5 nm

(2) 5/3 degrees, transition at 1200 ft/3.6 nm

For the majority of the turbojet engine-powered airplanes, under most conditions, the entry at 3000 ft/6 nm would permit transition to be initiated at 1000 ft. HAA and completed prior to 500 ft. HAA. However, for certain low drag airplanes, such as the DC-8, a 5 degrees upper segment is more appropriate than 6 degrees, and this would result in a very low transition altitude. The use of a 3000 ft/7 nm entry point not only accommodates such low drag but also allows for unusual variations in tailwind, airspeed, wind sheer, or other factors that may make the 6n.m. entry point marginal under some conditions.

Any two-segment ILS approach procedure approved by the Administrator for the use of a particular runway, would be established by him under procedures similar to those now used for the establishment of standard instrument approach procedures prescribed in Part 97. However, to distinguish the two-segment ILS approach procedures from the standard one-segment instrument approach procedures they would be placed in a separate Part 98, and portrayed on appropriate aeronautical charts, in addition to being published in the Airman's Information Manual.

<u>The Proposed Rule</u>

In consideration of the foregoing, it is proposed to amend §91.87 of the Federal Aviation Regulations as follows:

1. By striking the word "and" appearing at the end of paragraph (e) (1) and adding a semicolon and the word "and" at the end of paragraph (e) (2).

2. By adding a new subparagraph (e)(3) to read as follows:

§91.87 <u>Operation at airports with operating control towers.</u>

* * * * *

(e) Approaches

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(3) A civil turbojet engine-powered airplane shall, when making an approach for a landing on a runway having an approved ILS two-segment approach procedure, prescribed in Part 98 of this Chapter, use that procedure unless he notifies ATC that he finds it necessary in the interest of safety to use a different procedure approved for an approach and landing on that runway.

This notice of proposed rule making is issued under the authority of sections 313 (a), 307 (c), 601, and 611 of the Federal Aviation Act of 1958, as amended (49 U.S.C. 1354, 1358, 1421, and 1431); and sections 2(b)(2) and 6(c) of the Department of Transportation Act (49 U.S.C. 1651(b)(2) and 1655(c).

Issued in Washington, D.C. on

Administrator