U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB-274 589

Requirements for 3500 Foot Spacings for Simultaneous Parallel IFR Approaches

MITRE Corp, McLean, Va METREK Div

Prepared for

Federal Aviation Administration, Washington, D C Office of Systems Engineering Management

Jan 75

WASHINGTON OPERATIONS

PB 274 589

MTR-6841

REQUIREMENTS FOR 3500 FOOT SPACINGS FOR SIMULTANEOUS PARALLEL IFR APPROACHES

A.L. HAINES

JANUARY 1975

MITRE

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

Technical Report Documentation Page

1. Report No. MTR-6841	2. Government Accession No.	3. Recipient's Catalog No. PB274589
4. Title and Subtitle Requirements for 3500 Foot Spacings for Simultaneous Parallel IFR Approaches		5. Report Date January 1975
		6. Performing Organization Code W-43
7. Author(s) A. L. Haines		8. Performing Organization Report No. MTR-6841
9. Performing Organization Name and Address The MITRE Corporation METREK Division 1820 Dolley Madison Blvd. McLean, VA 22101		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT FA70WA-2448
12. Sponsoring Agency Name and Address Office of Systems Engineering Management Federal Aviation Administration Department of Transportation Washington, DC 20591		13. Type of Report and Period Covered
		14. Sponsoring Agency Code DOT/FAA/OSEM

15. Supplementary Notes

16. Abstract

This report presents the requirements for lowering the current 4300 foot rule for simultaneous parallel IFR approaches. Of especial interest are changes to 3500 feet or lower. An analysis is made, based upon the assumed introduction of a very accurate, high update rate surveillance system for special purpose use for monitoring parallel approaches.

17. Key Words	18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, VA 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	36	PCA03-A01

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

MITRE Technical Report
MTR-6841

REQUIREMENTS FOR 3500 FOOT SPACINGS FOR SIMULTANEOUS PARALLEL IFR APPROACHES

A.L. HAINES

JANUARY 1975

CONTRACT SPONSOR FAA
CONTRACT NO. DOT-FA70WA-2448
PROJECT NO. 178A
DEPT. D-43

THIS REPORT WAS PREPARED BY THE MITRE CORPORATION FOR THE OFFICE OF SYSTEMS ENGINEERING MANAGEMENT, FEDERAL AVIATION ADMINISTRATION UNDER CONTRACT NO. DOT FA70WA-2448. THE CONTENTS OF THIS REPORT REFLECT THE VIEWS OF THE MITRE CORPORATION, WHICH IS RESPONSIBLE FOR THE FACTS AND THE ACCURACY OF THE DATA PRESENTED HEREIN, AND DOES NOT NECESSARILY REFLECT THE OFFICIAL VIEWS OR POLICY OF THE FAA. THIS REPORT DOES NOT CONSTITUTE A STANDARD, SPECIFICATION, OR REGULATION.

THE MITRE CORPORATION
McLEAN, VIRGINIA 22101

Approved for public release; distribution unlimited.

1a

MITRE Department
and Project Approval: Fred Halland

ABSTRACT

This report presents the requirements for lowering the current 4300 foot rule for simultaneous parallel IFR approaches. Of especial interest are changes to 3500 feet or lower. An analysis is made, based upon the assumed introduction of a very accurate, high update rate surveillance system for special purpose use for monitoring parallel approaches.

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1-1
2.	ANALYSIS	2-1
3.	CONCLUSIONS	3-1
4.	RECOMMENDATIONS	4-1
APPENDIX A:	REFERENCES	A-1
APPENDIX B:	ATC PROCEDURES FOR CONDUCTING SIMULTANEOUS PARALLEL IFR APPROACHES	B-1
APPENDIX C:	IFR CAPACITY INCREASES REALIZABLE FROM SIMULTANEOUS PARALLEL IFR APPROACHES	C-1
APPENDIX D:	U.S. TOWER AIRPORTS WITH CURRENT PARALLELS SPACED 3000 - 4299 FEET	D-1
APPENDIX E:	ANALYTIC MODEL	E-1
APPENDIX F:	RUNWAY SPACINGS ACHIEVABLE WITH ALTERNATIVE SURVEILLANCE SYSTEMS	F-1
APPENDIX G:	DISTRIBUTION LIST	G-1

LIST OF ILLUSTRATIONS

		Page
TABLE E-1:	ELEMENTS OF RUNWAY SPACING	E-5
TABLE E-2:	ANALYSIS OF MISS DISTANCES	E-7
TABLE F-1:	RUNWAY SPACINGS ACHIEVABLE WITH ALTERNATIVE SURVEILLANCE SYSTEMS	F-2
FIGURE 2-1:	SPACING REDUCTIONS	2-2
FIGURE E-1:	SPACING GEOMETRY	E-2
FIGURE E-2:	NOZ SIZE VERSUS NOZ TRANSGRESSION DISPLAY RATE	E-8

1. INTRODUCTION

The new 4300 foot FAA-approved rule for simultaneous (front course) parallel IFR approaches (Reference 1) raises the question of the requirements for reducing spacing further to 3500 feet or lower. Reduction in spacing may be due to any of several system improvements. Of major interest in this paper is the critical system parameter of the surveillance system itself. In particular it appears that a special purpose system of high accuracy and update may be developable within the near future. Thus this report assumes an improvement due to an assumed presence of a very accurate (1 milliradian one-sigma azimuth measurement accuracy), high update rate (1 second update interval) surveillance system for monitoring approaches, instead of the present terminal area radar system (ASR). The new surveillance system's coverage could be limited to the approach course and would not necessarily be used for any function other than monitoring approaches. The requirements presented are based on the results of an analysis which focuses on preserving the current ability of the ATC system to provide safe separation in the unusual event that an aircraft on final approach suddenly and drastically veers off course toward an aircraft on the parallel ILS course.

The analysis is composed of two major steps:

1. A calibration of the present system (4300 foot spacing rule) for providing separation on simultaneous parallel IFR approaches is made.* This is based upon the assumption of the 4300 foot rule as a given, accepted measure of safe operation. The safety analysis is based on the assumed worst case blunder in which one aircraft makes a sudden 30 degree turn toward an aircraft on the parallel ILS course.

2. An extension of the calibration is made to lower spacings, accounting for improvements due to the assumed new surveillance system. This will include a tightening of the Normal Operating Zone (NOZ), but no increase in controller workload. The ability of the system to maintain safe separation remains the same.

The analysis considers the least runway spacings which may be achievable by this process. Of particular interest is the value

* Appendix B presents a brief description of the present system for monitoring close-spaced simultaneous parallel IFR approaches. Reference 1 (4300 foot spacing authorization) is also reproduced.

of 3500 feet, since this corresponds to the current minimum spacing rule for other simultaneous IFR operations (either departure and arrival, or departure and departure). Unless there is a change in this rule, it is doubtful that any new concrete for parallel runways would be laid at less than 3500 feet, even if the simultaneous parallel IFR approach rule were less than 3500 feet. However, certain existing parallel runways may benefit from a simultaneous parallel IFR approach rule less than 3500 feet, but still above the (FAA) wake vortex interaction spacing of 2500 feet. An illustration of the capacity gains achievable by simultaneous parallel IFR approaches is given in Appendix C. A list of airports with current parallel runways with spacings between 3000 and 4299 feet is given in Appendix D, based on References 5 and 6. At this time no list exists for potential new parallel runway pairs between 3000 and 4299 feet (or for those in Appendix D which have potential for use), but that list would be useful to have for the purpose of determining the number of potential applications for the improved surveillance system. Work is already under way within the FAA to develop that list.

In order to obtain any benefits from an accurate surveillance system it will be necessary to provide the controller with a means of achieving the accuracy inherent in the new accurate surveillance system. One method of accomplishing this is to make minor software changes to the ARTS III to provide a digital readout for the controller of the lateral deviation from centerline of each aircraft on a parallel approach course. As a convenience for spotting unusual deviations, this value might be rounded to the nearest 100 feet if the aircraft is near the centerline (say within 300 feet) and to the nearest 10 feet elsewhere. Thus, for a normally operating aircraft the data block would change infrequently. In the case of unusual deviations, however, it would change nearly every update (1 second) providing an additional visual cue for the controller. It is also assumed the hypothesized surveillance system will be essentially free of resolution and garble problems for the geometries under study.

2. ANALYSIS

All of the analysis herein assumes a simplified version of the essential features of a monitoring and control system, including the features of:

1) data acquisition with data presentation probability of 1.0;

2) positive action is always initiated by the controller at (or before) the time of the first data point presentation of an aircraft as outside the NOZ (described below);

3) ground-based control system along lines of current FAA philosophy.

Further the current FAA-approved 4300 foot spacing rule is taken as the accepted standard of system performance and safety.

The 4300 foot spacing rule for simultaneous parallel IFR approaches may thence be analyzed to determine the effect of a change in the azimuth accuracy and update rate of the improved surveillance system. For this purpose, the total spacing may be considered to be composed of three major elements, as described in the next paragraphs, and illustrated with the aid of Figure 2-1.

Normal Operating Zone (NOZ)

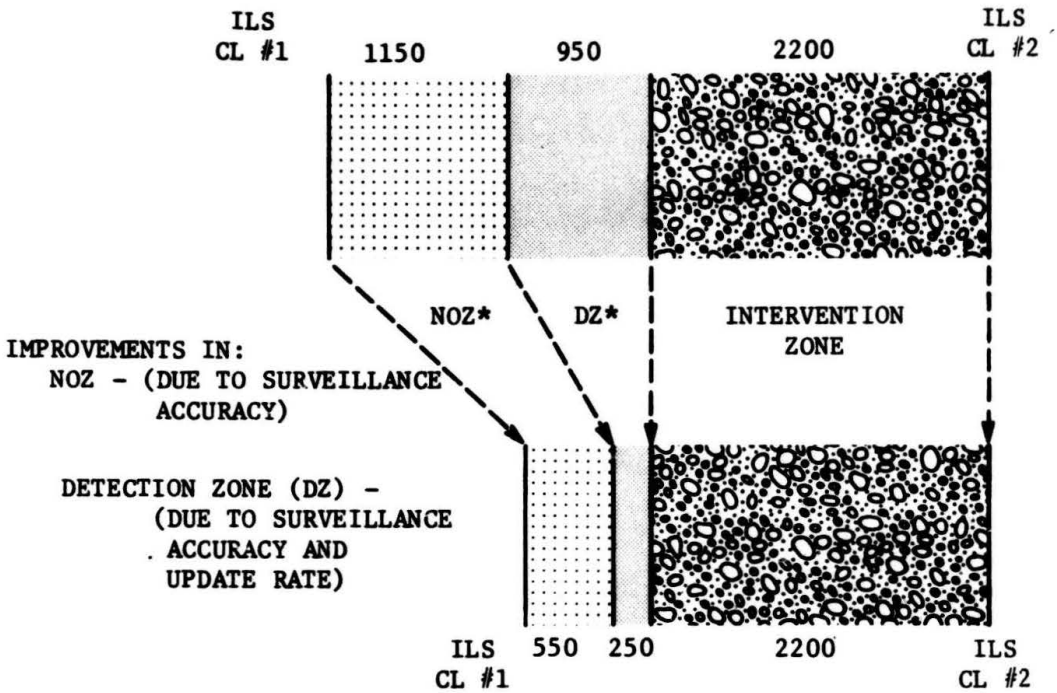
The Normal Operating Zone is that zone from the ILS centerline to either side in which an aircraft may operate. While the aircraft is within this zone, the controller may issue advisories, but it is not until the aircraft is outside the limits of the NOZ and possibly endangers an aircraft on the parallel approach that the controller must take positive action to vector the other aircraft away. The size of the NOZ for 4300 foot spacing is set at 1150 feet by the FAA. When considered against normal aircraft navigational inaccuracies and surveillance system errors, there is a small probability of the target of a normally operating aircraft being displayed outside of the NOZ. (NOZ transgression display).

Detection Zone (DZ)

In the event of a major blunder (here assumed 30 degrees with respect to the ILS centerline), the surveillance system may not first provide a display of a blundering aircraft as being outside of the NOZ until the aircraft is truly considerably outside of the NOZ. This can happen because of the surveillance update interval lag and the azimuth error in the surveillance measurements. The distance beyond the NOZ which an aircraft

4300 FOOT SPACING

(PRESENT 4 MILLIRADIAN - 4 SECOND SURVEILLANCE SYSTEM)



3000 FOOT SPACING

(IMPROVED 1 MILLIRADIAN - 1 SECOND SURVEILLANCE SYSTEM)

---

* NOZ + DZ = DEVIATION DISTANCE FROM ILS CENTERLINE BY WHICH ATC INTERVENTION WILL ALMOST CERTAINLY BE INITIATED.

FIGURE 2-1
SPACING REDUCTIONS

can deviate before first being displayed beyond the NOZ is henceforth called the Detection Zone (DZ). For the present 4300 foot spacing rule and control procedure, the present ASR surveillance system, and a 30 degree blunder at 150 knots airspeed, the width of the detection zone is 950 feet. This number was derived by establishing that the probability that a 30 degree blundering aircraft is greater than NOZ + DZ (1150 + 950) from the ILS centerline at the time of first being displayed to the controller as being beyond the 1150 foot NOZ is less than .01. The values of .01 and 950 feet assume the worst case phasing of the data acquisition interval and the event of the blundering aircraft first exiting the NOZ.

Intervention Zone

Once the blundering aircraft is NOZ + DZ distance from its centerline the air traffic controller will almost certainly see the existing problem and will take action by vectoring the other aircraft to safety. Accordingly, the remaining distance between centerlines is called the intervention zone. It accounts for controller to pilot communication delays and pilot and aircraft reaction delays, the rate of corrective maneuvers and resulting lateral miss distance. A detailed budget for the intervention zone may be developed by analysis to demonstrate how the 4300 foot spacing rule works. This is done in Appendix E. For the purposes of examining the effect of a change in the surveillance system, it is sufficient to consider the intervention zone as a whole to be fixed, since no element of it is dependent on the parameters of the surveillance system. The size of the intervention zone to be held fixed is runway spacing less NOZ size, less Detection Zone size, which equals 4300-1150-950 = 2200 feet.

The impact of a change from the present 4 milliradian one-sigma azimuth accuracy 4 second update system to a 1 milliradian 1 second system is on the NOZ and DZ. The NOZ may be decreased (due to less azimuth error) to a value which yields approximately the same rate of NOZ transgression displays.* The DZ may be decreased (due to less azimuth error and faster update) to a value which yields the same probability (.01) a blundering aircraft at 30 degrees gets beyond NOZ + DZ feet from its approach centerline before it is first displayed to the controller by the surveillance system as being beyond the NOZ.

---

* The NOZ transgression display rate is a relative measure of the controlled workload (exclusive of workload due to true blunders).

The improved surveillance system results in values of 550 feet for the NOZ and 250 feet for the Detection Zone. Added to a constant Intervention Zone of 2200 feet, this yields a minimum spacing with the proposed surveillance system of 3000 feet. An illustration of this change is given in Figure 2-1. This reduction offers the same safety inherent in the current 4300 foot spacing rule.

If spacings between 3000 and 4300 feet are desired, the NOZ may be increased one foot for each foot above 3000 feet. Thus at 3500 feet, the NOZ could be as wide as 550 + 500 = 1050 feet, with a consequently lower rate of NOZ transgression displays.

3. CONCLUSIONS

The availability of an improved surveillance system for the monitoring of parallel approaches which could operate with a one second update and provide one milliradian azimuth accuracy could provide the basis for significant decreases in the minimum spacing required for simultaneous parallel IFR approaches. An analysis has been made which shows that spacing could be reduced to 3500 feet with a 1050 foot NOZ. (The current NOZ is 1150 feet for 4300 foot spacing.) This value for the NOZ for the new surveillance system will provide a significantly lower rate of displays of normally operating aircraft as outside the NOZ (NOZ transgression displays) than that of the current surveillance system at 4300 feet (1150 foot NOZ). Setting the number of such displays in both cases approximately equal could yield a NOZ of 550 feet for the new surveillance system and a corresponding allowable minimum spacing of 3000 feet.

In order to implement such changes in spacing, the following conditions must be met:

1. An accurate, garble-free, and reliable surveillance system (1 milliradian azimuth accuracy, 1 second data interval) for monitoring parallel approaches, integrated into the ARTS III system or its equivalent.* The garble-free property must hold for spacings as low as 3000 feet for aircraft at various ranges and altitudes.

2. An updated ARTS III computer program to accept such radar input, and provide the controller with a digital readout of lateral deviation from ILS centerline of each aircraft on both approaches. Alternatively, some other modifications could be made, with the identical purpose of providing the controller with a means of achieving the accuracy inherent in the surveillance system. These possibilities could include a separate display device unique to the surveillance system to augment the ARTS III display.

3. A modification to the current control procedure for monitoring close-spaced parallel IFR approaches, by using a reduced NOZ value of 1050 feet for 3500 foot spacing, or 550 feet for 3000 foot spacing.

None of the requirements indicated for reducing runway spacing is of a nature which requires an extensive period of time for

---

* In this paper the term ARTS III is meant to include ARTS III systems or their equivalents (Atlanta ARTS and NYCIFRR).

development. Within perhaps a two-year period it should be possible for E&D to validate an improved surveillance system for monitoring parallel approaches. During that time the necessary modifications to ARTS III can be made and tested at NAFEC and simultaneously the necessary process of obtaining agreement on the reduced spacing can be pursued. Thus, the new spacing could possibly be achieved within two years from the time policy agreement and an action decision are reached on the requirements presented here.

Prior to adopting a reduced spacing rule, tests should be conducted at NAFEC and at the first applicable field site of this modified system for monitoring approaches so as to ensure appropriate performance of the overall procedure (controller response time and ability to detect blunders, ARTS III display presentation, surveillance system performance, pilot and aircraft response performance). This should include an actual test of a 30 degree blunder as was done in the 1962 operational evaluation tests for the 5000 foot spacing rule (Reference 4).

4. RECOMMENDATIONS

In order to expeditiously and effectively achieve a reduced spacing between simultaneous parallel IFR approaches, it is recommended that:

1. An investigation should be made into alternative surveillance systems now under development* to determine which of them may be most suitable for use for the parallel approach monitoring task. The best candidate system (s) should be tested in a manner compatible with IFR parallel approach applications. This should include consideration of airspace coverage, update rate, azimuth accuracy, and freedom from garble for targets at various relative positions with runway spacings as low as 3000 feet.

2. A modification to the ARTS III should be programmed to permit the introduction of the new surveillance data, and to provide a digital readout of lateral deviations from the ILS centerline for each of the aircraft on parallel ILS courses. Alternately, another method could be used with the goal of providing the controller with the accuracy of display inherent in the surveillance system.

3. A capability should be constructed at NAFEC to test the entire integrated system (surveillance, ARTS III, controller, aircraft and pilot) at a spacing of 3500 feet (1050 foot NOZ) and then 3000 feet (550 foot NOZ). These tests should use an instrumented set of simulated parallels and include a series of 30 degree blunder encounters.

   In order to provide the maximum safety in the conduct of these tests, they should be run in VFR weather conditions, and with longitudinal separation. These tests should be an important part of the evidence needed to convince pilots of the validity of the change in spacing.

4. The new surveillance system should be installed at a field site where 3500 foot parallels exist, and during VFR weather should be tested to verify that a reduced Normal Operating Zone is operationally feasible and offers an acceptable rate of false detections. IFR testing should proceed as confidence is achieved.

---

* There are fixed antenna systems that could be used to cover one or more of the approach paths with high accuracy and update rate.

5. In the event all of the above are successful, reduction of simultaneous parallel IFR approach spacing to 3500 feet (with a 1050 foot NOZ) could be made.

6. After accumulated experience, further reductions to as low as 3000 feet (550 foot NOZ) could then be considered for a particular field site, where validation and implementation would take place.

It should be possible to accomplish all of the above steps, 1 through 5, in a roughly two-year period from the time a policy decision is made.

APPENDIX A

REFERENCES

1. FAA, Air Traffic Service (AAT-300), Simultaneous ILS Approaches to Parallel Runways, 5 September 1974, letter of notification of change of rule, effective 1 October 1974.

2. FAA, Air Traffic Service, Terminal Air Traffic Control, Handbook 7110.8D, effective 1 January 1975.

3. Haines, A. L., "Reduction of Parallel Runway Requirements." The MITRE Corporation, MTR-6282, Washington, D. C., January, 1973.

4. FAA, Flight Standards Service, "An Operational Evaluation of the Parallel ILS System", November 1962.

5. FAA, Air Traffic Service (AAT-324), Numbered Parallel Runways at Airports within the U.S., 2/1/74, informal compilation.

6. Jeppesen & Co., Approach Charts, Denver, Colorado.

7. Harris, R. M., "Models for Runway Capacity Analysis." The MITRE Corporation, MTR-4102, Rev. 2, Washington, D.C., December, 1972.

8. Resalab, Inc., "Lateral Separation." Report FAA-RD-72-58, Volumes I and II, Dallas, Texas, July, 1972.

APPENDIX B

ATC PROCEDURES FOR CONDUCTING SIMULTANEOUS PARALLEL IFR APPROACHES

The ATC procedures for conducting simultaneous parallel IFR approaches are given in this appendix. First a brief summary of the procedures is given. Following that are reproduced extracts from the Terminal Air Traffic Control Handbook 7110.8D (Reference 2). Finally is attached a copy of Reference 1, the notification of the change in the minimum spacing from 5000 feet to 4300 feet.

Aircraft making simultaneous parallel IFR approaches turn on to the ILS course localizer with either 3 nmi horizontal separation or 1000 feet vertical separation from any other aircraft making such approaches. The separation is held until the aircraft is stabilized on the localizer. Subsequently designated controllers (parallel monitors) monitor the aircraft on the radar scope (which includes permanent display lines for ILS centerline and NOZ boundaries). They take appropriate action to turn the aircraft back toward the localizer course if an apparent non-correction would lead to a violation of the no-transgression zone (in excess of 1150 feet from ILS centerline). If the aircraft is detected to violate the no-transgression zone, and if there is an aircraft on the other ILS within 3 nmi longitudinally, then the controller monitoring the second ILS takes action to vector the latter aircraft to avoid the former. Monitoring ceases when visual separation is applicable, the aircraft sights the runway, or is 1 nmi from the runway threshold.

This approach sequence includes VFR aircraft only when such aircraft contact approach control and request the service. The landing sequence is established by the local controller.

(a) The succeeding aircraft reports sighting the preceding aircraft.

(b) The tower controller is informed of the succeeding aircraft's position in the approach sequence or where ARTS track data from the approach control facility is displayed on the tower's BRITE display, the aircraft is tagged by ARTS, the tower is quick looking the appropriate approach control position/s and the change of communications and control jurisdiction points are established in the facility directive.

(c) The succeeding aircraft is instructed to follow the preceding aircraft.

e. You may vector aircraft simultaneously to the traffic pattern for visual approaches to more than one runway or to the traffic pattern for visual approaches to one runway while aircraft are conducting a different type instrument approach to another runway provided the following conditions are met: (N)

1362.e. Note.—Vectoring simultaneously to the traffic pattern/s may be for more than one runway at the same or adjacent airports.

(1) **a, b, c,** and **d.** above are applied to aircraft conducting visual approaches to the same runway.

(2) Radar separation is maintained between IFR aircraft until the following conditions are met:

(a) If parallel runways separated by *less than* 3500 feet are in use—the pilot has reported sighting the preceding IFR aircraft making an approach to the other runway and all aircraft involved are informed that other arriving aircraft are using the other runway.

(b) If parallel runways separated by 3500 feet or more, or converging runways are in use—all aircraft involved are informed that other arriving aircraft are using the other runway.

(c) If crossing runways are used in accordance with **561.b.**

→1363. SIMULTANEOUS ILS APPROACHES

a. Authorize simultaneous ILS approaches to parallel runways only:

(1) When wind conditions permit straight-in landings.

(2) When ILS, radar, and communications equipment are operating normally, except that glideslope information need not be available.

b. Prior to clearing an aircraft to depart an outer fix, inform it that "simultaneous ILS approaches are in progress". This information may be provided through the ATIS.

c. Inform the aircraft of the ILS and runway number for final approach course and the localizer frequency when clearing the aircraft to depart an outer fix.

Phraseology:

DEPART [name of outer fix] HEADING [degrees] MAINTAIN [altitude] FOR VECTOR TO ILS RUNWAY [runway number] [left/right] FINAL APPROACH COURSE. LOCALIZER FREQUENCY IS [frequency].

d. Clear the aircraft to descend to the appropriate glideslope intercept altitude soon enough to provide a period of level flight for the aircraft to dissipate any excess speed accumulated during descent from the outer fix.

e. Vector the aircraft to intercept the appropriate final approach course at an angle not greater than 30 degrees.

f. Provide a minimum of 1,000 feet vertical or 3 miles radar separation between aircraft being vectored from outer fixes, during the turn-on and until aircraft are established on their respective final approach courses. Thereafter, provide aircraft on the same final approach course a minimum of 3 miles radar separation. Aircraft on parallel final approach courses within 3 miles of each other shall be considered to be adequately separated so long as neither aircraft penetrates the "no-transgression zone".

g. Inform the aircraft of his position and the ILS runway number approach to conduct when assigning it the final heading to intercept the localizer course.

Phraseology:

NOW [number of miles] MILES [direction] OF [name] OUTER MARKER. TURN [left/right] HEADING [degrees]. CLEARED FOR ILS RUNWAY [runway number] [left/right] APPROACH.

h. Monitor all approaches, regardless of weather conditions. Transmit control instructions and information to aircraft on the local control frequency. Monitor the local control frequency to receive any aircraft transmissions. (N)

1363.h. Note 1.—The purpose of radar monitoring simultaneous ILS approaches is to ensure longitudinal separation between aircraft on the same localizer course and lateral separation between aircraft on parallel courses.

1363.h. Note 2.—A "no transgression zone" is established equidistant between centerlines of each localizer

(1) Instruct the aircraft to return to the correct localizer course immediately if he is observed to overshoot the turnon.

Phraseology:

YOU HAVE CROSSED THE LOCALIZER COURSE. TURN [left/right] IMMEDIATELY AND RETURN TO COURSE.

(2) Issue such information and instructions as may be necessary to return aircraft to the localizer course when the target is observed to continue on a track which, if uncorrected, would cause the aircraft to penetrate the "no-transgression zone".

Phraseology:

[Number of feet] FEET [left/right] OF COURSE. TURN [left/right] AND RETURN TO LOCALIZER COURSE.

(3) When you observe an aircraft penetrating the "no-transgression zone" and in your opinion it will result in a potential conflict with an aircraft on the adjacent localizer course, take the following action immediately:

(a) Issue necessary instructions to the aircraft on the adjacent localizer course in potential conflict to alter its course to avoid the deviating aircraft. Transmit these instructions simultaneously on appropriate frequencies.

Phraseology:

TURN [left/right] HEADING [degrees] IMMEDIATELY, CLIMB AND MAINTAIN [altitude].

(4) Terminate radar monitoring when one of the following occurs:

(a) Visual separation is applied.

(b) The aircraft reports the approach lights or the runway in sight.

(c) The aircraft is 1 mile from the runway threshold.

(5) To minimize frequency congestion, do not inform the aircraft when radar monitoring is terminated since monitoring is conducted on the local control frequency.

(6) Do not apply the provisions of **1520** when simultaneous approaches are in progress. (R)

1364–1389. RESERVED

course and displayed on the radar monitor scopes. Since the primary responsibility for navigation rests with the pilot, transmissions of control instructions and information by the monitor controller are limited to those necessary to ensure separation between aircraft. Pilots are not expected to acknowledge these transmissions unless specifically requested to do so.

1363.h.(6). Reference.—Application, 1520.

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

DATE: SEP 5 1974

WASHINGTON, D.C. 20591

IN REPLY REFER TO: AAT-320

SUBJECT: Simultaneous ILS Approaches to Parallel Runways

FROM: Chief, ATC Operations and Procedures Division, AAT-300

TO:

Effective October 1, 1974, the minimum distance between runway centerlines for simultaneous ILS approaches will be changed from 5,000 feet to 4,300 feet.

There are no additional requirements for conducting simultaneous ILS approaches with runways separated by 5,000 feet or more. Additional requirements for simultaneous ILS approaches to runways separated by less than 5,000 feet are as follows:

(1) ILS front courses only.
(2) A monitor controller for each localizer.
(3) At least 1 mile of straight flight before final approach course intercept.

Handbooks 7110.8C and 7210.3B, as well as the Airman's Information Manual, will be amended to reflect this change. Due to publication cut-off dates, the Airman's Information Manual will not be amended until November 1974. The handbook changes will not be reflected until January 1975.

Prior to the October 1, 1974, implementation date, a GENOT containing the required procedural changes will be issued.

GLEN D. TIGNER

APPENDIX C

IFR CAPACITY INCREASES REALIZABLE FROM SIMULTANEOUS PARALLEL IFR APPROACHES

The converting of a parallel runway complex, under IFR conditions, from dependent to independent operations provides significant increases in the IFR capacity. The following examples indicate the magnitude of this difference:

Operation	Spacings (feet)	Capacity* (ops/hr)
Strictly dependent arrivals/departures	< 3500	53
Staggered dependent arrivals with interleaved dependent departures**	< 3500	61
Staggered dependent arrivals with interleaved independent departures***	3500-4299	77
Independent parallel arrivals/departures	≥ 4300	100

* Today's system, 45% heavy mix, (general methodology of Reference 7)

** Arrivals for parallel runways separated by 3 nmi, for same runway by twice that (satisfies wake vortex requirements); 2 nmi departure/arrival rule enforced.

*** Arrivals for parallel runways separated by 2 nmi, for same runway by resultant 3.8 miles or 4 or 5 miles (to safisfy wake vortex rules); 2 nmi departure/arrival rule is not applicable (spacing over 3500 feet). As practiced previously on ATL 4400 foot parallels.

APPENDIX D

U.S. TOWER AIRPORTS WITH CURRENT PARALLEL RUNWAYS SPACED 3000 TO 4299 FEET
(SOURCE: REFERENCES 5 AND 6)

AIRPORT	CODE	RANK*	CENTERLINE SPACING (FEET)	RUNWAYS	RUNWAY LANDING LENGTHS (FEET)	INSTRUMENT APPROACHES
DALLAS-LOVE FIELD, DALLAS, TX	DAL	7**	3000	13L 13R 31R 31L	7754 8800 7754 8800	ILS-13L, LOC(BC) -13R LOC(BC)-31R, ILS-31L
KENNEDY INTERNATIONAL, NEW YORK, NY	JFK	4	3000	4L 4R 22R 22L	11352 8400 8330 8400	ILS-4L, ILS-4R ILS-22R, ILS-22L
LINCOLN MUNICIPAL, LINCOLN, NB	LNK	147	3025	17L 17R 35R 35L	4000 12900 4000 12900	LOC (BC)-17R, VOR-17L ILS-35L
ABILENE MUNICIPAL, ABILENE, TX	ABL	222	3100	17L 17R 35R 35L	7199 6000 7199 6000	LOC (BC)-17L ILS-35R
PORTLAND INTERNATIONAL, PORTLAND, OR	PDX	29	3100	10L 10R 28R 28L	8000 11000 8000 11000	LOC (BC)-10L, ILS-10R ILS-28R
MINNEAPOLIS-ST. PAUL INTERNATIONAL, MINNEAPOLIS, MN	MSP	19	3200	11L 11R 29R 29L	8201 10000 8201 10000	ILS (BC)-11R, LOC (BC)-11L ILS-29L, ILS-29R
BROWNSVILLE INTERNATIONAL, BROWNSVILLE, TX	BRO	244	3300	17L 17R 35R 35L	5116 5002 5116 5002	
LONG BEACH AIRPORT LONG BEACH, CA	LGB	197	3300	7L 7R 25R 25L	4887 5420 5661 5420	
PHOENIX-SKY HARBOR INTERNATIONAL PHOENIX, AR	PHX	28	3400	8L 8R 26R 26L	8753 10300 8753 9594	ILS-8R VOR-26L, LOC(BC)-26L
MEMPHIS INTERNATIONAL, MEMPHIS, TN	MEM	23	3406	17L 17R 35R 35L	8400 9320 8400 9320	ILS-17L, VOR DME-17R ILS-35R, ILS-35L
LUBBOCK REGIONAL, LUBBOCK, TX	LBB	90	3500	17L 17R 35R 35L	2800 8500 2540 7600	ILS-17R LOC (BC) - 35L
ALLEN C. THOMPSON, JACKSON, MS	JAN	71	3600	15L 15R 33R 33L	8500 5508 8500 6608	ILS-15L, VOR-15R LOC (BC)-33R, VOR DME-33L
BALTIMORE-WASHINGTON INTERNATIONAL, BALTIMORE, MD	BAL	30	3800	15L 15R 33R 33L	3010 9500 3010 9500	ILS-15R LOC (BC)-33L
DETROIT WAYNE METROPOLITAN, DETROIT, MI	DTW	13	3800	3L 3R 21R 21L	10500 8500 10500 8500	ILS-3L, VOR-3R ILS-21R
CLEVELAND HOPKINS INTERNATIONAL, CLEVELAND, OH	CLE	17	3812	10L 10R 28R 28L	6014 3783 6014 3783	 ILS-28R
SAN ANTONIO INTERNATIONAL, SAN ANTONIO, TX	SAT	45	3900	3L 3R 21R 21L	2624 7502 2624 7502	ILS-3R
FT. LAUDERDALE-HOLLYWOOD INTERNATIONAL, FT. LAUDERDALE, FL	FLL	35	4000	9L 9R 27R 27L	7452 3201 7441 3201	ILS-9L LOC (BC)-27R, VOR-27R

*FY73 AIR CARRIER RANK (FAA TOWERED AIRPORTS)

**CHANGED RECENTLY WITH OPENING OF DALLAS-FT. WORTH (DFW)

APPENDIX E

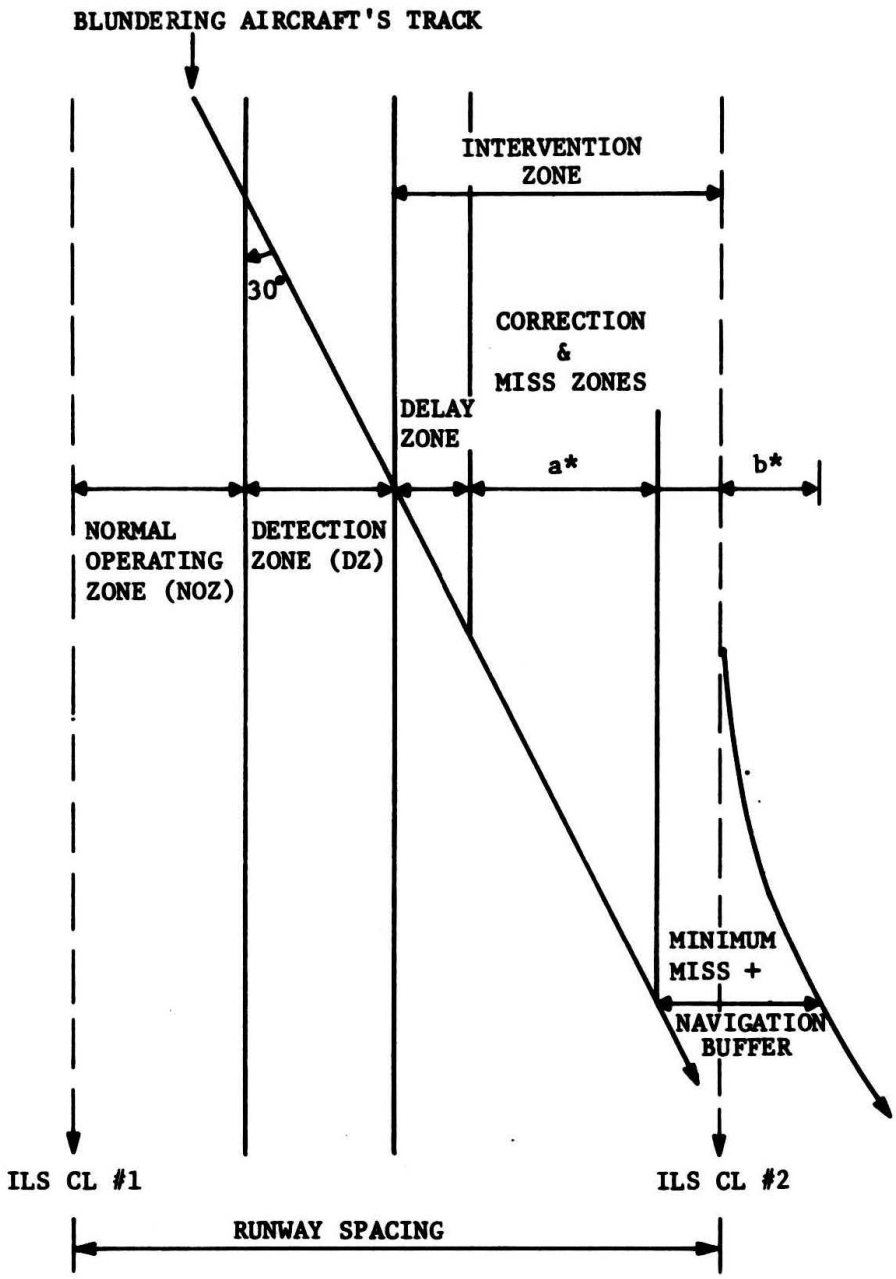
ANALYTIC MODEL

The model concept presented in Section 2 considers the impact of the NOZ and the detection zone. The remainder of the spacing between centerlines (2200 feet for the present 4300 foot spacing rule) is grouped and called the intervention zone. It is held constant in size throughout the analysis. The intervention zone may, however, be budgeted for the various considerations of delay, correction and minimum lateral miss distance. The choice of values for these items does not impact minimum achievable spacings since the intervention zone has been held constant in the analysis. This appendix presents the details of that analysis, based upon the concepts of Reference 3.

The spacing between ILS centerlines is developed based on an assumed worst case blunder scenario under which the control procedure must give satisfactory performance. The blunder scenario assumed is a massive failure on board one aircraft, resulting in a constant angle flight toward the other ILS of 30 degrees with respect to the ILS centerline. This scenario corresponds to that used in validation tests of the original 5000 foot spacing rule for simultaneous parallel IFR approaches (Reference 4). Both aircraft are assumed to maintain 150 knots airspeed and the non-blundering aircraft to make a corrective turn at 3 degrees/second. The blunder is assumed to occur at 8 nmi from touchdown, roughly at the point of loss of 1000 foot altitude separation between two approach courses, and thus at the point of poorest navigation and surveillance accuracies.

The control system assumed is a conservative simplification of the ground based system used in practice. It calls for a positive command the first time a data point as displayed to the controller is outside the NOZ. Reliability of data point processing is assumed 1.0. Suitable displays, resolution procedures, and anti-garbling scenarios are assumed such that the data points presented to the controller (whether graphically, digitally or whatever) reflect the surveillance accuracy hypothesized.

For the purposes of analysis, the spacing between centerlines can be thought of as being divided into several parts, each serving a function in the process of assuring separation. In the following paragraphs each of these parts is defined. Figure E-1 presents a schematic of these parts, with an illustration of a 30 degree blunder and its resolution.



* CORRECTION ZONE = a - b

FIGURE E-1
SPACING GEOMETRY

Normal Operating Zone (NOZ)

The NOZ is used by the controller as the basis for issuing a command to an aircraft because the aircraft on the other approach is considered as failed (beyond the boundary of its NOZ). The NOZ, from the point of view of safety, can be any size so long as the other elements in the total spacing are appropriately sized. From a practical viewpoint, however, it should be large enough that a display to the controller of an aircraft as outside of the NOZ when it is actually navigating normally (effect of surveillance and normal navigation errors) happens only a small percent of the time. For 4300 foot centerline spacing, the NOZ is established at 1150 feet. The rate of display of normally operating aircraft as outside the NOZ (NOZ transgression display rate) is thence held constant for NOZ values for new surveillance system assumptions. The normal navigation distribution is assumed Gaussian, with a one sigma value of 100 feet.

Detection Zone (DZ)

The detection zone reflects the fact that, in the case of a blunder, due to the surveillance system's measurement error (assumed Gaussian) and update interval, detection of the blunder may not occur at the first instant the blundering aircraft is outside of the NOZ. Thus for some time the aircraft may remain displayed to the controller as inside the NOZ, although it has really exited the NOZ. The detection zone's size has been constructed such that there will only be one chance in 100 that the 30 degree blundering aircraft is more than NOZ + Detection Zone from the centerline prior to the surveillance system providing a displayed data point beyond the NOZ for the air traffic controller. This one chance in 100 sizing of the DZ is based on the assumption that the data acquisition interval is phased in the worst possible way with the event of the aircraft first crossing the NOZ boundary.

Delay Zone

After the controller detects the failure there is a delay before the evasive maneuver of the non-blundering aircraft commences. This accounts for communications delay from controller to pilot, and pilot and aircraft reaction delays. This delay will perhaps be decreased somewhat by controller anticipation of a future detection. A value of eight seconds has been assumed, which exceeds the values of the field tests of 30 degree blunders run by the FAA in 1962 (Reference 4).

Correction Zone

The blundering aircraft is assumed to continue at 30 degrees toward the other ILS as the non-blundering aircraft makes his 30 degree corrective turn to a parallel course. The closing action of the blundering aircraft is alleviated somewhat as the non-blundering aircraft begins to achieve lateral velocity, and thus lateral position, away from the blundering aircraft, in the course of his evasive turn. For the values used, the blundering aircraft closes 1250 feet in the ten seconds required to correct the 30 degree blunder at 3 degrees/second. The non-blundering aircraft achieves 650 feet of lateral distance during this maneuver, for a net of 1250 - 650 = 600 feet net closing. This last must thence be a part of the total spacing.

Navitation Buffer and Miss Distance

The remainder of the runway spacing accounts for the fact the normally operating (non-blundering) aircraft may not be on the ILS centerline at the time of the blunder (navigation buffer) and allows a miss distance in the lateral dimension once the aircraft have achieved parallel courses. From the data in References 3 (Appendix D) and 8 (Appendix E, page E-11) a one-sigma value of 100 feet has been assumed for the normal navigation distribution, with a Gaussian form. (This applies as well to NOZ calculations.) The total of the navigation buffer and the miss distance has been chosen as 600 feet.

Table E-1 summarizes the various zones as they have been described, with the parameter values which were used, and the results for each zone as assumed or calculated from assumptions. Also shown are the changes in NOZ and DZ for the new surveillance system, and the total (lower) runway spacing resulting. It shows that a decrease to 3050 feet is possible under the same specifications for the Detection Zone, and NOZ transgression display rate as are implicit in the 4300 foot rule.

Some discussion of these results is useful. First, it should be noted that any longitudinal or vertical separation which may result is discounted, and only lateral miss distance is studied. It is of interest to look at the range of miss distances which may be achieved in the case of a worst case blunder not detected until the blundering aircraft is more than NOZ + DZ from its ILS centerline. The probability of non-detection is only .01. It is possible to calculate, in a bounding fashion, the miss distance versus the location of the non-blundering aircraft, and the associated probability that the lateral miss distance is not achieved. This calculation is

TABLE E-1

ELEMENTS OF RUNWAY SPACING

COMMON PARAMETER VALUES:

VELOCITY IS 150 KNOTS

BLUNDER IS AT 30 DEGREES

CORRECTIVE TURN IS AT 3 DEGREES/SECOND

DELAY TIME BETWEEN DETECTION AND AIRCRAFT ACTION IS 8 SECONDS

PROBABILITY OF NON-DISPLAY WITHIN DETECTION ZONE LIMITS IS .01

NORMAL NAVIGATION ERROR (1-SIGMA) IS 100 FEET

RANGE AT POINT OF BLUNDER IS 8 NMI

SPACING (FEET)		4300	3050
UPDATE INTERVAL (SECONDS)		4	1
AZIMUTH ERROR (MILLIRADIANS ONE-SIGMA)		4	. 1
NOZ	(FEET)	1150	600
DETECTION ZONE	(FEET)	950	250
DELAY ZONE	(FEET)	1000	1000
NET CORRECTION ZONE	(FEET)	600	600
NAV. BUFFER + MISS DISTANCE	(FEET)	600	600
SUM	(FEET)	4300	3050
ORDER OF MAGNITUDE OF NOZ TRANSGRESSION DISPLAY PROBABILITY PER AIRCRAFT (PER WORST 4 SECONDS)		10^{-7}	10^{-7}

summarized in Table E-2. Note the final probabilities are very conservative due to the following:

1. No account is taken of longitudinal or vertical separation,

2. Probability is necessarily a rough upper bound,

3. A worst case blunder is the assumed blunder.

Table E-1 has shown that a minimum runway spacing of 3050 feet can be achieved by the introduction of a 1 milliradian - 1 second surveillance system. With a reduction of the NOZ to 550 feet, and an increase in the NOZ transgression display rate, a spacing of 3000 feet could be achieved. Similarly if spacings larger than 3050 feet are used, the NOZ could be increased one foot for each foot increase in runway spacing. Thus for a 3500 foot spacing with the improved surveillance system, a NOZ of 1050 is usable. This has the effect of decreasing the NOZ transgression display rate below that implied by an 1150 foot NOZ at 4300 foot spacing. This is shown graphically in Figure E-2, and gives the NOZ transgression display rate (per aircraft approach) decreasing from 10^{-7} at 600 foot NOZ to 10^{-20} at a 1050 foot NOZ. Also, the 550 foot NOZ increases the rate to 10^{-6} It should be noted that both the slope of this curve, and indeed the evaluation of the proper NOZ size for the improved surveillance system is very sensitive to the assumptions made as to the distributional form of the lateral deviations of the normally operating aircraft.

Thus, while the decision to reduce spacing to 3500 feet with a 1050 foot NOZ has little technical risk in terms of an unexpected high alarm rate, the possible reduction to 3000 feet has some uncertainty about it. This uncertainty can be, in the bounding limit, rather great, as if the navigation distribution were changed to Laplacian (two sided exponential) a NOZ of the order of that required at 3500 feet spacing (1050 feet) would be necessary. Thus, the experience gained at 3500 feet would be valuable in verifying how large any further reductions could practically be.

Other potential values for accuracy and update for a new surveillance system, and the resultant minimum spacings achievable, are summarized in Appendix F.

TABLE E-2

ANALYSIS OF MISS DISTANCES

ASSUMPTIONS:

WORST CASE BLUNDER

NO LONGITUDINAL SEPARATION

NO VERTICAL SEPARATION

ONLY BOUNDING PROBABILITIES ARE CALCULATED

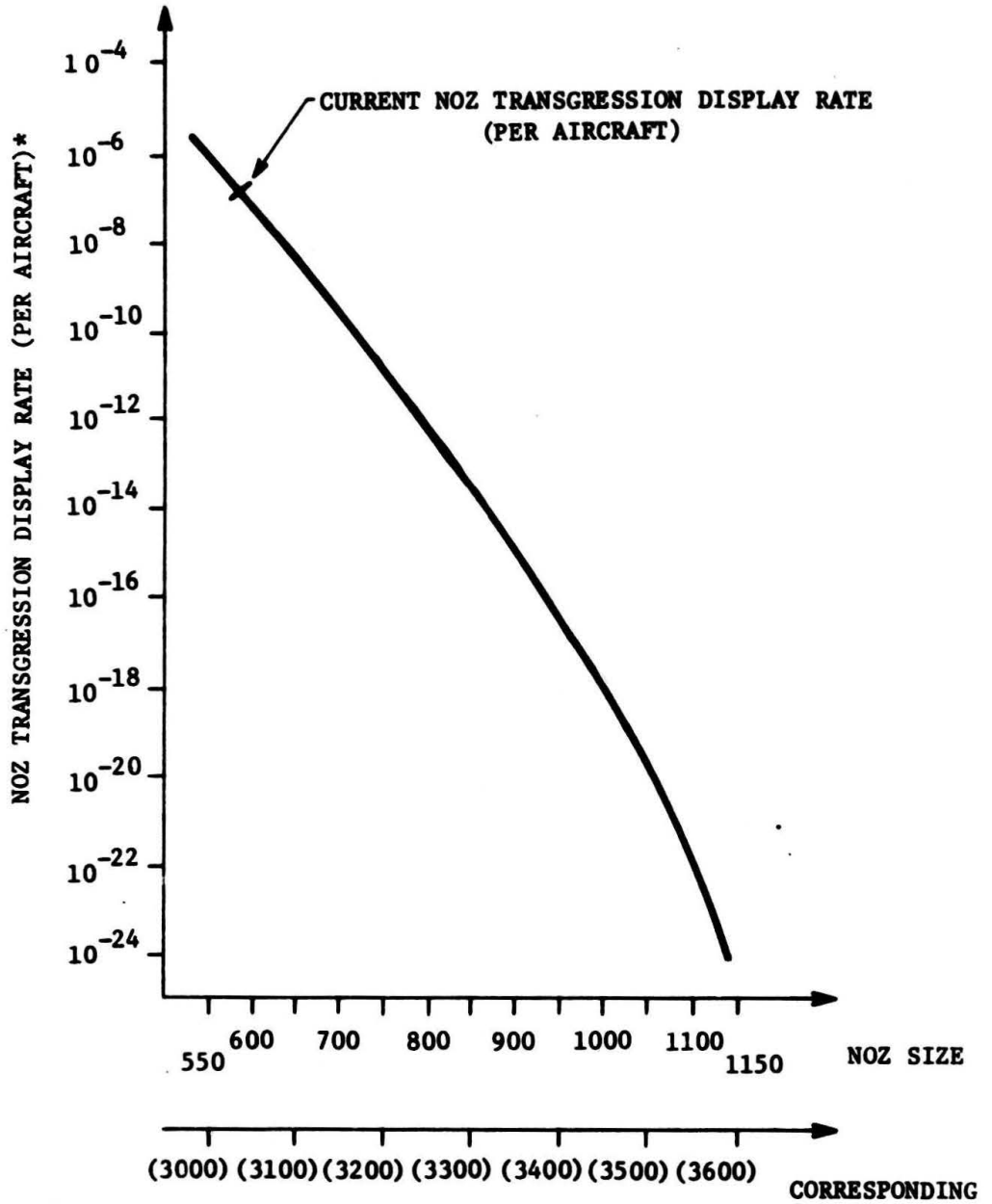
LATERAL MISS DISTANCE	ALLOWABLE NAVIGATION BUFFER (1)	PROBABILITY NON-BLUNDERING AIRCRAFT EXCEEDS NAVIGATION BUFFER (2)	PROBABILITY LATERAL MISS DISTANCE NOT REALIZED (3)
300	300	.001	.00001
400	200	.02	.0002
500	100	.15	.0015
600	0	.5	.005

NOTES:

(1) Equals 600 minus hypothesized lateral miss distance

(2) From normal tables for sigma value of 100 feet

(3) Previous column times the probability the first display of the blundering aircraft as beyond the NOZ occurs when the aircraft is truly more than NOZ + DZ from the ILS centerline (= .01). Assumes maximum 8 seconds delay is required.



* PROBABILITY OF AN AIRCRAFT BEING DISPLAYED PAST THE NOZ BOUNDARY (FOR NORMALLY OPERATING AIRCRAFT) - 1 MILLIRADIAN, 1 SECOND SURVEILLANCE SYSTEM (GAUSSIAN NAVIGATION AND SURVEILLANCE, WORST 4 SECONDS OF OBSERVATION)

FIGURE E-2
NOZ SIZE VERSUS NOZ TRANSGRESSION DISPLAY RATE

APPENDIX F

RUNWAY SPACINGS ACHIEVABLE WITH ALTERNATIVE SURVEILLANCE SYSTEMS

The analysis of this report is predicated upon the presence of a particular new surveillance system which is both accurate (1 mr azimuth accuracy) and quick (1 sec update interval). As has been noted, this assumption was made based upon the likelihood that such a surveillance system may be available relatively soon for special purpose use in monitoring closely spaced parallel approaches.

However, it may be that alternative values for the specifications of accuracy and update for this (or another) system evolve. Table F-1 presents the minimum runway spacings which would be achievable under a variety of specifications for a new surveillance system. The logic of the analysis and the parameter values are the same as in the body of this report.

TABLE F-1

RUNWAY SPACINGS ACHIEVABLE WITH
ALTERNATIVE SURVEILLANCE SYSTEMS

COMMON PARAMETER VALUES:

VELOCITY IS 150 KNOTS

BLUNDER IS AT 30 DEGREES

PROBABILITY OF NON-DISPLAY WITHIN DETECTION ZONE LIMITS IS .01

NORMAL NAVIGATION ERROR (1-SIGMA) is 100 FEET

RANGE AT POINT OF BLUNDER IS 8 NMI

MINIMUM RUNWAY SPACINGS ACHIEVABLE (IN FEET) WITH NOZ VALUE (IN FEET) IN PARENTHESES:

AZIMUTH ACCURACY (MR)*

UPDATE INTERVAL (SEC)	4	3	2	1
4	4300 (1150)	4000 (950)	3650 (750)	3400 (600)
2	4000 (1200)	3700 (950)	3400 (750)	3150 (600)
1	3800 (1200)	3550 (1000)	3250 (750)	3050 (600)
1/2	3700 (1250)	3450 (1000)	3200 (800)	3000 (650)

* Assumption made that presentation to controller reflects this surveillance accuracy

To expedite publication, please coqrdinate with Mr. James G. Cain, AEM-10, Office of Systems Engineering Management. A verbal approval would be appreciated, and a follow up letter can be processed at your convenience.

To our knowledge, no information of a Classified, Proprietary or Government Sensitive nature is included in these documents.

Approval is hereby requested for release of these documents for public dissemination in accordance with the terms and conditions fo Contract DOT-FA70WA-2448.

Very truly yours,

C. Michael Broderick

C. Michael Broderick
Senior Contract
Negotiator/Administrator

JSY:CMB:pap

Enclosures

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20591

DATE: AUG 0 1 1977

IN REPLY REFER TO: ALG-311 (LH)

SUBJECT: DOT-FA70WA-2448; Release of Information

FROM: Contracting Officer, ALG-311

TO: The Mitre Corporation
Metrek Division
1820 Dolley Madison Blvd.
McLean, Va. 22101

You requested approval to release the information contained in nine documents by your letter of 17 May 1977, Serial No. B52-1664. The documents have been reviewed and the seven of them which can be released at this time are listed below:

1. Reduction of Parallel Runway Requirements not rec'd ntis
2. An analysis of Fuel Conservation through Aircraft Towing
3. Requirements for 3500 foot Spacings for Simultaneous Parallel IFR Approaches
4. Benefits of MLS Guidance for Curved Approaches, Vol I, Noise Abatement Case Studies not rec'd, ntis - too large to reproduce
5. Benefits of MLS Guidance for Curved Approaches, Vol II, Operational Benefits for New York Airports
6. Concepts for Determination of Longitudinal Separation Standards on Final Approach
7. Concepts for Estimating Capacity of Basic Runway Configurations

The remaining two documents can not be approved.

All of the documents are returned as you requested.

M. Stephens

M. STEPHENS

END
DATE
FILMED
1-12-78
NTIS