Kansas City International Airport

Capacity Plan

September 1990

Prepared jointly by the U.S.
Department of Transportation
Federal Aviation Administration,
City of Kansas City, Kansas City
Association, the Airlines and
General Aviation serving Kansas City

Executive Summary

Kansas City International Airport (MCI) was the 30th busiest airport in the United States in 1988, enplaning more than 4.7 million passengers and handling more than 212,000 aircraft operations. Based on data from its annual delay computer model, the Federal Aviation Administration estimates annual flight delays of 5,000 hours, at a cost of 5.3 million dollars, for a baseline traffic level of 212,000 aircraft operations.

The Design Team chose to construct this report using several specific forecast traffic levels. Constructed in this manner, this document should retain its validity until the highest traffic level is attained.

The traffic levels used were:

- Baseline (212,000 annual operations)
- Future 1 (260,000 annual operations)
- Future 2 (325,000 annual operations)
- Future 3 (450,000 annual operations)

The major objective of the Kansas City Study was to develop recommended options which, if implemented, would increase airport capacity, improve airport efficiency, and reduce aircraft delays.

Figure 1

Kansas City International Airport
Airfield Improvements

Figure 2

Studied Options and Annual Savings

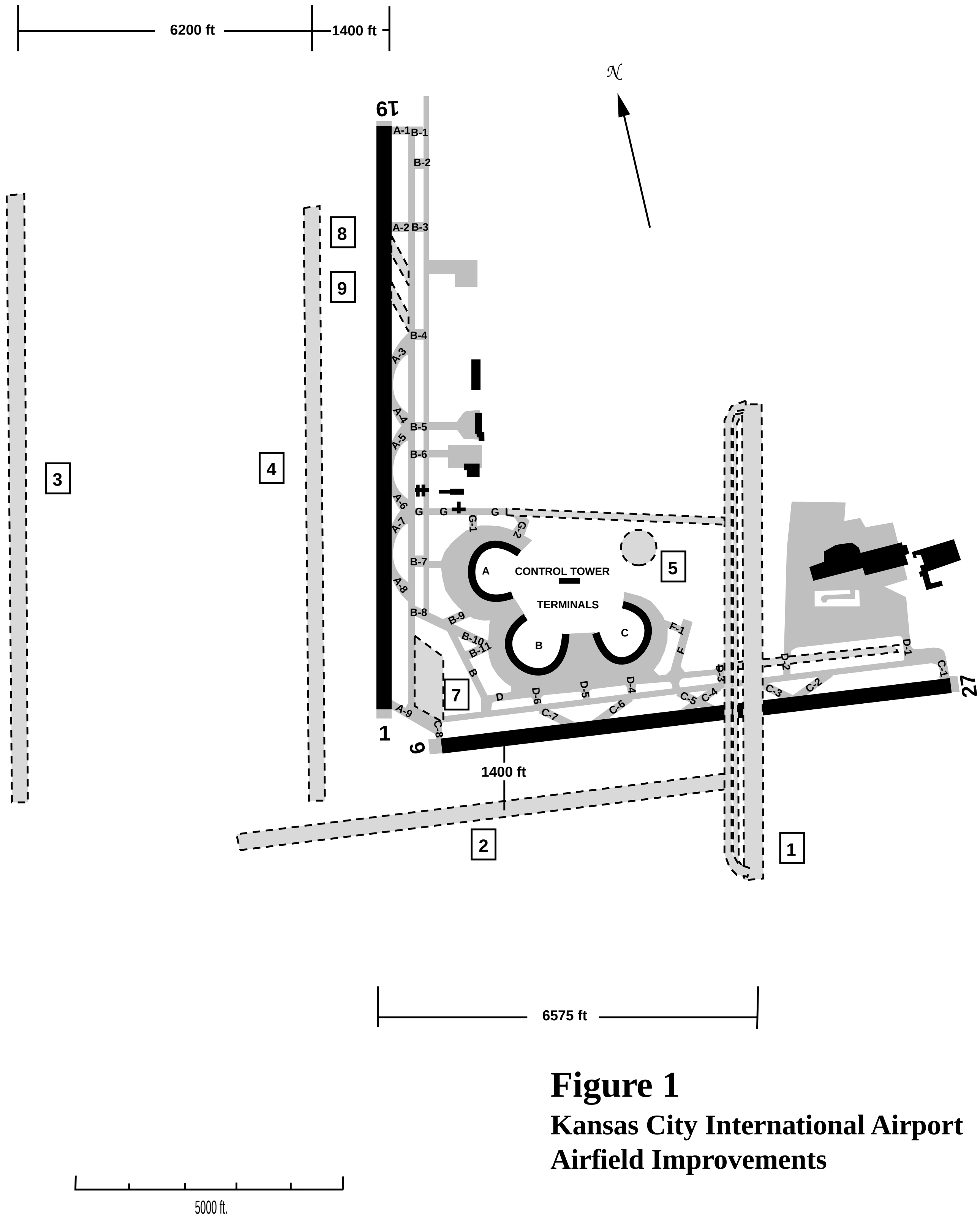

Figure 1
Kansas City International Airport
Airfield Improvements

Figure 2
Studied Options and Annual Savings

Airfield Improvements	Time Frame[1]	Responsible Agency	Estimated Construction Costs in 1988 (Millions of 1988 Dollars)[2]
1. Independent 9500' Runway 1R/19L	Near Term	Airport Authority	$48.3
2. Dependent 10,000' parallel runway 9R/27L	Far Term	Airport Authority	$40.9*
3. Independent 10,000' parallel runway 18R/36L	Far Term	Airport Authority	$ 46.3*
4. Dependent 10,000' parallel runway 18L/36R	Far Term	Airport Authority	$ 40.9*
5. Add fourth terminal	Near Term	Airport Authority	$ 110.0
6. Extend Taxiways B&D to Taxiway H (not pictured)	Near Term	Airport Authority	$ 2.1
7. Build holding aprons west of Terminal B	Near Term	Airport Authority	$ 1.3
8. High Speed exit at A2 for Runway IL	Near Term	Airport Authority	$ 0.7
9. High Speed exit at A3 for Runway 19R	Near Term	Airport Authority	$ 0.7
10. Extend Taxiway B5 to Runway 19R for GA	Near Term	Airport Authority	$ 0.2

1. Time Frame: Improvement available and producing benefits by Future 1 (near term), Future 2 (intermediate term) or Future 3 (far term).

2. Costs do not include real estate purchase costs. Final costs will be the subject of master plan and economic studies which are beyond the scope of this effort.

* Includes dual parallel taxiway system.

Annual Savings in Thousands of Hours [3]				Annual Savings in Millions of 1988 Dollars [3]			
Baseline	**Future 1**	**Future 2**	**Future 3**	**Baseline**	**Future 1**	**Future 2**	**Future 3**
2.7	8.3	28.2	176.0	2.8	8.6	29.1	181.8
—	—	—	3.6	—	—	—	3.7
—	—	0.2	4.9	—	—	0.2	5.1
—	—	—	—	—	—	—	—
See Narrative							
See Narrative							
Savings Included in Item 16							
Savings Included in Item 16							
See Narrative							

3. Baseline, Future 1, Future 2 and Future 3 reflect demand levels of 212,000; 260,000; 325,000; 450,000 operations.

* Costs not available.

(—) Annual Savings not directly attributable to this improvement

Note: Both costs and savings presented here are non additive.

Figure 2
Studied Options and Annual Savings (continued)

Airfield Improvements	Time Frame [1]	Responsible Agency	Estimated Construction Costs in 1988 (Millions of 1988 Dollars) [2]
11. High Speed exit between C5&C7 for Runway 27R	Near Term	Airport Authority	$ 0.7
12. CAT III ILS Runway 1R	Near Term	FAA	Included in Savings for 1R/19L
13. CAT I ILS for Runway 19L	Near Term	FAA	Included in Savings for 1R/19L
14. Install ILS/MLS for for Runway 27R	Intermediate Term	FAA	Included in Savings for Simultaneous Converging Instrument Approaches
15. DME for Runway 1L/19R and Runway 1R/19L	Near Term	FAA	
16. RVR for Runway 1R/19L	Near Term	FAA	Included in Savings for 1R/19L
17. Upgrade Runway 1L ILS to CAT III	Near Term	FAA	
18. Benefit of ASDE	Intermediate	FAA	
19. Simultaneous converging instrument approaches	Near Term	FAA	

1. Time Frame: Improvement available and producing benefits by Future 1 (near term), Future 2 (intermediate term) or Future 3 (far term).

2. Costs do not include real estate purchase costs. Final costs will be the subject of master plan and economic studies which are beyond the scope of this effort.

* Includes dual parallel taxiway system.

Annual Savings in Thousands of Hours [3]				Annual Savings in Millions of 1988 Dollars [3]			
Baseline	Future 1	Future 2	Future 3	Baseline	Future 1	Future 2	Future 3
—	—	—	1.3	—	—	—	1.4
See Narrative							
See Narrative							
See Narrative							
0.2	0.9	4.6	167.5	0.2	0.9	4.7	173.0

3. Baseline, Future 1, Future 2 and Future 3 reflect demand levels of 212,000; 260,000; 325,000; 450,000 operations.

* Costs not available.

(—) Annual Savings not directly attributable to this improvement

Note: Both costs and savings presented here are non additive.

Figure 2
Studied Options and Annual Savings (concluded)

Airfield Improvements	Time Frame[1]	Responsible Agency	Estimated Construction Costs in 1988 (Millions of 1988 Dollars)[2]
20. Impact of terminal service road	Near Term	FAA/Airport	
21. Impact of perimeter service road	Intermediate Term	FAA	
22. Effect of noise restrictions	Intermediate Term	FAA	
23. Effect of ARSA separations within the TCA	Intermediate Term	FAA	
24. Uniformly Distribute Scheduled Commercial Operations within the hour	Intermediate Term	Airlines	
25. Reduced ROT through pilot & controller education	Intermediate Term	Airport Authority Airport Users/FAA	
26. Reduce longitudinal separations to 2.5 NM	Near Term	FAA	

1. Time Frame: Improvement available and producing benefits by Future 1 (near term), Future 2 (intermediate term) or Future 3 (far term).

2. Costs do not include real estate purchase costs. Final costs will be the subject of master plan and economic studies which are beyond the scope of this effort.

* Includes dual parallel taxiway system.

Annual Savings in Thousands of Hours [3]				Annual Savings in Millions of 1988 Dollars [3]			
Baseline	Future 1	Future 2	Future 3	Baseline	Future 1	Future 2	Future 3
See Narrative							
See Narrative							
0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1
See Narrative							
2.3	6.3	16.0	29.0	2.4	6.5	16.5	30.0
—	0.6	1.8	14.1	—	0.6	1.9	14.6
0.1	0.8	1.4	11.9	0.1	0.8	1.4	12.3

3. Baseline, Future 1, Future 2 and Future 3 reflect demand levels of 212,000; 260,000; 325,000; 450,000 operations.

* Costs not available.

(—) Annual Savings not directly attributable to this improvement

Note: Both costs and savings presented here are non additive.

Preface

This study was conducted by an airport capacity Design Team, composed of representatives of the Federal Aviation Administration, the Kansas City Aviation Department, the Air Transport Association, the airlines serving Kansas City, the Kansas City Chamber of Commerce and other airport users. The FAA Technical Center Aviation Capacity Branch and Howard, Needles, Tammen, and Bergendoff, the Aviation Department's consultants, provided technical support for the study.

The Design Team studied several alternatives for increasing capacity and reducing delays at the Kansas City International Airport.

In particular, the Kansas City Design Team studied the conditions causing current delays, forecasted future delays and evaluated various improvements for reducing aircraft delays and increasing airport capacity. These recommendations are intended to be acted upon by the appropriate agencies. Since all technical or procedural concerns may not have been fully addressed in this study, additional analysis will be required before the alternatives are implemented.

The goal of this study was to consider the technical feasibility of airport capacity projects. Environmental, political, and socio-economic consequences of the projects must be included in the airport master planning process, and other appropriate forums.

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Introduction

Background

The Kansas City International Airport (MCI) was the 30th busiest airport in the United States in 1988.

More than 4.7 million passengers enplaned at MCI in calendar year 1988. During this same period, the airport handled over 212,000 aircraft operations.

Delays at MCI increase dramatically as the weather deteriorates. Therefore, improvement in IFR capacity to levels approaching those of the airport's VFR capacity is extremely important.

The Design Team chose to construct this report using several specific forecast traffic levels. Constructed in this manner, this document should retain its validity until the highest traffic level is attained.

The traffic levels used were:

- Baseline (212,000 annual operations)
- Future 1 (260,000 annual operations)
- Future 2 (325,000 annual operations)
- Future 3 (450,000 annual operations)

The annual traffic levels used resulted from a group consensus of what was realistically achievable provided appropriate improvements were accomplished. The baseline daily demand was created from May of 1988. Using the baseline, daily and annual operations, the number of equivalent days (the number of daily demand replications required to achieve the annual demand) was determined. The daily demands for Future 1, Future 2 and Future 3 were then computed using the number of equivalent days from corresponding annual demands.

Based on data from its annual delay computer model, the Federal Aviation Administration (FAA) estimates that for a Baseline traffic level of 212,000 operations, each operation will be delayed an average of 1.4 minutes. This adds up to an annual delay of approximately 5,000 hours at an annual cost of $5.3 million. In this study, an operation is considered delayed if the flight time is over and above the scheduled operating time and the increase in time is caused by the interaction with other aircraft competing for the same facilities and airspace in the Kansas City area.

Objectives

The major objective of the Kansas City Task Force Study was to develop recommended options which if implemented would increase airport capacity, improve airport efficiency and reduce aircraft delays.

In addition to achieving this objective, the Design Team accomplished the following:

- Assessed current airport capacity and established the causes of delays associated with airspace, airfield, and apron/gate area operations.
- Evaluated capacity and delay benefits of alternative air traffic control (ATC) procedures, navigational improvements, airfield changes and user improvements.
- Examined the relationship between air traffic demand and delay that could be used as an aid in establishing acceptable air traffic movement levels.

Scope

The Kansas City Design Team limited its analyses to aircraft activity within the terminal area airspace and on the airfield. It considered improvements that could increase capacity and reduce delays.

The Design Team realizes that there are groundside and environmental considerations, which are beyond the scope of its mission, that will be addressed by further studies in future airport planning. The data developed in this study will provide important inputs to these future studies.

Methodology

The FAA used two computer models to study proposed improvements that would enable MCI to accommodate anticipated future traffic demands. Appendix A contains a discussion of the Airfield Delay Simulation Model (ADSIM), the Runway Delay Simulation Model (RDSIM), and the methodology used.

Studied Options and Annual Savings

The Kansas City Design Team studied the improvements listed in Figure 2 as “Studied Options” to meet anticipated growth in demand without excessive delays.

Figure 2 also shows the annual delay savings in hours and dollars for each improvement studied by the Design Team for the periods Baseline, Future 1, Future 2 and Future 3, which refer to annual aircraft operations levels of 212,000, 260,000, 325,000 and 450,000 respectively. Benefits are not necessarily additive.

The proposed recommendations for increasing airport capacity and reducing aircraft delays at MCI are categorized and discussed under the following four headings:

- Airfield Improvements.
- Facilities and Equipment Improvements
- Air Traffic Control Operational Improvements.
- Airport User Improvements.

Airfield Improvements

1. Independent 9500’ Parallel Runway 1R/19L

Construction of a new north/south runway east of Terminal C will allow the airport to provide fully independent operations on two runways during VFR and IFR conditions. This improvement assumes a dual parallel taxiway system with holding aprons at each end to facilitate the safe and efficient flow of traffic while providing departure staging capability. This improvement additionally assumes the extension of taxiway D to D1 to provide an expeditious traffic flow across 1R/19L while providing additional departure staging capability for both 1R/19L and the existing 9/27; and it assumes that the extension of taxiway G is in place. This runway will enhance the overall capacity of the airport and facilitate the movement of aircraft to and from the airport. This runway is currently under construction.

Estimated 1988 construction cost is $48.3 million. Estimated annual delay savings at the 325,000 annual operations level are 28,000 hours amounting to $29 million.

2. Dependent 10,000' Parallel Runway 9R/27L

Construction of a new east/west runway south of the existing east/west runway will provide additional VFR capacity. This is important especially when strong wind conditions dictate the use of the crosswind runway. Also, the east/west runway layout will expedite the flow of aircraft between the runway and terminal areas.

Estimated annual delay savings at the 450,000 operations level are 3,600 hours amounting to $3.7 million.

3. Independent 10,000' Parallel Runway 18R/36L

A second new north/south runway, proposed 7,600 feet west of the existing north/south runway (1/19) will provide additional VFR and IFR airfield capacity. It is located in a position to allow a future terminal complex to be constructed between the proposed and existing north/south runways allowing convenient access to both runways.

Estimated 1988 construction cost is $46.3 million. Estimated annual delay savings at the 450,000 operations level are 4,900 hours amounting to $5.1 million.

4. Dependent 10,000' Parallel Runway 18L/36R

A third new north/south runway (proposed 1,400 feet west of the existing north/south runway (1/19), will provide additional VFR capacity. It is located to provide convenient access to the existing terminal complex as well as for the proposed future terminal complex located to the west.

Estimated 1988 construction cost is $40.9 million. At the 450,000 operations level, appreciable delay savings were not observed due to delay reductions being negated by increased travel time to and from this runway. At higher operations levels than considered in this study, this runway should provide significant delay savings.

5. Add Fourth Terminal

A fourth terminal, containing 46 gates, will help in reducing congestion on the taxiways and apron areas around Terminals A and B and will aid in balancing parallel runway use for the most expeditious movement of air traffic.

Estimated 1988 construction cost is $110 million. Annual delay savings were not estimated for this improvement however this terminal expansion is vital to the continued growth of air traffic.

6. Extend Taxiways B & D to Taxiway H

This will reduce the congestion that occurs when Runway 1 or Runway 9 is used for departures. It also will create options for taxi routes not available when confronted with opposite direction taxiing aircraft south and west of Terminal B. In conjunction with a holding apron west of Terminal B, these taxiway extensions will create easier and more expeditious sequencing of departing aircraft. It will allow the Tower to sequence aircraft that have received precise release times from Central Flow Control or Traffic Management.

Estimated 1988 construction cost is $2.1 million. No estimated annual delay savings for this improvement were perceived.

7. Build Holding Aprons West of Terminal B

Aircraft waiting for vacant gates in Terminals A and B are frequently held at taxiways B-11, B-12, or B-13, or on taxiway B between taxiways B-9 and B-10. As a result access to these taxiways has become limited and has increased taxi route distances and taxi times. A holding apron west of Terminal B will open taxi routes during peak arrival periods which were previously used by aircraft awaiting gate access. This apron could also be used as an area for aircraft waiting for departure releases from Central Flow Control of Traffic Management. It could also be used as a centralized area for deicing, or as an area to perform engine runups.

Estimated 1988 cost is $1.3 million. No estimated annual delay savings were perceived for this individual improvement.

8. High Speed Exit at A2 for Runway 1L

A high speed exit at A2 will reduce Runway 1L occupancy time for large aircraft which rollout past A-3, and will reduce arriving cargo taxi time.

Estimated 1988 cost is $0.7 million. Estimated annual delay savings for this improvement are included with item 16.

9. High Speed Exit at A3 for Runway 19R

A high speed exit at A3 will expedite arriving General Aviation aircraft exiting Runway 19R as well as light twin engine cargo aircraft. Presently most light twin aircraft exit the runway at A4 high speed. A high speed at A3 will reduce taxi time from B7 to B6, and will reduce the runway occupancy time now required to exit at A2 or A4.

Estimated 1988 cost is $0.7 million. Estimated annual delay savings for this improvement are included with item 16.

10. Extend Taxiway B5 to Runway 19R for GA

A B5 extension to Runway 19R will expedite departing General Aviation aircraft during light traffic periods only. During heavy traffic periods, and especially at peak departure times, the use of an intersection for departure will create delays (3 minute wake turbulence delay for a small aircraft taking off from an intersection behind a preceding large aircraft).

A B5 extension to Runway 19R might expedite small General Aviation aircraft (single engine or light twin engine) exiting the runway at B5, but a high speed at A3 coupled with an extension of B5 to Taxiway A will better serve all users by reducing runway occupancy time and providing a "straight shot" into General Aviation from Taxiway A.

Estimated 1988 cost is $0.2 million. No estimated annual delay savings were perceived for this individual improvement.

11. High speed exit between C5 and C7 for Runway 27R

A high speed exit between C5 and C7 will reduce runway occupancy time, especially for large aircraft now using C7 as the primary runway exit. In conjunction with construction of a fourth terminal, and with aircraft using Terminal C, this high speed exit will be a convenience and reduce taxi time from runway to gate. This will provide an exit for Runway 27R arrivals; the arrival will be able to cross Runway 19L/1R before exiting. This will reduce delays for departures from 19L/1R which must be held for Runway 27R arrivals.

Estimated 1988 cost is $0.7 million. Estimated annual delay savings for all high speed exit improvements at the 450,000 operations level are 1,300 hours amounting to $1.4 million.

Facility and Equipment Improvements

12. CAT III ILS for Runway 1R

The instrument landing system on Runway 1L is CAT I. This permits an approach to the north with an RVR as low as 1800 feet. A proposed CAT III system for Runway 1R will lower the approach minimums on an approach to the north to zero ceiling and 700 feet RVR. Simultaneous approaches to runways 1R and 1L could be continued to CAT I minimums. It is anticipated that once Runway 1R is open, Runway 1L will be closed periodically for maintenance. In this case, an ILS system on Runway 1R will be indispensable. This improvement assumes full instrumentation on the runway.

Estimated annual delay savings for this improvement are included with the construction of 01R/19L.

13. CAT I ILS for Runway 19L

A CAT I ILS for RWY 19L will allow for simultaneous approaches to 19L and 19R down to CAT I minimums. When RWY 19L opens, it is anticipated that RWY 19R will be closed periodically for maintenance. In this instance an ILS system for RWY 19L will be indispensable.

Estimated annual delay savings for this improvement are included with construction of 01R/19L.

14. Install ILS / MLS for RWY 27R

If an ILS/MLS were installed on RWY 27R it would provide a precision approach to that runway. The present LOC BC RWY 27R only permits an approach with visibility as low as 1 mile. An ILS/MLS system for RWY 27R could lower the approach minimums to 700 feet RVR. During inclement weather and strong westerly winds, RWY 27R is the only suitable runway. The installation of an ILS/MLS will also allow for simultaneous converging approaches in IFR conditions without the application of visual separation.

An ILS is preferred initially with plans to install an MLS in the future. Most Air Carriers have not installed the MLS system in their aircraft due to cost restraints and it could be several years before the change over is accomplished.

Once the MLS system is installed, higher glide paths could be developed as well as wide angle coverage.

Multiple glide paths could be developed which would help in avoiding turbulence by allowing light aircraft to approach and land at a higher glide angle. The MLS could serve more than one runway and a curved approach could be developed to Runway 27R which would alleviate airspace conflicts with Kansas City Downtown Airport (MKC).

Annual delay savings are included with item 19 (converging instrument approaches).

15. DME for Runway 1L/19R and Runway 1R/19L

Pilots could use the DME as a reference to the airport and the TCA. A DME could be used to set up intersections and approach fixes and could aid pilots in descent planning. A DME would also reduce approach minimums.

Estimated annual savings for this improvement are included with the construction of 1R/19L.

16. RVR for Runway 1R/19L

The RVR is an indispensable part of any ILS system and the necessity of an ILS on Runway 1R/19L has already been addressed (3 transmissometers one each at touchdown, midpoint and rollout).

Estimated annual savings for this improvement are included with the construction of 1R/19L.

17. Upgrade Runway 1L ILS to CAT III

If Runway 1L ILS is upgraded, it will permit approaches with zero ceiling and 700 feet RVR. Simultaneous approaches could be continued longer if both Runway 1L and 1R were equipped for CAT III operations.

18. Benefit of ASDE

The ASDE is necessary to overcome the loss of visual observations of surface traffic during periods of reduced visibility. ASDE will aid the controller in determining aircraft positions without relying on pilot position reports, thus increasing safety and reducing delays and traffic congestion.

Operational Improvements

Operational improvements will be made possible by the installation of facilities and equipment as well as feasible procedural changes in the terminal air traffic control system. These savings have their primary benefit in adverse weather, i.e., instrument flight rule weather (IFR) or weather just above this level. By way of these improvements, a reduction of arrival delay should occur due to the capability to operate with reduced separation minimums or different combinations of runways than presently available during IFR weather conditions. These improvements may be implemented either independently, alternately or in combination. However, delay savings presented are not cumulative. This feasibility is explored for five improvements, identified as items 19 through 23.

19. Simultaneous Converging Instrument Approaches

The volume and complexity of aircraft operations at MCI will require the use of simultaneous converging instrument approaches in IFR conditions without the application of visual separation. For this to occur, a precision approach is necessary on Runway 27R.

Estimated annual delay savings at 212,000 annual operations level are 200 hours amounting to $0.2 million which increases to 167,500 hours amounting to $173.0 million at the 450,000 operations level.

20. Impact of Terminal Service Road

A terminal service road will reduce the possibility of accidents on the apron areas. It also will eliminate the need for service vehicles to exit the airport operations area and then re-enter this area near the operations/maintenance building before proceeding to the cargo area.

This improvement is recommended based on safety and not annual delay savings.

21. Impact of Perimeter and NAVAID Service Road

The perimeter service road will allow for inspection of outer perimeter fences, serve as an access to possible crash scenes and serve as an access to NAVAIDs. It will also reduce the possibility of Runway Incursions by reducing the need for vehicles to cross runways and or taxiways.

This improvement is recommended based on safety and not annual delay reduction.

22. Effect of Noise Restrictions

An identified noise sensitive area three miles southeast of Kansas City International Airport has caused Air Traffic Control to modify departure turn procedures and runway assignments. To avoid the areas with turbo-jet aircraft at altitudes below 3,500 feet, departures are taxied to another less efficient runway or kept on a non-impacting heading until above the protected altitude. Both of these avoidance measures restrict optimum airspace utilization, increase delays and increase user expenses.

23. Effect of ARSA Separations Within the TCA

Present separation minima within the TCA use State III criteria i.e., 500 feet vertical separation between VFR aircraft or VFR and IFR aircraft. Radar separation varies depending on the size of aircraft and aircraft distance from the radar antenna. Within 15 miles of the radar antenna, category I and II VFR aircraft are separated from:

a) other category I or II, VFR or IFR aircraft by 1 1/2 miles.
b) category II VFR or IFR aircraft by 1 1/2 miles on parallel courses only.

ARSA separations between IFR and VFR aircraft require traffic advisories and conflict resolution so that radar targets do not merge, or 500 feet vertical separation (except behind heavy aircraft) with traffic advisories and safety alerts as appropriate.

ARSA separation within the TCA will reduce separation requirements during the critical phase of sequencing aircraft to follow each other on final approach to the runway in VFR conditions. Once the runway acceptance rate is met, ARSA separation will not aid in increasing that arrival rate. Another separation criteria requires that category III aircraft be clear of the runway prior to a succeeding aircraft landing. Therefore, ARSA separation applied between an arriving category III aircraft and a VFR aircraft in trail will not be practical, since the category III aircraft must clear the runway prior to the following aircraft touching down.

With the availability of fan headings to local control, ARSA separation applied to departing aircraft will provide only minimal benefits. Aircraft performance characteristics will still be considered prior to clearing any aircraft for takeoff.

VFR operations at MCI comprised only 8% of the total itinerant traffic count in 1988.

Airport User Improvements

Airport user improvements affect airlines and General Aviation serving Kansas City. These improvements are major policy change issues and require extensive coordination and cooperation between carriers and airport tenants. However, the benefits are feasible to attempt implementation of these improvements.

24. Uniformly Distribute Scheduled Commercial Operations Within the Hour

More uniform scheduling for both arrivals and departures within the peak hours will produce a more orderly flow of traffic on the airport surface and reduce congestion. Theoretically, this offers the potential for immediate reduction of delays, provided flights are allowed to operate as scheduled by Central Flow Control not only in and out of the MCI Terminal Area, but in and out of the flight's origin or destination airport.

Estimated annual delay savings at the Baseline activity level are 2,300 hours amounting to $2.4 million.

25. Reduced Runway Occupancy Time Through Pilot and Controller Education

Reducing Runway Occupancy Time will permit substantial reductions in the spacing of arrival aircraft thereby allowing higher arrival acceptance rates and an increased arrival to departure ratio.

Estimated annual delay savings at the 260,000 operations level are 600 hours per year amounting to $0.6 million.

26. Reduce Longitudinal Separations to 2.5 NM

Reducing arrival in trail separations to 2.5 NM between similar class non heavy aircraft will increase the arrival acceptance rate and reduce future anticipated delays.

Estimated annual delay savings at the 260,000 operations level are 800 hours amounting to $0.8 million.

Aircraft Delays

Aircraft delay is the time over and above the unimpeded travel time taken by an aircraft to move from its origin to its destination due to interference from other aircraft in the system competing for the use of the same facilities.

The major factors influencing aircraft delays are:

- Weather
- Airfield demand
- Airfield physical characteristics
- Air traffic control procedures
- Aircraft operational characteristics

Annual delay cost expressed in millions of dollars for various daily demand levels are shown in figures 3, 4, and 5. These figures present comparisons between "Do Nothing" and "Airfield" improvements (Figure 3), "Operational" improvements (Figure 4) and "Airport User" related improvements (Figure 5) for daily demand levels through Future 3. Under the "do nothing" situation, the annual delay cost would increase from \$5.3 million in Baseline (1988) to \$242.5 million in Future 3.

The average delay of 1.4 minutes per operation in Baseline would increase by 22.4 times to 31.3 minutes per operation by Future 3.

Figure 3 — Annual Delay Costs, Improvements: Airfield

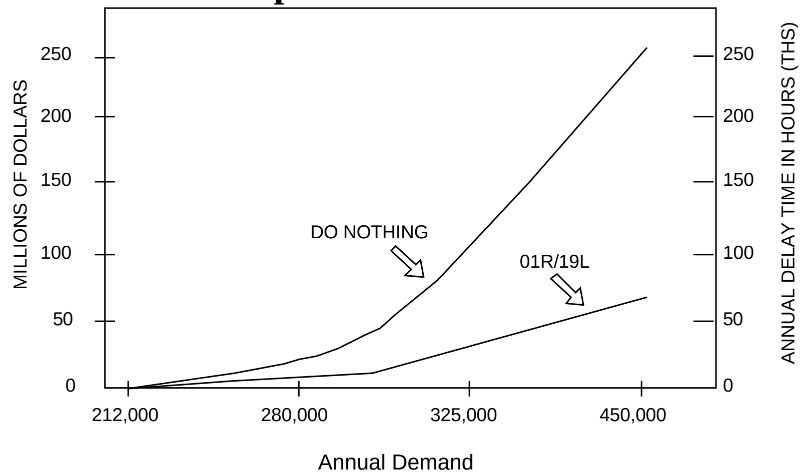


Figure 4 — Annual Delay Costs,

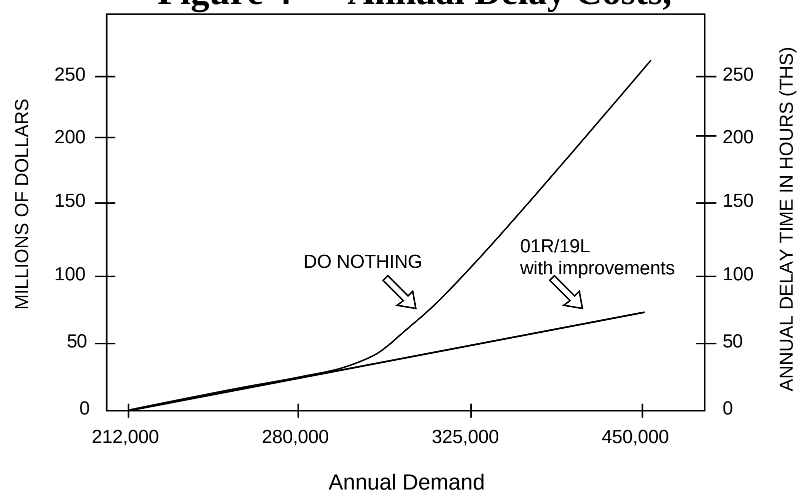
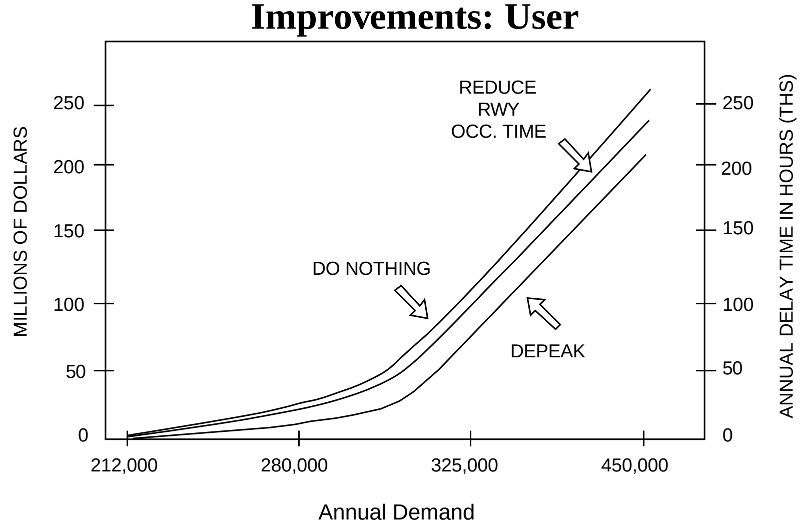


Figure 5 — Annual Delay Costs, Improvements: User



Capacity Measures

Capacity was calculated for four minute capacity and for maximum throughput. Four minute capacity is defined to mean the activity level that for arrival aircraft results in an average delay of four minutes. The maximum throughput capacities were based on unlimited arrival and departure queues and produced very large delays. Operationally unacceptable, the maximum throughput delays are included for comparison purposes only.

Figure 6 shows the results of both types of calculations and illustrates the severe penalty associated with maximum throughput. The average arrival delay per aircraft is plotted against arrival capacity for one of the VFR runway configurations.

The maximum throughput approach provided an increase in capacity at a severe increase in delay.

This method yielded an arrival flow rate of 78 aircraft per hour at an arrival delay of 16 minutes per aircraft.

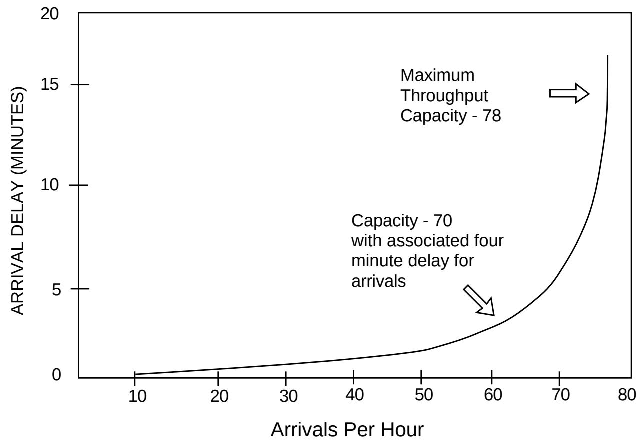


Figure 6 — Airport Delay Curve

Summary of Technical Studies

The Kansas City Task Force evaluated the operation of the existing airfield and the potential benefits of the improvements in terms of airfield capacity, airfield demand, and average aircraft delays.

The Task Force used the airfield simulation model to determine peak period aircraft delays for current and future operations.

Daily operations corresponding to an average day in the peak month, for each of the forecast time periods, were used in this study.

Daily delays were annualized to determine the potential economic benefits of the proposed improvements, including different runway use strategies. The annualized delays provide a baseline measurement for comparing the benefits of the proposed changes.

A $17.22 dollar value is attached to each minute of average aircraft annual delay for both present and proposed operations. This dollar figure is the average direct operating cost per minute for the fleet mix at MCI and does not consider lost passenger time, disruption to airline schedules or any other intangible factors.

The cost of a particular improvement is measured against its annual delay savings. Thus, a comparison of the costs and delay reductions associated with proposed improvements indicates which are the most effective in a given time period.

For an anticipated increase in demand, an optimum combination of improvements can be implemented in stages so that airfield capacity is increased and aircraft delays are kept within acceptable limits.

The figures shown on the following pages illustrate airfield weather and runway utilization, and demand levels at Kansas City International Airport.

Figure 7
Airfield Weather and Runway Utilization
Kansas City International Airport

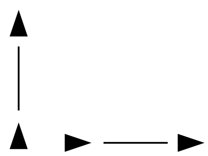
Weather	**Visibility/Ceiling**	**Occurrence (%)**
VMC	3 miles/1000 ft. or above	89
IMC	Less than 3 miles/below 1000 ft.	11

VMC - Visual Meteorological Conditions

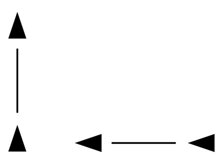
IMC - Instrument Meteorological Conditions

Runway Use

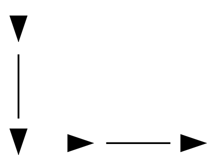
Present



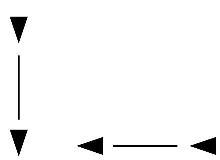
VFR 18%
IFR 0%



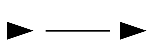
VFR 9%
IFR 2%



VFR 16%
IFR 0%



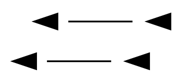
VFR 12%
IFR 5%



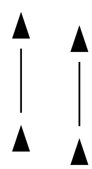
VFR 32%
IFR 4%

ALL SINGLE RUNWAY CASES

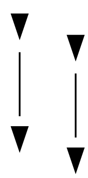
Future



VFR 2%
IFR 0%



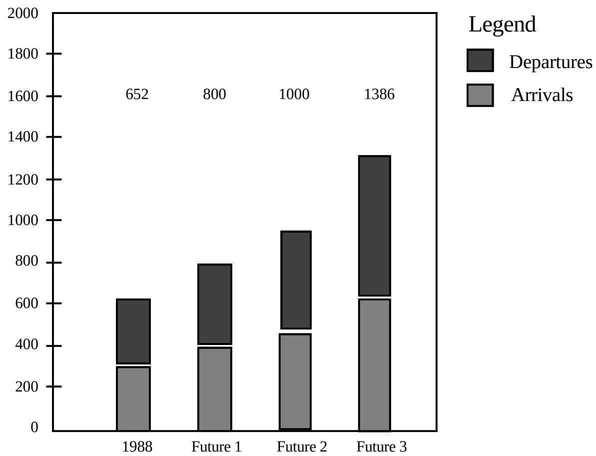
VFR 44%
IFR 5%



VFR 43%
IFR 6%

Figure 8
Airfield Demand Levels
Kansas City International Airport

Demand for Average Day of Peak Month

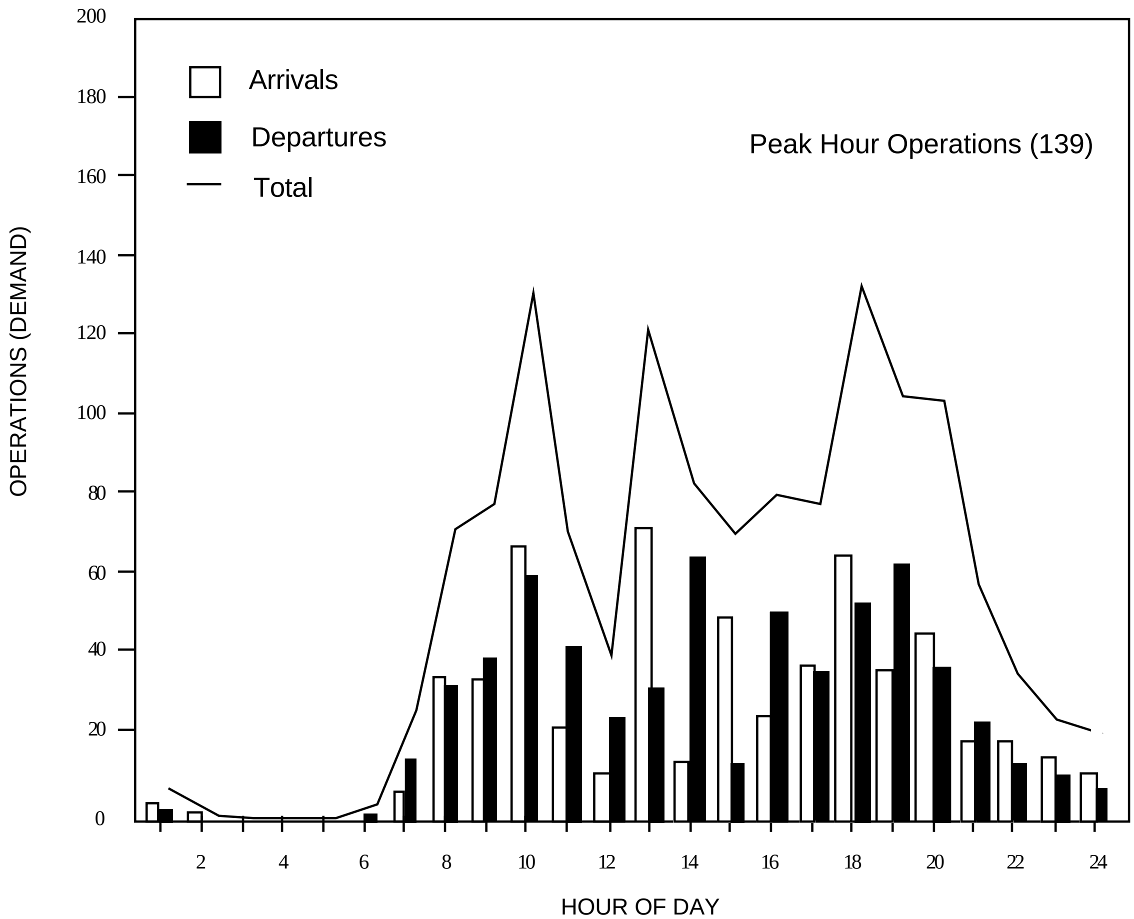


24 hour total

Aircraft Operations

	Annual	24-hour day (average day, peak month)	Peak Hour
Baseline 1988	212,000	652	66
Future 1	260,000	800	81
Future 2	325,000	1000	101
Future 3	450,000	1386	139

Hourly Variation of Future 3 Demand (Average Day, Peak Month)



24 HOUR TOTAL = 1386

Airfield Capacity

Airfield capacity is the maximum number of aircraft operations (landings or takeoffs) that can take place in a given time under the following conditions:

- Acceptable level of arrival delay
- Airspace constraints
- Ceiling and visibility conditions
- Runway layout and use
- Aircraft mix
- Percent arrival demand

The capacity results, as illustrated in Figure 9, are expressed in operations per hour for both a four minute average arrival delay and the maximum throughput capacity. Airfield Capacity Analysis is presented for current and future runway uses under VFR and IFR separations.

Capacity in hourly operations, and average delay in minutes per operation, for the four minute average arrival delay and the maximum throughput were generated by the Runway Delay Simulation Model (RDSIM) as described in Appendix A.

Figure 9
Airfield Capacity Analysis
Kansas City International Airport

Runway Usage		Four Minute Capacity* Hourly Operations	Four Minute Capacity* Avg. Delay (min) per Operation	Maximum Throughput** Hourly Operations	Maximum Throughput** Avg. Delay (min) per Operation
Configuration 1:					
	VFR	ARR = 40	(4)	ARR = 45	(61)
		DEP = 43	(1)	DEP = 88	(18)
A & D = 01, 09					
	IFR	ARR = 45	(4)	ARR = 56	(45)
		DEP = 41	(6)	DEP = 57	(55)
A & D = 01, 09					
Configuration 2:					
	VFR	ARR = 70	(4)	ARR = 78	(16)
		DEP = 47	(18)	DEP = 42	(46)
A & D = 01, 27					
	IFR	ARR = 25	(4)	ARR = 30	(107)
		DEP = 27	(1)	DEP = 60	(38)
A & D = 01, 27					
Configuration 3:					
	VFR	ARR = 60	(4)	ARR = 72	(28)
		DEP = 49	(10)	DEP = 49	(49)
A & D = 09, 19					
	IFR	ARR = 46	(4)	ARR = 54	(37)
		DEP = 43	(7)	DEP = 47	(48)
A & D = 09, 19					
Configuration 3a:					
	IFR	ARR = 25	(4)	ARR = 30	(96)
		DEP = 28	(1)	DEP = 60	(33)
A = 19, D = 09					
Configuration 4:					
	VFR	ARR = 65	(4)	ARR = 79	(22)
		DEP = 35	(27)	DEP = 34	(71)
A & D = 19, 27					
Configuration 5:					
	VFR	ARR = 36	(4)	ARR = 40	(89)
		DEP = 20	(5)	DEP = 23	(88)
A & D = 09					
	IFR	ARR = 26	(4)	ARR = 30	(108)
		DEP = 24	(6)	DEP = 24	(135)
A & D = 09					

Figure 9 (concluded)
Airfield Capacity Analysis
Kansas City International Airport

Runway Usage		Four Minute Capacity*: Hourly Operations	Four Minute Capacity*: Avg. Delay (min) per Operation	Maximum Throughput**: Hourly Operations	Maximum Throughput**: Avg. Delay (min) per Operation
Configuration 6:					
	VFR	ARR = 36	(4)	ARR = 40	(64)
		DEP = 39	(1)	DEP = 65	(28)
A & D = 27R, 27L					
	IFR	ARR = 26	(4)	ARR = 30	(91)
		DEP = 28	(2)	DEP = 40	(59)
A = 27L, D = 27R					
Configuration 7:					
	VFR	ARR = 70	(4)	ARR = 79	(16)
		DEP = 59	(9)	DEP = 58	(30)
A & D = 01L, 01R					
	IFR	ARR = 50	(4)	ARR = 59	(32)
		DEP = 50	(4)	DEP = 55	(36)
A & D = 01L, 01R					
Configuration 8:					
	VFR	ARR = 70	(4)	ARR = 79	(22)
		DEP = 75	(2)	DEP = 93	(14)
A = 36R, 01R D = 01L, 01R					
	IFR	ARR = 50	(4)	ARR = 59	(39)
		DEP = 51	(3)	DEP = 66	(34)
A = 36R, 01R D = 01L, 01R					
Configuration 9:					
	VFR	ARR = 70	(4)	ARR = 78	(22)
		DEP = 73	(3)	DEP = 87	(18)
A = 18L, 19L D = 19R, 19L					
	IFR	ARR = 50	(4)	ARR = 59	(39)
		DEP = 53	(1)	DEP = 83	(20)
A = 18L, 19L D = 19R, 19L					
Configuration 10:					
	VFR	ARR = 71	(4)	ARR = 80	(45)
		DEP = 77	(1)	DEP = 129	(17)
A = 36L, 01L D = 36R, 01R					
	IFR	ARR = 5	(4)	ARR = 54	(40)
		DEP = 54	(1)	DEP = 95	(11)
A = 36L, 01L D = 36R, 01R					

*Four minute average arrival delay

**Maximum throughput capacity means there is always an arrival or departure aircraft available for every possible slot under ideal weather conditions. This implies a large average delay would be required to achieve the maximum throughput capacity.

Appendix A — Computer Models and Methodology

The FAA studied the effects of proposed delay reduction and capacity increase options on Kansas City International Airport's (MCI) anticipated increase in future demands using computer modeling.

Model simulations involved present and future air traffic control procedures, various airfield improvements, and traffic demands for different time frames. To assess projected airfield improvements, the FAA used different airfield configurations derived from present and projected airport layouts. The time frame for air traffic control procedures and system improvements determined the aircraft separations used for IFR and VFR weather simulations.

For the delay analysis, agency specialists developed traffic demands based on the Official Airline Guide, historical data and Task Force forecasts. Aircraft volume, mix and peaking characteristics were developed for four demand periods (Baseline, Future 1, Future 2 and Future 3) based on the changing nature of the airport. Annual delay estimated for the proposed improvement options were extrapolated from the experimental results. The estimates took into account the yearly variations in runway configurations, weather and demand based on historical data.

The Task Force then compared the annual delay estimates and assessed the potential delay reductions.

Airfield Delay Simulation Model (ADSIM):

This is a fast-time, discrete event model that employs stochastic processes and Monte Carlo sampling techniques. It describes significant movements by aircraft on the airport and the effects of delay in the adjacent airspace. The model was validated in 1978 at Chicago O'Hare International Airport against actual flow rates and delay data. It was then calibrated for this study against field data collected at MCI to insure that the model was site specific.

Inputs for the simulation model were empirically derived from the collected field data. The model repeated each experiment 10 times using Monte Carlo sampling techniques to introduce system variability. The results were then averaged to produce output statistics for total and hourly aircraft delays, travel times and flow rates for the airport and for the individual runways.

Runway Delay Simulation Model (RDSIM):

This is the short form of the Airfield Delay Simulation Model. It simulated demand only for the runways and does not consider the taxiway network nor the terminal complexes. It is suitable for capacity analysis because the majority of airfield delays are runway related.

For a given demand, the model calculated the hourly flow rate and average delay per aircraft during the full period of airport operations. Arrival demand was assumed to equal departure demand, and aircraft were randomly assigned arrival and departure times. Arrivals received priority over departures.

The experiments were repeated 40 times using Monte Carlo sampling techniques to introduce system variability into each run. The results were then averaged to produce the capacity/delay outputs for a given demand level. Using the same aircraft mix, computer specialists simulated different demand levels for each run to generate demand versus delay relationships.

Appendix B — Participants

Dick White	Air Transport Association-Central Region
Norm Schemner	Mid America Regional Council
Bob Sloan	Howard, Needles, Tammen & Bergendoff
Evan Futterman	Howard, Needles, Tammen & Bergendoff
Delbert Karmeier	Director Kansas City Aviation Department
Brent Myers	Kansas City Aviation Department
Sandy Komula	Kansas City Aviation Department
Herb Gile	Kansas City Aviation Department
Dave Napoli	Kansas City Aviation Department
Phil Franke	Eastern Airlines
Max Norman	Chamber of Commerce of Greater Kansas City
W.E. McFarland	Braniff Airlines
Harold Cornine	FAA Flight Standards Central Region
Woody Duffin	FAA Airway Facilities Central Region
Harry Hale	FAA Air Traffic Central Region
Jim Smith	FAA System Capacity & Requirements Office
Bob Yatzeck	FAA System Capacity & Requirements Office
Mike Harrison	FAA System Capacity & Requirements Office
Anees Adil	FAA System Capacity & Requirements Office
John VanderVeer	FAA Aviation Capacity Branch
Bob Holladay	FAA Aviation Capacity Branch
Don Hehr	FAA ATCT Kansas City International Airport
Chris Hatem	FAA ATCT Kansas City International Airport
Lloyd Gilworth	FAA Airports Central Region
Troy Butler	FAA Airports Central Region
Roland Elder	FAA Airports Central Region
George Hendon	FAA Airports Central Region

Glossary

ASC - Systems Capacity &Requirements Office, FAA HQ
ADSIM - Airfield Delay Simulation Model
AFS - Airway Facilities Division, FAA Central Region
AOPA - Aircraft Owners and Pilots Association
APO - Office of Aviation Policy and Plans, FAA HQ
ARR - arrival
ASDE - Airport Surface Detection Equipment
ATC - Air Traffic Control
ATCT - Air Traffic Control Tower
ACE - FAA Central Region
DEP - departure
DME - Distance Measuring Equipment
IFR - Instrument Flight Rule
ILS - Instrument Landing System
IMC - Instrument Meteorological Conditions
MCI - Kansas City International Airport
MKC - Kansas City Downtown Airport
MLS - Microwave Landing System
NAVAID - Navigational Aids
RDSIM - Runway Delay Simulation Model
RWY - runway
RVR - Runway Visual Range
Stochastic - random variable or random process
TCA - Terminal Control Area
TWA - TransWorld Airlines
TWY - taxiway