A BENEFITS ASSESSMENT OF THE FAA's ENHANCED TRAFFIC MANAGEMENT SYSTEM (ETMS): The Impact of Initial Products of the ATMS Program

FINAL REPORT

DECEMBER, 1992

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Prepared for

Advanced Traffic Management System Program Office
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PREFACE

Over the past decade, commercial aviation has witnessed extraordinary growth. As a result of airport expansions, and the increased flexibility of routes and competitive fares brought about by the deregulation of the airlines, the United States has seen a 58% growth in revenue passengers and a 33% increase in scheduled air carrier operations between 1980 and 1990. In 1991, U.S. air carriers will serve almost a half-billion passengers. If the current trend in growth continues, the number of revenue passengers is projected to double by 2010, reaching a billion passengers a year. That means more flights, more planes, and a higher workload for the FAA.

The accelerated growth in the demand for air travel has caused problems with available capacity at some airports and in the terminal airspace around these airports. The worst shortages in capacity occur at major airports that serve a large portion of the total National Airspace System (NAS) demand. Congestion and delays at these airports cause a ripple effect throughout the system, affecting passengers and planes across the country.

One of the FAA's most prominent responses to the need of expanding airspace capacity has been "... the strategic management of traffic flow to minimize delays and congestion while maximizing the overall throughput of the national airspace system. The existing traffic flow system is being improved and upgraded in phases to achieve a fully integrated Enhanced Traffic Management System (ETMS). The ETMS will significantly improve the efficiency of air traffic management and will assist traffic managers in alleviating congestion, reducing delays, and avoiding traffic flow problems nation-wide[1]."

Enhancements to the ETMS are developed under the Advanced Traffic Management System (ATMS), an FAA research, engineering and development program. The ATMS program develops new concepts, technologies and automation capabilities and demonstrates the operational feasibility of such elements for inclusion in the ETMS. The ETMS takes proven functions from the ATMS prototype development and integrates these products in the FAA's current operational traffic management system.

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1 Enhanced Traffic Management System (ETMS) brochure; Federal Aviation Administration, U.S. Department of Transportation; undated.

The current ETMS system is comprised of two major ATMS developed products: the Aircraft Situation Display (ASD) and the Monitor Alert (MA) function. The ASD provides a near real-time graphical display of current aircraft positions on a national scale superimposed on maps of NAS airspace boundaries. The ASD is used as a strategic tool to plan and monitor traffic management actions. The MA function assists traffic managers in the effective utilization of the airspace by providing the capability to project traffic demand for all airports, sectors and fixes within the continental United States and to generate alerts whenever the projected demand exceeds capacity thresholds. Future functions planned for ATMS program development and ETMS application include Automated Demand Resolution (ADR), Strategy Evaluation (SE), and Automated Execution (AEX).

This study examined the benefits associated with the application of initial ATMS products, the Aircraft Situation Display and the Monitor Alert function, within the FAA's ETMS system. The benefits presented in this report represent those benefits accrued by the airlines, airline passengers, and the FAA, based on current and projected operations of the ASD and MA within the ETMS. Potential benefits, as a result of future ATMS program developments and ETMS applications of planned new functions, were not addressed in this study. Projected direct benefits to the airlines and airline passengers are a result of expected reductions in delays and annual delay hours for NAS air carrier operations.

EXECUTIVE SUMMARY

FAA's TRAFFIC MANAGEMENT SYSTEM

The overall objective[1] of the FAA's Traffic Management System is to balance the air traffic demand with the capacity of the system, to ensure the most efficient utilization of the National Airspace System (NAS) and to produce a safe, orderly, and expeditious flow of traffic, while minimizing delays.

Within the NAS, air traffic is managed by the FAA through a hierarchical organizational structure that includes the Air Traffic Control System Command Center (ATCSCC), Traffic Management Units (TMUs) within the Air Route Traffic Control Centers (ARTCCs), and TMUs at various Terminal Radar Approach Control (TRACON) facilities. The ATCSCC is responsible for the overall coordination of traffic flows within the NAS. ARTCC and TRACON TMUs are responsible for balancing traffic flows within their respective areas in accordance with the national flow directives and the terminal airspace/airport capabilities.

ATMS/ETMS SYSTEM

The Advanced Traffic Management System (ATMS) is a multi-year, multi-phased Research, Engineering, and Development (RE&D) program of the FAA designed to develop new concepts and technologies for inclusion in the next generation of the FAA's Traffic Management System. The ATMS[2] has a five-phase development plan; major elements include:

- The Aircraft Situation Display (ASD)
- A Monitor Alert (MA) function
- An Automated Demand Resolution (ADR) function
- A Strategy Evaluation (SE) function
- An Automated Execution (AEX) function

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[1] Facility Operation and Administration Manual; Federal Aviation Administration's Air Traffic Rules and Procedures Service; Manual 7210.3J; July 25, 1991.

[2] Enhanced Traffic Management System (ETMS) Functional Description; Volpe National Transportation Systems Center; Report No. VNTSC-DTS-56-TMS-002, Version 4.0; April 1991.

The ETMS[3] is an operational system of ATMS-developed flow management software and hardware products which are fully integrated into the operations of the FAA's NAS traffic management system. Currently, the ETMS is comprised of the Aircraft Situation Display and the Monitor Alert functions of the ATMS development program. This system is deployed within the FAA's ATCSCC, the TMUs of the twenty CONUS ARTCCs, and the TMUs at three TRACONs (New York Common IFR, Chicago C-90, and Los Angeles TRACON).

STUDY OBJECTIVE

In support of the FAA's ATMS Program Office (ARD-100), VNTSC was requested to conduct an independent assessment of the benefits of the ATMS/ETMS. The study examined the benefits associated with the application of the initial ATMS products, the Aircraft Situation Display and the Monitor Alert function within the FAA's ETMS. Table ES-1 presents the postulated benefits (direct and indirect) of the ETMS and an allocation of these benefits to primary beneficiary groups.

Table ES-1 ETMS Potential Benefits and Beneficiaries

	AIRLINES	AIRLINE PASSENGERS	FAA / AIRPORT OPERATORS
Terminal Airspace:	- reduced A/C operating costs	- reduced delays - value of time savings	- reduced delays - improved airport utilization
Enroute Airspace:	- reduced A/C operating costs	- reduced delays - value of time savings	- reduced delays - improved enroute airspace utilization
NAS Traffic Management:	- reduced ATC restrictions		- reduced ATC restrictions - improved NAS traffic flows - improved ATC workloads

[3] Enhanced Traffic Management System; Federal Aviation Administration; Brochure, undated.

STUDY FRAMEWORK

The scope of this study consisted of operational assessments of current ETMS applications within identified ATC facilities and an analysis of expected direct and indirect benefits against a referenced "baseline scenario."

With the cooperation of the FAA's Office of Traffic Management (ATM), site visits and interviews of FAA traffic managers were conducted at ten air traffic control facilities to assess the operations of the ETMS. The sites considered in this assessment were selected by FAA/ATM to provide a broad representation of ARTCC and TRACON TMU operations in the application of the ETMS. A summary of the ETMS site assessments is presented within Section 3.

Table ES-2 ETMS Assessment Sites

- Air Traffic Control System Command Center
- Boston Center (ZBW)
- New York TRACON (N-90)
- Kansas City Center (ZKC)
- Chicago Center (ZAU)
- Chicago TRACON (C-90)
- Miami Center (ZMA)
- Albuquerque Center (ZAB)
- Los Angeles Center (ZLA)
- Los Angeles TRACON

A study scenario was defined to include the projected terminal airspace and airport operations of sixty-seven of the largest airports within NAS. The current operations (1990) of these airports represent approximately 85% of the total air carrier operations and 98% of total passenger enplanements within the NAS. The projected enroute operations of the FAA's twenty enroute traffic control centers (ARTCCs) were also considered in this assessment. A fifteen year analysis time-frame (1990-2005) was selected as the expected period in which the ETMS technology would have the most significant impact on NAS operations.

Standard FAA data sources, forecasting procedures, and cost assumptions were used to determine the "economic value" of the direct ETMS benefits. Projections of future air travel demand and operations within the NAS terminal and enroute airspace were obtained from FAA aviation forecast documents[4]. A FAA/APO delay forecasting methodology, used to develop FAA delay projections as presented in the

[4] References: "FAA Aviation Forecasts"; FAA Report FAA-APO-91-1; FAA Office of Policy and Plans; February 1991. "NAS Terminal Area Forecasts (1991-2005)"; FAA Report FAA-APO-91-5; FAA Office of Policy and Plans; July 1991.

FAA's System Capacity Plan[5], served as the basis for study's delay projections. Standard FAA procedures and data[6] were used for all cost estimates. The primary cost factors used in this assessment were data that measure the value of passenger time savings and air carrier operating costs for fuel, crews, and aircraft maintenance. All ETMS direct benefits are referenced in 1990 constant dollars.

ETMS BENEFITS

The benefits presented in this report represent those benefits accrued by the airlines, airline passengers, and the FAA based on current and projected operations of the Aircraft Situation Display and the Monitor Alert function within the ETMS system. Potential benefits, as a result of future ATMS program developments and ETMS applications of planned new functions, were not addressed in this study. The assessment considered only air carrier operations (current and projected) in the determination of direct ETMS benefits. The benefits presented in this report are a result of expected reductions in delays and annual delay hours for NAS air carrier operations.

Case analyses of various ETMS evaluation scenarios were conducted. These evaluation scenarios were defined to represent expected capacity gains in the terminal and enroute airspace, through improved NAS ETMS traffic management operations, and high and low estimates[7] on the range of direct benefits to be accrued in the form of passenger "value of time" savings. The results of case analyses, representing 2%, 4%, and 6% gains in the capacity of the terminal/enroute airspace are presented in Section 5 of this report.

For this assessment, the evaluation scenario, representing a 4% capacity gain in the terminal/enroute airspace, was selected as the most likely range of direct benefits to be accrued from ETMS operations. Figure ES-1 illustrates the expected range of direct benefits, as measured in millions of $1990 (undiscounted) dollars. As shown, for a low estimate, the accrued annual direct benefits would range from

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5 Reference: "1990-1991 Aviation System Capacity Plan"; Report: DOT/FAA/SC-90-1; FAA Office of System Capacity (ASC); September 1990.

6 "Economic Values for the Evaluation of Federal Aviation Administration Investment and Regulatory Programs;" FAA Office of Aviation Policy and Plans Report FAA-APO-89-10; October 1989.

7 In determining the benefits associated with passenger time savings, low and high range estimates were established based on assumptions of the "value of passenger time." A low estimate considered passenger time savings on only those delays that exceed 15 minutes. The high estimate considered all passenger delays.

$121.2M in 1990 to $262.8M in the year 2005. The high estimate of annual direct benefits would range from $207.1M in 1990 to $476.9M in the year 2005. The total cumulative direct benefits, over the fifteen year analysis period, would range from **2.7 billion dollars** (low estimate) to **4.8 billion dollars** (high estimate).

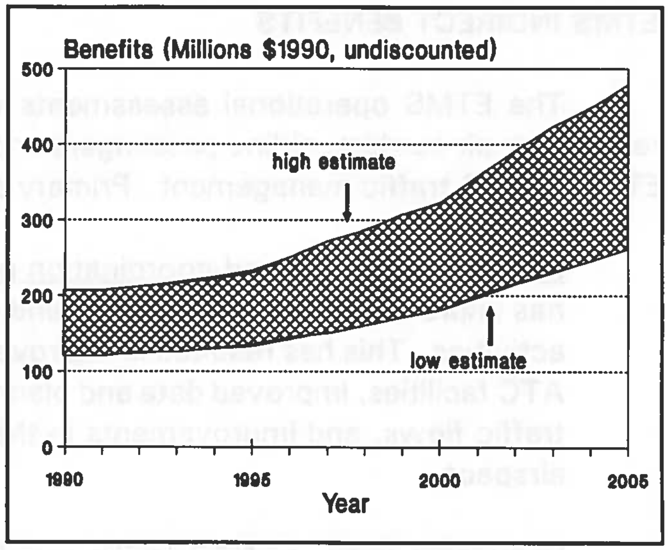

Figure ES-1 ETMS Direct Benefits

Table ES-3 presents a summary of the benefits as accrued by the airlines and the airline passengers. The overall benefit picture of ETMS is highly sensitive to assumptions made on the "value of passenger time." In the low estimate of ETMS direct benefits, air carriers accrue 58% of the total benefits, with the remaining 42% representing benefits to airline passengers. Under the high estimate, air carrier benefits represent 33% of the total, while passenger "value of time" savings represent 67% of the total accumulated direct benefits.

Table ES-3 ETMS Direct Benefits

ATMS/ETMS Direct Benefits
(Millions 1990 $, undiscounted)

	Air Carrier Benefits			Passenger "Value of Time"		Total Benefits	
	Fuel	Crew	Maint.	Low	High	Low	High
1990	36.4	23.6	14.8	46.4	132.3	121.2	207.1
1995	38.6	25.2	16.0	53.8	153.4	133.6	233.2
2000	49.6	32.2	21.1	77.4	220.6	180.3	323.6
2005	70.9	45.9	30.3	115.7	329.8	262.8	476.9
Cumulative 1990-2005						2,720.6	4,833.2

ETMS INDIRECT BENEFITS

The ETMS operational assessments identified a number of indirect benefits realized by air carriers, airline passengers and the FAA as a result of the utilization of ETMS in NAS traffic management. Primary areas of indirect benefits identified were:

Improved planning and coordination of NAS traffic management. The ETMS has improved the overall planning and coordination of NAS traffic management activities. This has resulted in improvements in NAS communications between ATC facilities, improved data and planning information on current and projected traffic flows, and improvements in the utilization of the NAS terminal/enroute airspace.

Reduced number of NAS traffic restrictions. The ETMS was instrumental in supporting FAA/ATM's efforts, over the past two years, to eliminate and/or reduce the number and magnitude of static "miles-in-trail" restrictions that existed in NAS operations. The removal of these restrictions has provided significant benefits to the airlines in operating cost savings.

Improved and balanced controller workloads. The ETMS has helped FAA traffic managers and area supervisors to manage and balance controller workloads. With ETMS information on current and projected traffic demands, ATC supervisors can more effectively balance traffic within sectors and adjust sector staffing and sector configurations to meet the projected NAS demand.

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1. INTRODUCTION

1.1 FAA's TRAFFIC MANAGEMENT SYSTEM

The overall objective[1] of the FAA's Traffic Management System is to balance the air traffic demand with the capacity of the system to ensure maximum efficiency utilization of the National Airspace System (NAS) and to produce a safe, orderly, and expeditious flow of traffic while minimizing delays.

Within the NAS, air traffic is managed by the FAA through a hierarchical organizational structure that includes the Air Traffic Control System Command Center (ATCSCC), Traffic Management Units (TMUs) within the Air Route Traffic Control Centers (ARTCCs), and TMUs at various Terminal Radar Approach Control (TRACON) facilities. The ATCSCC is responsible for the overall coordination of traffic flows within the NAS by providing a more disciplined flow of traffic to achieve an optimum use of the navigable airspace and to minimize the effects of air traffic delays. The ATCSCC functions are accomplished through the issuance of flow directives to ARTCC and TRACON TMUs, which are responsible for balancing traffic flows within their respective areas in accordance with the national flow directives and the terminal airspace/airport capabilities.

Key national traffic flow management programs utilized by the ATCSCC include:

- Ground Delay Programs and ground stops are instituted where aircraft are held on the ground to maintain operationally acceptable levels of traffic enroute and to limit airborne holding in terminal approach control areas.
- Traffic Flow Management Programs, such as Departure Flow Management (DFM), Enroute Flow Management (EFM), Enroute Spacing (ESP), and Arrival Sequencing (ASP), are designed to balance traffic flows from the

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1 Facility Operation and Administration Manual; Federal Aviation Administration's Air Traffic Rules and Procedures Service; Manual 7210.3J; July 25, 1991.

terminal to the enroute airspace environment. These programs are used to regulate traffic flows in order to maintain in-trail separations, to avoid enroute sector overload conditions, and to condition terminal airspace volumes to airport acceptance rates.

- Preferred IFR Routings are initiated over designated airways to provide most direct fuel efficient routings between selected terminal areas and to minimize ATC restrictions and coordination activities on such traffic.

- Miles-in-Trail and Altitude Restrictions, whether in the form of static or dynamic restrictions, are established to ensure a safe and orderly movement of traffic during periods of predictable fluctuations in traffic demand and to reduce periods of sector and airport saturation.

- Severe Weather Avoidance Plans (SWAPs) are formalized programs for the rerouting of aircraft around areas of severe weather in order to minimize ATC restrictions and coordination requirements in the use of available airspace.

1.2 ATMS/ETMS SYSTEM

The Advanced Traffic Management System (ATMS) is a multi-year, multi-phased Research, Engineering, and Development (RE&D) program of the FAA designed to develop new concepts and technologies for inclusion in the next generation of the FAA's Traffic Management System. The ATMS program utilizes a phased approach in the development of national traffic flow management automation concepts and software and hardware prototypes for evaluation and deployment as part of the FAA's Enhanced Traffic Management System (ETMS).

The ATMS[2] has a five-phase development plan; major elements include:

- The Aircraft Situation Display (ASD) which provides a near real-time graphical display of current aircraft positions on a national scale superimposed on maps and air traffic boundaries of NAS facilities. The ASD display options include ARTCC boundaries, enroute sector and stratum boundaries, airways, airspace fixes, airports, and military/special-use airspace areas.

- A Monitor Alert (MA) function which provides the capability to project traffic demand for all airports, sectors, and fixes within the continental United States (CONUS) and to generate an alert automatically whenever the projected demand exceeds the capacity alert thresholds.

- An Automated Demand Resolution (ADR) function which will examine projected Monitor Alert conditions, and identify alternative strategies to resolve situations where air traffic congestion exist.

- A Strategy Evaluation (SE) function which will provide air traffic managers the capability to evaluate alternative strategies produced by ADR and to select a "best strategy" for implementation.

- An Automated Execution (AEX) function which will automate the execution and dissemination of traffic management directives, advisories, and/or messages to appropriate ATM entities to implement the chosen strategy.

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2 Enhanced Traffic Management System (ETMS) Functional Description; Volpe National Transportation Systems Center; Report No. VNTSC-DTS-56-TMS-002, Version 4.0; April 1991.

The ETMS[3] is an operational system of ATMS developed flow management software and hardware products which are fully integrated into the operations of the FAA's NAS traffic management system. Today, the ETMS is comprised of the Aircraft Situation Display and the Monitor Alert functions of the ATMS development program. This system is currently deployed within the FAA's ATCSCC, the TMUs of the twenty CONUS ARTCCs, and the TMUs at three TRACONs (New York Common IFR, Chicago C-90, and Los Angeles TRACON). As shown in Figure 1-1, deployments and improvements to the ETMS span the past five years, from the initial deployment of the ASD at the ATCSCC in 1987 to the most recent deployment of the ETMS at the Los Angeles TRACON in November, 1991.

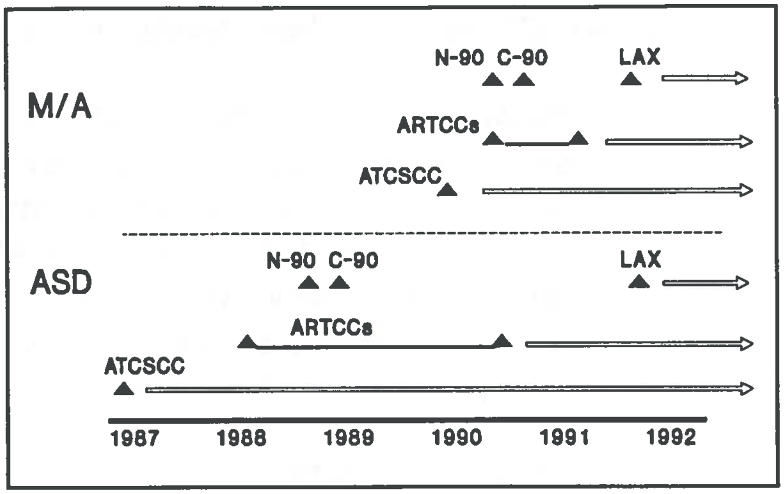

Figure 1-1 ETMS System Deployments

Within the ATCSCC and the NAS TMUs, the ETMS monitors and maintains national air traffic data and displays this information in a variety of forms to air traffic managers. The ASD is utilized as a strategic tool by providing the capability for traffic managers to monitor active aircraft and traffic flows system wide and initiate plans for resolving specific traffic situations or implementing traffic management initiatives. The ETMS's Monitor Alert (MA) data allows traffic managers to examine past, current, and projected traffic demands at airports, sectors and fixes, and to identify those areas where projected demand levels are expected to exceed NAS facility capacity thresholds. The MA function is effectively used to balance demand against capacity, to prevent overload situations, and to reduce or eliminate areas of congestion on critical NAS ATC resources.

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[3] Enhanced Traffic Management System; Federal Aviation Administration; Brochure, undated.

1.3 STUDY OBJECTIVE

In support of the FAA's ATMS Program Office (ARD-100), VNTSC was requested to conduct an independent assessment of the benefits of the ATMS/ETMS system. The study examined the benefits associated with the application of the initial ATMS products, the Aircraft Situation Display and the Monitor Alert function, within the FAA's ETMS.

With the cooperation of the FAA's Office of Air Traffic Management, site visits and interviews[4] were conducted with traffic managers within the ATCSCC, six ARTCCs, and three TRACON TMU facilities. These interviews provided the VNTSC study team with an understanding of the current applications of ETMS within the Traffic Management Units of these facilities, as well as an initial identification of potential direct and indirect benefits that FAA/ATC traffic managers feel have been realized through the use of the ETMS system.

The results of the ATC site interviews were coupled with an extensive data analysis and analytical modeling effort to determine the magnitude of potential ETMS airspace capacity and efficiency gains. Conservative estimates were then made of the direct, quantifiable benefits of the ETMS system. Indirect, non-quantifiable benefits of the ETMS, identified by the ATC traffic managers, were also addressed and a qualitative discussion of these indirect benefits is also presented within this report.

As a guide to the sections that follow, Section 2 presents a summary of the postulated benefits, a description of the overall study approach, study assumptions and a definition of the baseline scenario. The section also covers the issues and factors that were not considered. Section 3 presents a characterization of the NAS terminal and enroute operations (current and forecasted) that served as a framework for the assessment and results of the ETMS operational assessments. A qualitative discussion of the ETMS indirect benefits is summarized within Section 4. Section 5 presents the data sources, methodologies used, and results of the assessment of ETMS direct benefits. Detailed charts, graphs and tables of data that were either used

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[4] The selection of sites for this assessment was made by the FAA's Office of Air Traffic Management (ATM). The sites were selected to provide a broad representation of ARTCC and TRACON TMU operations in the application of the ETMS.

2. ASSESSMENT APPROACH

2.1 POSTULATED BENEFITS and BENEFICIARIES

Through discussions with ATMS/ETMS program managers, an initial set of postulated benefits (direct and indirect) and potential beneficiaries of the ETMS system was established. These benefit areas served as a basis for formulating an analytical framework for the assessment, for identifying study data requirements, and for guiding the structure of the ETMS operational assessments within the FAA ATC facilities. Table 2-1 illustrates the major potential benefit areas and beneficiaries of the ETMS. The cited potential benefit areas and beneficiaries are not comprehensive but do represent the major sources of direct and indirect benefits that are expected to be accrued as a result of the operations of the ETMS.

Table 2-1 ATMS/ETMS Potential Benefits and Beneficiaries

	AIRLINES	AIRLINE PASSENGERS	FAA / AIRPORT OPERATORS
Terminal Airspace:	- reduced A/C operating costs	- reduced delays - value of time savings	- reduced delays - improved airport utilization
Enroute Airspace:	- reduced A/C operating costs	- reduced delays - value of time savings	- reduced delays - improved enroute airspace utilization
NAS Traffic Management:	- reduced ATC restrictions		- reduced ATC restrictions - improved NAS traffic flows - improved ATC workloads

As shown, the primary direct benefits of the ETMS are expected improvements in the capacity of the NAS terminal and enroute airspace. A number of factors would contribute to the capacity gains of the NAS terminal and enroute airspace. The primary factor would be the reductions in the number and magnitude of "in-trail" restrictions and improvements in NAS traffic flow management. The primary beneficiaries would be the airlines and the airline users. The airlines would benefit from reduced aircraft operating costs for fuel, crews and maintenance, and through improved utilization of its fleet and crews. The airline users (business and leisure travel) would benefit from reductions in airline delays as measured in passenger value of time savings.

The primary indirect benefits of the ETMS[1] would be accrued to the FAA and the airport operators. Primary indirect benefits identified include improvements in the utilization of the NAS airports and improved NAS traffic flow management resulting in more balanced controller workloads.

2.2 STUDY SCENARIO

2.2.1 Baseline Scenario

In order to measure the benefits of ETMS, a "baseline scenario" was selected as a reference against which expected ETMS improvements in the NAS terminal and enroute airspace could be measured and direct benefits could be quantified. The selection of a "baseline scenario" is necessary in order to present a reasonable context in which benefits could be evaluated and to avoid a "double-counting" of direct benefits.

For this assessment, the "baseline scenario" of projected NAS operations was defined by the following elements:

Time Frame:

A fifteen year time-frame (1990-2005) was selected as the expected period in which the ETMS technology would have the most significant impact to NAS operations. The selection of this time-frame was based on the current operational deployments of ETMS within the ATCSCC, ARTCCs and key TRACONs, the planned development and deployment schedules of the ETMS program within the FAA, and the planned introduction of new terminal and

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[1] For this study, indirect benefits are defined as those benefits that cannot be directly quantified. A discussion of ATMS/ETMS indirect benefits are presented within Section 4.

enroute ATC programs (TATCA, AERA, AAS) which are scheduled to occur in the post-2005 time-frame.

Airport/Terminal Airspace Operations:

The projected terminal airspace and airport operations of sixty-seven of the seventy largest airports[2] within NAS were selected for inclusion in the "baseline scenario" and study analysis. The current operations (1990) of these airports represent approximately 85% of the total air carrier operations and 98% of total passenger enplanements within the NAS. In 2005, the projected operations of these airports are expected to represent 80% of all NAS air carrier operations and 92% of total NAS passenger enplanements. Associated with the selection of these airports, the "baseline scenario" also assumed that airport expansion and capacity improvements[3] would be made at these sites, through the FAA's Airport Improvement Program (AIP), in the 1990-2005 time-frame. Table 2-2[4] identifies the sixty-seven airports considered in this assessment along with their proposed airport and capacity improvements and a composite measure (annual service volume) of each airport's capacity to service an annualized volume of traffic[5].

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[2] Initially, the seventy largest airports (as measured by total air carrier operations) within the NAS were considered in the definition of the "baseline" scenario. Three of the top seventy airports (Midway-MDW, Dallas Love-DAL, and San Juan-SJU) were discarded when it became apparent that reasonable delay projections could not be developed for these airports, because of data inconsistencies that existed within the FAA/APO's delay forecasting methodology for these sites.

[3] The assumption of airport and capacity improvements is critical in the development and utilization of the FAA/APO's delay forecasting methodology for air carrier delay projections. The parameters and forms of the delay forecasting methodology are presented within Section 5.2.4 of this report.

[4] Data associated with the proposed airport and capacity improvements for each of the sites was obtained from FAA's Office of Policy and Plans (APO) and data presented within the FAA's 1990-1991 Aviation System Capacity Plan, Report DOT/FAA/SC-90-1, September 1990.

[5] A definition of the term "annual service volume" and its relationship to the delay forecasting methodology used in this analysis will be presented within Section 5.2.4

TABLE 2-2 Baseline Scenario Airports

	AIRPORT		ANNUAL SERVICE VOLUMES 1990	1995	2000	2005	AIRPORT IMPROVEMENT
1	Albuquerque	ABQ	310	310	335	335	
2	Anchorage	ANC	307	307	307	307	
3	Atlanta	ATL	720	780	930	930	Additional rwy
4	Austin	AUS	310	335	514	514	New airport
5	Windsor Locks	BDL	300	300	300	300	
6	Nashville	BNA	340	455	510	510	Third parallel rwy
7	Boston	BOS	285	285	285	285	
8	Buffalo	BUF	275	275	275	275	New rwy 5L/23R
9	Burbank	BUR	215	215	215	215	
10	Baltimore	BWI	310	370	330	330	New rwy 10R/28L - Extend 15L/33R
11	Cleveland	CLE	215	215	275	275	
12	Charlotte	CLT	435	570	635	635	New rwy 18R/30L
13	Columbus	CMH	275	275	300	300	
14	Cincinnati	CVG	435	435	510	510	New rwy 18L/36R
15	Dayton	DAY	320	320	320	320	
16	Washington	DCA	273	273	273	273	
17	Denver	DEN	300	750	750	750	Capacity for New Denver Airport
18	Dallas/Ft.Worth	DFW	557	750	750	750	New runways & ATC procedures
19	Detroit	DTW	400	505	505	505	New rwy 9R/27L
20	El Paso	ELP	220	220	285	285	New rwy 8L/26R
21	Newark	EWR	280	280	280	280	
22	Ft Lauderdale	FLL	275	305	315	315	Extend both parallel rwys
23	Honolulu	HNL	400	400	580	580	
24	Houston	HOU	350	350	350	350	
25	Washington	IAD	390	450	450	450	2 new parallel rwys
26	Houston	IAH	390	450	450	450	New rwy 8L/26R - Extend 14R/32L
27	Indianapolis	IND	320	370	370	370	New rwy 4R/22L
28	Jacksonville	JAX	220	315	315	315	New rwy 7R/25L
29	New York	JFK	272	272	272	272	
30	Las Vegas	LAS	225	300	300	300	New rwy 7R/25L
31	Los Angeles	LAX	675	675	675	675	
32	New York	LGA	200	200	200	200	
33	Kansas City	MCI	220	315	315	315	New rwys 1R/9L & 9R/27L
34	Orlando	MCO	510	565	720	720	2 new rwys 18/36 L+R
35	Memphis	MEM	365	460	495	495	New rwy 18L/36R
36	Miami	MIA	315	370	370	370	
37	Milwaukee	MKE	270	320	320	320	Replace rwy 7L/25R
38	Minneapolis	MSP	480	480	480	480	
39	New Orleans	MSY	225	300	320	320	New rwy 1L/19R
40	Oakland	OAK	285	285	285	285	
41	Kahului	OGG	225	225	225	225	
42	Oklahoma City	OKC	369	385	385	385	New rwy 17R/35L
43	Ontario	ONT	195	195	195	195	
44	Chicago	ORD	841	841	841	841	ATC flow restrictions
45	Norfolk	ORF	310	310	350	350	
46	W Palm Beach	PBI	275	275	275	275	
47	Portland	PDX	330	365	365	365	New taxi-ways
48	Philadelphia	PHL	320	370	400	400	
49	Phoenix	PHX	300	300	300	300	
50	Pittsburgh	PIT	580	600	600	600	New rwy parallel 14/32
51	Raleigh-Durham	RDU	300	330	510	510	New rwy 5L/23R
52	Reno	RNO	275	275	275	275	
53	Rochester	ROC	280	360	360	360	New rwys 4R/22L & 10R/28L
54	Fort Myers	RSW	195	300	305	305	New rwy 6L/24R
55	San Diego	SAN	225	225	225	225	
56	San Antonio	SAT	285	330	330	330	
57	Seattle	SEA	380	380	380	380	
58	San Francisco	SFO	393	393	393	393	
59	San Jose	SJC	335	345	345	345	Replace rwy 11/29
60	Salt Lake City	SLC	275	475	475	475	New rwy parallel to 16/34
61	Sacramento	SMF	205	305	305	305	New rwy 16L/34R
62	Santa Ana	SNA	355	355	355	355	
63	St Louis	STL	285	300	510	510	Improved ATC procedures
64	Syracuse	SYR	268	318	318	318	New rwy 10L/28R
65	Tampa	TPA	305	455	455	455	New rwy 17/35
66	Tulsa	TUL	364	385	385	385	New rwy 17C/35C
67	Tucson	TUS	330	315	410	410	New rwy 11R/29L

ARTCC/Enroute Airspace Operations:

The projected enroute operations of the FAA's twenty enroute traffic control centers (ARTCCs) were also considered for this assessment and the "baseline scenario." Data associated with current and projected traffic volumes, reported ATRCC enroute traffic delays, and data associated with current sector loads and capacities were analyzed as part of this assessment.

2.2.2 Study Assumptions

Principal assumptions made in the performance of this assessment were as follows:

- All direct benefits associated with ETMS operations are referenced to the "baseline scenario." Direct savings in air carrier delays and delay hours were determined based on conservative assumptions made on the expected capacity gains in the terminal and enroute airspace as a result of current and projected operations of the Aircraft Situation Display and the Monitor Alert function.

- Forecasted airport/terminal airspace and enroute airspace operations for the "select 67" airports and the twenty CONUS ARTCCs were referenced in 5-year increments within the 1990-2005 time-frame. Intermediate year estimates were developed through an interpolation of the 5-year forecasts.

- Standard costing assumptions and procedures were used in the development of an "economic value" of the direct ETMS benefits. All ETMS direct benefits are computed and referenced (unless otherwise noted) in discounted and undiscounted 1990 constant dollars. Standard FAA procedures and data[6] were used for all cost estimates. The OMB[7]

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[6] "Economic Values for the Evaluation of Federal Aviation Administration Investment and Regulatory Programs;" FAA Office of Aviation Policy and Plans Report FAA-APO-89-10; October 1989.

recommended discount rate of 10% was used for all dollar cost discounting.

2.2.3 Issues and Factors Not Considered

Some of the principal issues and factors not considered in this assessment were:

- The assessment considered only air carrier operations (current and projected) in the determination of direct ETMS benefits. Current and projected total operations (air carrier, air taxi, general aviation and military) were used in the development of the airport delay forecasts and in the projection of enroute sector traffic loads. <u>The direct ETMS benefits presented in this report are a result of the reduction of delays and annual delay hours for only air carrier operations</u>.

- With the exception of the expected airport and capacity improvements, planned under the FAA's AIP, this assessment does not consider any improvements as a result of FAA programs and technologies that are expected to be introduced under the FAA's Capital Investment Plan (CIP).

- In the development of delay estimates associated with the "select 67" airports, the assessment does not attempt to model the dynamics of traffic flows within the NAS terminal and enroute airspace. To do so would require the application of detailed network and/or simulation models to measure the impacts of various traffic management strategies or ATC restrictions on NAS operations. The development and application of such modelling techniques are beyond the scope of this study.

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[7] Defined within OMB Circular A-94 as required by Gramm-Rudmann-Hollings legislation per FAA/ABU-10 direction (January, 1991).

2.3 STUDY FRAMEWORK

Figure 2-1 illustrates the overall assessment framework used to measure the direct benefits of the ETMS system.

As shown, using FAA terminal area/airport forecasts and data on the characteristics of NAS delays, projections of air carrier delays were developed for each of the "select 67" airports within the 1990-2005 time-frame. These delay projections were applied to the defined "baseline scenario" and estimates of total NAS delays and delay hours were developed for the referenced scenario.

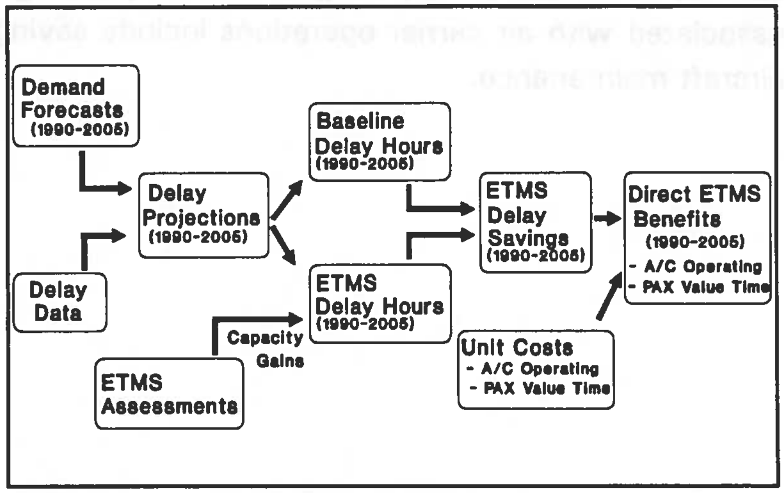

Figure 2-1 Study Framework

Assessments of ETMS operations along with interviews of FAA traffic managers were conducted at ten air traffic control facilities. These assessments identified primary areas of ETMS benefits and provided the study team with reasonable FAA estimates of the types and levels of capacity gains and delay reductions that were being experienced with the installation of the ETMS. The results of these assessments were used to establish "ETMS comparative scenarios," representing improvements[8] in NAS operations through the application of the ETMS system. Using the delay projections and the forecasted NAS travel demands (1990-2005), corresponding estimates of NAS delays and delay hours were developed under the scenarios of ETMS operations.

Estimated savings in delays and delay hours were determined by comparing the delays and delay hours of the "ETMS scenarios" with that of the "baseline scenario."

8 In establishing "comparative scenarios" of ETMS operations within the NAS, improvements were defined in the form of capacity gains in the terminal and enroute airspace.

The difference between the two, measured as delay savings, served as the basis for determining the direct benefits of ETMS.

The primary direct ETMS benefits, for air carriers and airline passengers, were savings in air carrier operating costs and passenger value of time. The benefits associated with air carrier operations include savings of costs for fuel, crews and aircraft maintenance.

3. CHARACTERIZATION OF NAS OPERATIONS

3.1 NAS TERMINAL AIRSPACE OPERATIONS

NAS terminal airspace and airport operations are projected to increase at an average annual rate of 1.5% from a level 63.5M total operations in 1990 to 80.9M total operations in the year 2002. Approximately 21% of the total NAS operations are air carrier operations. General aviation, air taxi/commuter and military operations, respectively, account for 62%, 14% and 4% of all NAS operations. As was identified in the study framework (Section 2), <u>this assessment considered only air carrier operations for 67 of the largest airports within the NAS</u>.

Of current (1990) NAS operations, the "baseline scenario" of select-67 airports represent approximately 85% of total NAS air carrier operations and 98% of all passenger enplanements. By the year 2005, the projected air carrier operations of the select-67 airports will represent 80% of all NAS air carrier operations and 92% of total NAS passenger enplanements.

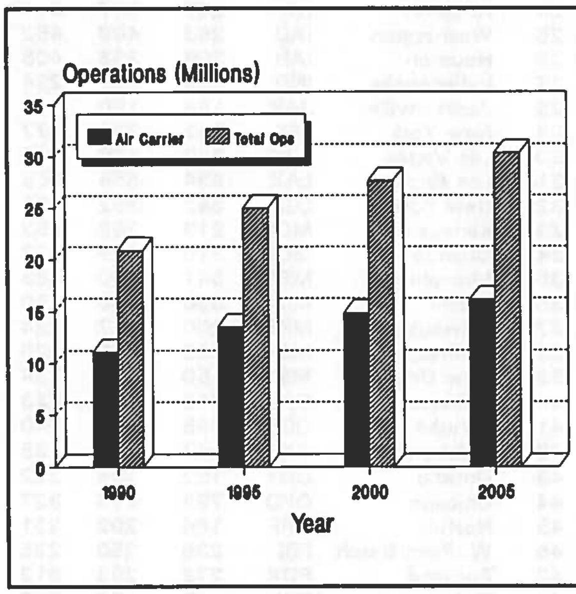

Figure 3-1 Projected Operations (Baseline Scenario)

Figure 3-1 illustrates the forecasted growth in air carrier operations for the select-67 airports of the "baseline scenario." As shown, air carrier operations are projected to increase from 11.2 million operations in 1990 to a level of 16.2 million operations by the year 2005. This forecast is based on an average annual growth rate of 4% between 1990-1995 and an average rate of 2% per year between 1995 and 2005. Air carrier operations account for nearly 54% of the total operations at these airports. Table 3-1 lists the projected (1990-2005) total and air carrier operations for each of the select-67 airports considered in this assessment.

Table 3-1 Select-67 Airport Terminal Volumes

			TOTAL OPERATIONS				AIR CARRIER OPERATIONS			
			1990 (Ks)	1995 (Ks)	2000 (Ks)	2005 (Ks)	1990 (Ks)	1995 (Ks)	2000 (Ks)	2005 (Ks)
1	Albuquerque	ABQ	252	341	420	498	71	75	79	84
2	Anchorage	ANC	216	241	267	293	97	102	109	115
3	Atlanta	ATL	725	883	932	962	530	619	637	651
4	Austin	AUS	208	311	359	404	73	128	148	168
5	Windsor Locks	BDL	191	284	321	357	75	123	137	151
6	Nashville	BNA	289	340	359	377	136	166	184	199
7	Boston	BOS	425	459	504	548	244	264	274	284
8	Buffalo	BUF	141	160	174	189	69	79	86	82
9	Burbank	BUR	247	278	295	312	49	67	76	85
10	Baltimore	BWI	318	370	425	479	160	174	187	200
11	Cleveland	CLE	261	277	282	290	143	158	165	175
12	Charlotte	CLT	429	486	530	575	232	264	292	321
13	Columbus	CMH	241	278	304	330	62	75	83	90
14	Cincinnati	CVG	306	434	510	576	161	241	289	325
15	Dayton	DAY	216	265	298	331	113	141	166	190
16	Washington	DCA	332	366	385	401	194	200	200	200
17	Denver	DEN	508	748	816	867	365	607	665	706
18	Dallas/Ft.Worth	DFW	728	924	1031	1145	531	654	727	811
19	Detroit	DTW	389	485	514	543	282	360	391	421
20	El Paso	ELP	203	267	324	380	55	61	67	72
21	Newark	EWR	387	427	445	464	281	313	325	337
22	Ft Lauderdale	FLL	225	286	326	366	94	133	152	171
23	Honolulu	HNL	411	461	484	512	201	230	240	255
24	Houston	HOU	267	307	344	380	121	143	162	180
25	Washington	IAD	263	408	452	490	159	283	307	325
26	Houston	IAH	305	363	408	454	215	256	290	325
27	Indianapolis	IND	214	251	294	337	102	114	131	148
28	Jacksonville	JAX	158	180	195	209	53	58	61	63
29	New York	JFK	341	359	377	396	227	243	259	275
30	Las Vegas	LAS	393	490	533	560	200	303	346	380
31	Los Angeles	LAX	634	654	665	702	429	448	455	487
32	New York	LGA	382	382	382	382	278	278	278	278
33	Kansas City	MCI	219	286	352	418	134	173	211	250
34	Orlando	MCO	310	429	528	626	212	307	392	477
35	Memphis	MEM	341	440	483	527	202	253	260	268
36	Miami	MIA	390	440	490	540	259	309	354	399
37	Milwaukee	MKE	200	217	234	256	77	97	117	142
38	Minneapolis	MSP	392	466	526	588	240	285	320	352
39	New Orleans	MSY	150	202	234	265	95	118	129	140
40	Oakland	OAK	419	481	533	586	79	99	109	120
41	Kahului	OGG	188	224	240	254	64	88	94	100
42	Oklahoma City	OKC	147	196	238	280	58	61	66	72
43	Ontario	ONT	152	199	222	245	94	138	160	182
44	Chicago	ORD	798	813	827	842	636	669	692	715
45	Norfolk	ORF	166	202	231	260	55	71	79	87
46	W. Palm Beach	PBI	236	250	235	243	58	69	73	82
47	Portland	PDX	272	293	312	330	98	107	113	120
48	Philadelphia	PHL	438	496	563	643	205	230	257	288
49	Phoenix	PHX	490	551	599	647	294	351	395	439
50	Pittsburgh	PIT	393	487	573	664	257	321	379	437
51	Raleigh-Durham	RDU	313	415	460	498	163	256	293	322
52	Reno	RNO	176	242	325	388	46	51	78	85
53	Rochester	ROC	213	257	299	340	52	60	70	79
54	Fort Myers	RSW	65	111	136	161	44	68	83	96
55	San Diego	SAN	212	240	266	290	138	154	172	190
56	San Antonio	SAT	213	273	327	381	79	87	95	102
57	Seattle	SEA	326	356	384	405	184	209	230	246
58	San Francisco	SFO	443	486	494	523	318	344	349	375
59	San Jose	SJC	336	433	517	601	100	123	142	160
60	Salt Lake City	SLC	306	344	379	413	160	193	219	243
61	Sacramento	SMF	185	219	244	269	59	70	75	80
62	Santa Ana	SNA	550	630	668	707	68	96	100	103
63	St Louis	STL	431	468	503	538	290	320	350	380
64	Syracuse	SYR	189	226	254	282	70	90	99	109
65	Tampa	TPA	219	287	319	351	126	185	210	234
66	Tulsa	TUL	198	247	287	328	58	67	73	80
67	Tucson	TUS	246	357	459	561	44	55	61	68
	Total		20927	25028	27696	30359	11118	13534	14867	16167

An analysis of airport and terminal airspace delays[1], as reported under the FAA's ATOMS system for 55 major airports, showed a slight decrease (1.5%) in the number of delays experienced at these airports between 1989 and 1990. In 1989, these airports reported delays of 368,058 on a total volume of 9.9 million operations as compared to a total of 367,054 delays reported in 1990 on a volume of 10.1 million operations. Comparable data[2] indicate that in 1991 there was a significant decrease (18%) in the number of reported delays (297,758) at these airports as compared to the number of delays reported in 1990.

Figures 3-2 and 3-3 identify, respectively, the principal categories and causes of delays, as reported in 1990 under the FAA ATOMS system. As shown, the primary delays reported by the ATOMS select-55 airports are departure delays (42%) and delays associated with NAS traffic management actions (TMS) (46%). Delays on arrivals and enroute delays account for, respectively, 12% and less than 1% of all ATOMS delays. As shown in Figure 3-3, the principal causes of delays are weather

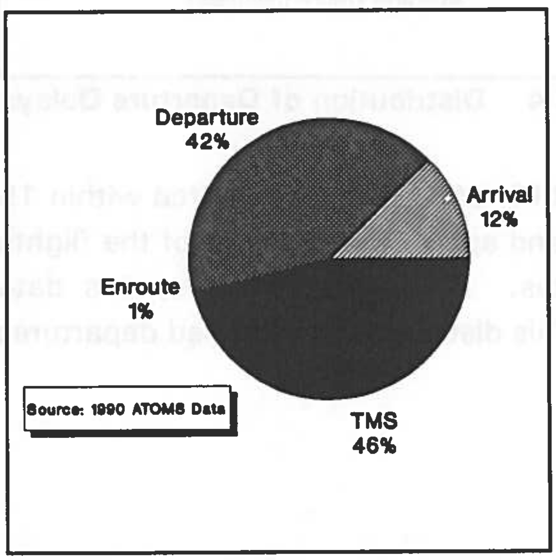

Figure 3-2 Delay Categories (1990)

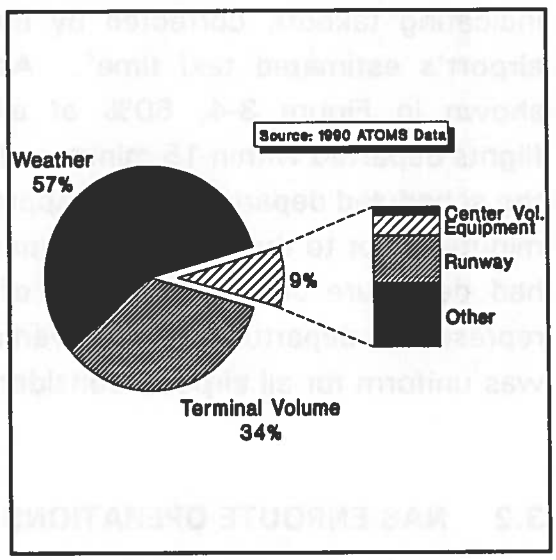

Figure 3-3 Delay Causes (1990)

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1 These delays represent delays in excess of 15 minutes that are reported by 55-select airports under the FAA's ATOMS system. ATOMS delay data for 1989 and 1990 were analyzed as part of this study. Source of the ATOMS delay data was the FAA's Office of Traffic Management (ATM).

2 As reported in a USA TODAY article (February 19, 1992) on airport delays, based on 1991 FAA ATOMS data.

(57%) and airport terminal volume (34%). Other causes, such as center volumes, NAS equipment failures, airport runway closures and other events, account for approximately 9% of all ATOMS delays in 1990.

This assessment also examined data relating to the nature and duration of delays using NAS data logged by the ETMS system. The ETMS data represented over 600 thousand flight departures during a nine month period (3/91-11/91) for eleven airports.[3] The ETMS departure delay is a measure of the time lapse between the proposed departure time (as indicated in the flight plan) and the DZ message, indicating takeoff, corrected by an airport's estimated taxi time[4]. As shown in Figure 3-4, 60% of all flights departed within 15 minutes of the scheduled departure time. Approximately 11% of the flights departed within 15 minutes prior to the scheduled departure time and approximately 30% of the flights had departure delays in excess of 15 minutes. As indicated above, this data represented departures from eleven airports. This distribution of delayed departures was uniform for all airports considered.

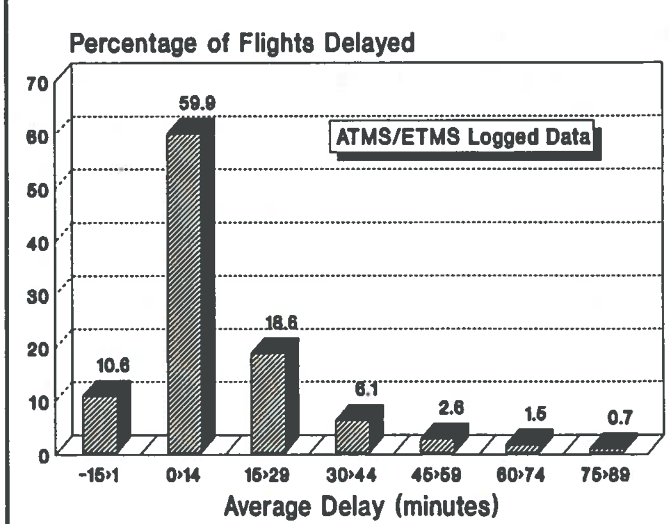

Figure 3-4 Distribution of Departure Delays

3.2 NAS ENROUTE OPERATIONS

NAS enroute IFR operations are forecasted to increase by nearly 40% from the current level of 36.3 million operations in 1990 to 50.9 million operations in the year 2005. This projected growth represents an increase at an average annual rate of 3%

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3 See data reference within Section 5.2.3 for list of airports considered.

4 The ATMS/ETMS departure delay data excluded delay outliers, i.e. flights that departed earlier than 15 minutes or later than 90 minutes of scheduled departure time.

between 1990 and 1995 and then at a rate of approximately 2% per year between 1995 and 2005. Air carrier operations represent nearly 50% of all ARTCC operations with general aviation, air taxi and military operations representing, respectively, 22%, 16% and 12% of the total. Figure 3-5 illustrates the forecasted (1990-2005) NAS enroute annual operations for air carrier, general aviation, air taxi and military. A summary of these operations is presented in Table B-1 of Appendix B.

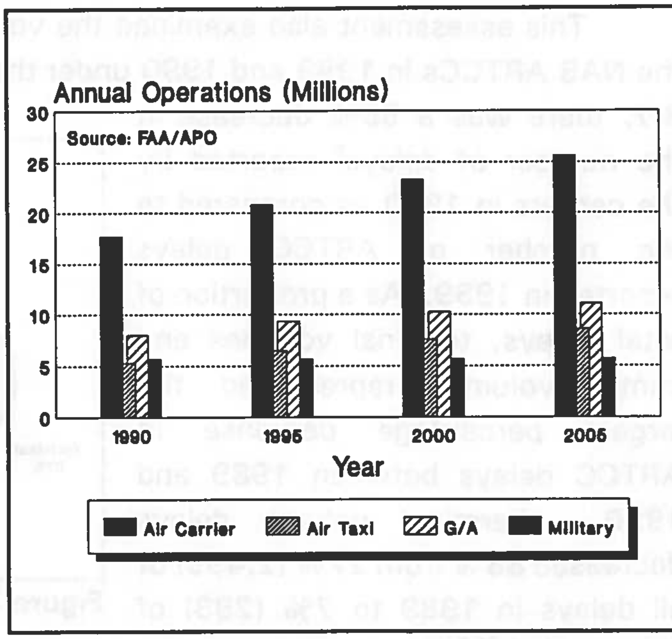

Figure 3-5 NAS ARTCC Operations

A comparison of the projected year 2005 annual operations over current year (1990) operations for each of the CONUS ARTCCs is presented in Figure 3-6. As shown, ten centers are forecasted to have annual operations in excess of 2.5 million of which three centers (ZAU, ZJX and ZLA) are projected to have annual operations of more than 3 million by the year 2005. Five of the twenty CONUS centers have a forecasted growth in annual operations of more than 60% over the 1990-2005 time-frame. Centers with the largest projected increase in annual operations by the year 2005 include ZLA (82%), ZJX (79%), ZOA (78%), ZDV (63%) and ZLC (60%).

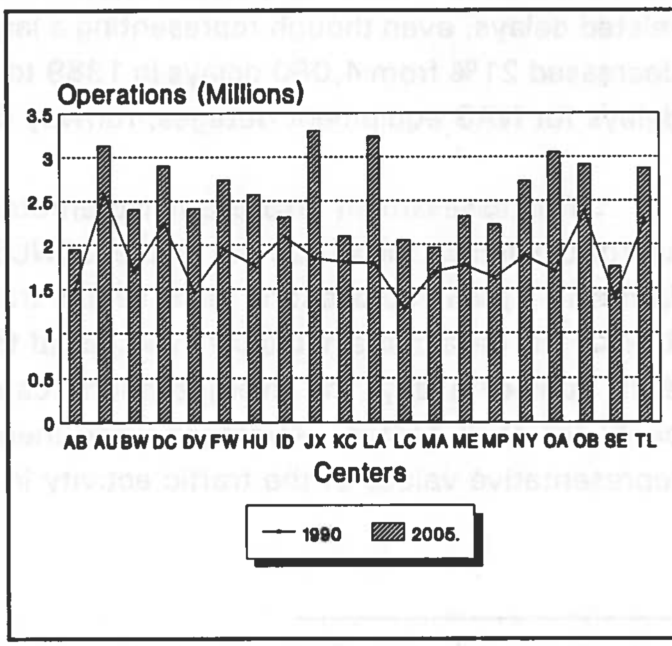

Figure 3-6 NAS ARTCC Traffic Volumes

This assessment also examined the volume and causes of delays reported by the NAS ARTCCs in 1989 and 1990 under the ATOMS system. As shown in Figure 3-7, there was a 55% decrease in the number of delays[5] reported by the centers in 1990 as compared to the number of ARTCC delays reported in 1989. As a proportion of total delays, terminal volumes and center volumes represented the largest percentage decrease in ARTCC delays between 1989 and 1990. Terminal volume delays decreased 88% from 27% (2,495) of all delays in 1989 to 7% (293) of delays in 1990. Center volume delays decreased 72% from 1,629 delays in 1989 to 454 delays in 1990. Weather related delays, even though representing a larger percentage of total delays in 1990, decreased 21% from 4,060 delays in 1989 to 3,178 in 1990. "Other delays" include delays for NAS equipment outages, runway closures and other events.

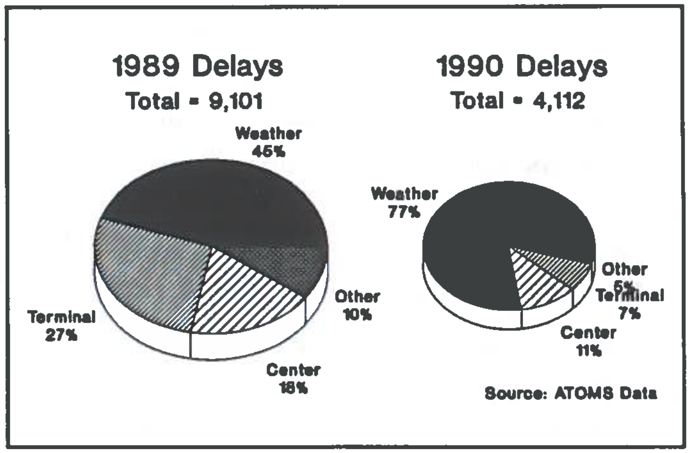

Figure 3-7 ARTCC Delays

This assessment also examined enroute sector traffic loads in comparison to sector capacities for all sectors of the CONUS ARTCCs. Sector data was collected from the ETMS representing NAS sector traffic volumes for November and June, 1991. The data contained daily averages of the monthly sector traffic activity during each hour of a day, the average hourly capacity,[6] and the average hourly traffic peak[7] for each sector. Averages were then taken of the hourly data to obtain a representative values of the traffic activity in each sector. Using this data, average

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[5] These are delays of more than 15 minutes as reported by individual ARTCC facilities under the FAA/ATM ATOMS system.

[6] The sector capacity measure is the "alert threshold," defined within the ETMS, that triggers alert messages whenever the number of aircraft in the sector exceeds the threshold limit.

[7] The average hourly peak is the average maximum instantaneous aircraft count during the hour of the day. This value was computed by detecting the highest aircraft count every minute within the hour. The maximum value for each day in the month is totalled and divided by the number of days in which data was collected during the month.

sector traffic loads were then projected[8] for 1995, 2000, and 2005 using FAA/APO forecasts of ARTCC total annual operations. The data representing each ARTCC sector identification, the average sector capacity and the average sector traffic load for the current (1991) and the 2005 forecast year are presented in Table B-2 of Appendix B.

For each ARTCC, the average, maximum, and minimum percents of sector capacities were calculated. Figure 3-8 illustrates the minimum, maximum and average traffic loads as a percentage of sector capacity of each center for current year (1991) and the year 2005. The analysis showed that, for the projected year 2005 ARTCC

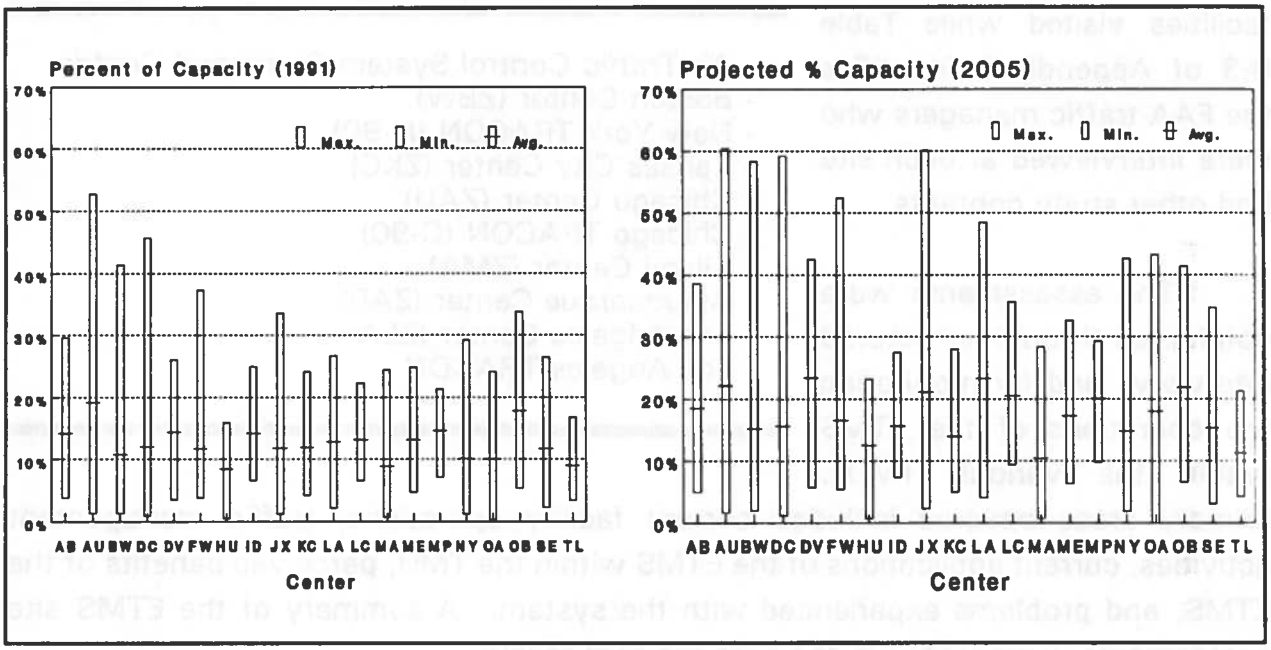

Figure 3-8 ARTCC Projected Sector Volumes (1991 and 2005)

traffic volumes, there exists a significant dispersion between the minimum and maximum sector track loads (as measured as a percentage of sector capacity) for a number of centers (ZAU, ZBW, ZDC, ZFW, ZJX and ZLA). The projected average sector track load (in the year 2005) for each of the centers showed only a slight increase over current (1991) levels.

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[8] Future traffic loads were calculated as follows: (avg. sector load * % growth/year) + avg. sector load. Future year percent of capacity was calculated using the formula (future traffic load/avg. sector capacity). The assumption was made that the average sector capacity remains constant for each sector in the forecasted years.

3.3 NAS ETMS OPERATIONS

3.3.1 ETMS Operational Assessments

With the cooperation of the FAA's Office of Traffic Management (ATM), site visits and interviews of FAA traffic managers were conducted at ten air traffic control facilities to assess the operations of the ETMS system. The sites considered in this assessment were selected by FAA/ATM to provide a broad representation of ARTCC and TRACON TMU operations in the application of the ETMS.

Table 3-2 lists the ATC facilities visited while Table B-3 of Appendix B identifies the FAA traffic managers who were interviewed at each site and other study contacts.

Table 3-2 ETMS Assessment Sites

- Air Traffic Control System Command Center
- Boston Center (ZBW)
- New York TRACON (N-90)
- Kansas City Center (ZKC)
- Chicago Center (ZAU)
- Chicago TRACON (C-90)
- Miami Center (ZMA)
- Albuquerque Center (ZAB)
- Los Angeles Center (ZLA)
- Los Angeles TRACON

The assessments were conducted through structured interviews and by monitoring the operations of the ETMS within the various TMUs. Primary areas covered included current facility operations, traffic management activities, current applications of the ETMS within the TMU, perceived benefits of the ETMS, and problems experienced with the system. A summary of the ETMS site assessments is presented in the sections that follow.

3.3.2 Air Traffic Control System Command Center (ATCSCC)

The ATCSCC is responsible for national traffic flow planning, the coordination of activities between individual ARTCC TMUs, and the initiation of all national flow control and ground delay programs. The ATCSCC is also responsible for the approval and the coordination of monthly static and daily dynamic flow control restrictions between centers. Other functions performed within the ATCSCC include the establishment of fuel/wind routes, the approval of preferred IFR direct routings, and alternative routings under SWAPs.

To accomplish these functions, the ATCSCC is fully dependent on the ETMS which has been operational within the ATCSCC over the past 2-1/2 years. The ASD is effectively used for national traffic flow planning[9], for monitoring of traffic flows into key airports[10], and for monitoring the in-trail spacings on routes and the projected traffic densities within NAS sectors.

Traffic managers within the ATCSCC view the ASD as a major strategic tool not only their operations but also within the operations of the ARTCC TMUs. Generally, the traffic management coordinators see a wide range of uses of ETMS within the various centers including setting-up traffic streams, sequencing traffic flows, maintaining miles-in-trail (MIT) restrictions, and controlling traffic in high density areas. One of the primary benefits cited for the ETMS is that the ASD allows ARTCC TMUs to see beyond their airspace boundaries and to take early action to avoid or minimize potential traffic flow problems. By doing so, centers can avoid congestion problems within their sectors or key terminal areas and generally improve the overall utilization of their airspace.

The introduction of the ETMS within the ATCSCC and ARTCC TMUs has also been instrumental in the FAA/ATM's efforts,[11] over the past two years, to reduce the number and the magnitude of monthly static and daily dynamic miles-in-trail and altitude restrictions that exist within the NAS. Although, no estimate was given on the number of "restrictions eliminated" that could be attributed to ETMS operations, ATCSCC traffic managers estimated that "without ASD, in-trail traffic restrictions could increase an average 10-15 MIT." With more and improved information through the use of the ASD, ATCSCC and ARTCC TMUs can now monitor current and

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[9] The ATCSCC utilizes the ASD to track blocks of traffic flows.

[10] The ATCSCC tracks the flows for 26 primary airports of which 16 airports (SFO, ORD, JFK, MIA, SEA, STL, LGA, DCA, LAX, DFW, ATL, IAH, DEN, BOS, CLT, MSP) routinely have problems.

[11] Although the FAA/ATM does not attribute the reduction in the number of static restrictions solely to ETMS operations, they feel that the ETMS has enabled them to reduce their dependency on the use of restrictions to prevent traffic overload situations. A further discussion of the volume and types of static restriction reductions that have occurred over the past two years are presented in Section 4 of this report.

projected traffic flows[12] more effectively and are less reliant on in-trail restrictions as a "traffic overload safety net."

Another benefit area cited by the ATCSCC is that the ETMS provides them with an improved mechanism for planning and coordinating national traffic management actions with ARTCC TMUs and with the airlines. With the ASD, ATCSCC and TMUs can effectively monitor the timing of major streams of traffic (i.e. West Coast departures, traffic flows into major hub airports, etc.), throughout the day, and can plan or adjust the day's national traffic plan to current and projected demands. By having the ETMS system within all the CONUS ARTCC TMUs, ATCSCC traffic managers have found that the coordination and communication of the ATCSCC national traffic management actions/directives have been improved.

Within the ATCSCC, the ETMS's Monitor Alert function is not used. According to the ATCSCC traffic managers, "M/A is a good idea...but functionally it is not there yet." The primary problem cited with the M/A is that the ATCSCC cannot stay current with changing sectors and sector capacities within the ARTCCs. This has caused a number of "false alerts," especially in high density areas around major airports.

3.3.3 Boston Center

The Boston Center (ZBW) handles, on average, 5,000 operations per day, approximately 60% of which are internal to the center or to/from the New York City area airports. The ZBW airspace is divided into 30 sectors with 5 areas of specialization. The busiest sectors are those sectors that take handoffs from or set up traffic streams (direct handoffs) to the New York TRACON (N-90). The primary functions performed by the ZBW TMU include: Arrival Sequencing (ASP), Departure Sequencing (DSP)[13], and reports on miles-in trail restrictions, weather and delays.

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[12] In order for certain ATCSCC TM actions (i.e., ground delays/stops, in-trail spacings, etc.) to be effective a 3-4 hour initiation lead time is often required.

[13] DSP is usually run daily for six airports (EWR, ORD, DTW, PIT, BWI, and IAD) because of static restrictions that usually exist for these airports.

to the information and count of flight progress strips, which provided an advanced warning of 15 minutes. With the ASD, incoming flights from across the U.S. are now displayed as much as two hours in advance. This has proved invaluable to N-90 operations for establishing streams to certain arrival fixes and for planning any changes in the configurations of its three primary airports during the course of a day's operations.

N-90 relies completely on the ASD for the handling of its traffic flows. The ASD has allowed them to balance the operations of the various airports and handle more aircraft. Prior to ETMS, N-90 assigned the highest in-trail restrictions to the busiest arrival fixes; static 15 MIT restrictions on all arrivals were common. With the ASD, the static restrictions on arrivals have been removed and arrival restrictions are now dynamically established based on volume, weather and airport capacities.

N-90 utilizes the ETM's M/A function to monitor terminal overloads. Because of the number of airport configurations that exists for its three primary airports and the number of configuration changes these airports may go through during the course of a day, N-90 has had problems in establishing good M/A thresholds for their airports. Also, they do not feel that the M/A's aircraft prediction capability is accurate beyond two hours.

N-90 traffic managers feel that the ETMS has helped remove a number of the parochial barriers that exist in air traffic control and, in general, has improved the coordination and communication of ATC activities among facilities. Before ASD, "there were walls around the centers... now, ASD gives the centers and Central Flow credibility for their decisions and actions."

3.3.5 Kansas City Center

The Kansas City center (ZKC) ranks tenth among all centers in the volume of traffic (primarily overflights) handled. ZKC is divided into six areas of specialization with a total count of 37 sectors (2 super high, 16 high, 19 low); 60% of its traffic is in the high sectors. ZKC controls primarily enroute traffic but is also responsible for setting-up traffic flows into St. Louis (STL), Kansas City (MCI), Oklahoma City (OKC), and Tulsa (TUL). ZKC does not have any static restrictions, but daily restrictions are evaluated for traffic to/from ZAU, ZID and ZME. Generally, they have 20 MIT

The ETMS has been operational at ZBW for approximately a year; it was one of the last centers to receive the system. ZBW's use of ETMS is somewhat limited. ETMS is primarily used as a metering tool to stream traffic, which originates from ZBW airports as well as international oceanic traffic, for direct handoff to the New York TRACON. Using three separate ASD screens, ZBW monitors traffic in and out of Boston; Newark (EWR) and La Guardia (LGA) traffic; and ZBW and international traffic destined for Kennedy (JFK). According to ZBW traffic managers, the ASD has been effective in establishing the ZBW and international oceanic traffic streams for direct handoff to NY TRACON. ZBW TMU personnel estimate that "the ASD has saved 100 miles of airspace daily into Kennedy."

ZBW does not use the ETMS's Monitor Alert function because of the number of "false alerts" that have been experienced. They attribute these "false alerts" to the fact that ETMS cannot adequately recognize stratified sector boundaries. ZBW has had problems in defining, due to shelving, a number of its stratified sectors within ETMS.

3.3.4 New York TRACON

The New York TRACON (N-90) is divided into five areas of specialization (La Guardia, Kennedy, Newark, Islip, and Liberty) and is responsible for all terminal airspace operations within the New York, New Jersey and Southern Connecticut metropolitan areas. The primary airports handled by N-90 include: La Guardia (LGA), Kennedy (JFK), Newark (EWR), Teterboro (TEB), Westchester (HPN), Islip (ISP), and Stewart (SWF). Traffic into the N-90 airspace is fed by three centers (ZBW, ZNY and ZDC) of which no one center's traffic is dominant. The N-90 airspace is confined to certain airport (LGA, JFK, and EWR) arrival/departure configurations that impact the overall TRACON airspace. Arrivals from all three centers (ZBW, ZNY and ZDC) require a balancing of all operations in order to achieve the best airport/airspace utilization. N-90's overall objective is "to keep the pressure on the system, without any gaps in the airspace, and move the greatest number of aircraft without restrictions."

The ASD was initially installed in February, 1988 and has been operational over the past 2 1/2 years. Three screens are used on the ASD to monitor the arrivals into LGA, JFK and EWR. The ASD is also used to show the enroute aircraft coming into the N-90 airspace. Before ASD, N-90's knowledge of incoming arrivals was limited restrictions on ORD-bound traffic. ZKC performs Enroute Sequencing (ESP) for Denver (DEN), St. Louis (STL), Chicago (ORD) and occasionally for Dallas/Ft. Worth (DFW) and Atlanta (ATL).

The ASD has been operational in ZKC for about a year; it is actively used for enroute metering and traffic management. The ETMS system is used in a multiple window environment, showing MCI and STL arrivals, ORD or DFW arrivals, and ZKC Monitor Alerts.

ZKC has found the ETMS system to be very useful in setting up arrival flows and enroute spacing of traffic. With ASD, they can monitor long range traffic and can be more effective in enroute management of such traffic. Before ASD, ZKC had the following static restrictions: 20 MIT to ZAB, 25 MIT from ZME, 20 MIT from ZDV, and 10-15 MIT on all traffic to STL. Now, ZKC has no static restrictions. ZKC traffic managers feel that "the ASD has improved the utilization of its airspace by 10%-15%." The Monitor Alert function has allowed ZKC to balance traffic loads within its sectors more effectively, and thus improve controller workloads, and the communications and coordination of traffic management actions with their first-tier centers and the ATCSCC.

3.3.6 Chicago Center

The Chicago center (ZAU) has a total of 46 sectors (6 super high, 12 high and 28 low). Approximately one-third of its traffic is O'Hare's (ORD) with the remaining two-thirds representing ZAU overflights. One of ZAU's primary functions is to maintain a constant volume of traffic to the Chicago TRACON (C-90) in order to accommodate an effective utilization of O'Hare (ORD) and Midway (MDW) airports[14]. ZAU runs Arrival Sequencing (ASP) for all traffic from its first tier centers[15] and Departure Sequencing (DSP) for the three primary New York airports (LGA, JFK, EWR), Minneapolis (MSP) and Detroit (DTW). ZAU's static restrictions include: ZOB traffic 15-30 MIT; ZID traffic 20 MIT; ZKC traffic 20 MIT; and ZMP traffic 20 MIT.

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[14] The nominal acceptance rate for ORD is 80 arrivals/hour; MDW is 32 arrivals/hour.

[15] ZAU's first-tier centers are ZOB, ZMP, ZID and ZKC.

The ASD was installed within ZAU in November, 1988. The ETMS system is used primarily for enroute metering of traffic within the ZAU airspace. ZAU has three ASD monitors each used with multiple windows. One monitor is dedicated to ORD/MDW traffic, the second is used for enroute metering, and the third is used for sector monitor alerts.

ZAU traffic managers feel that the ASD has significantly improved their view of operations and has allowed them to be more effective in the metering and management of their traffic. Since ASD was installed, there has been a significant reduction in delays[16] at ORD and MDW and less of a reliance on ZAU's part in requesting the initiation of ATCSCC ground delays on ORD/MDW traffic. With the expanded view of their airspace, ZAU feels that there has been a 30%-40% improvement in the utilization of their airspace. They feel that this can be attributed, in part, to ETMS and to improved traffic management (TMU) actions. With the use of ETMS and expanded TMU functions, ZAU expects an additional improvement (20%-30%) in the utilization of their airspace. ZAU is dependent on the ETMS as an integral part of its TMU functions. Without the ASD, they feel that their current miles-in-trail restrictions would have to be increased by 10%-20% to protect themselves from traffic overload situations. ZAU utilizes the ETMS's M/A function to monitor the current and projected traffic loads within its enroute sectors. However, ZAU has experienced what they consider to be too many "false alerts" due in part to problems in defining sector boundaries, poor M/A traffic projections (beyond 2 1/2 hours), and a slow update cycle of the M/A function within ETMS.

3.3.7 Chicago TRACON

The Chicago TRACON (C-90) is responsible for the terminal airspace of the Chicago metropolitan area which includes the airport operations of O'Hare (ORD), Midway (MDW) and the Chicago satellite airports[17]. ORD has a continuous traffic demand that "flip-flops" between East and West coast arrivals throughout the day.

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16 ZAU stated that in 1989 there was a 26% decrease in ORD/MDW delays as compared to the delays reported for these airports in 1988. Although no percentage was given, ZAU reported that 1990 delays at ORD/MDW were below those reported in 1989.

17 Chicago TRACON's satellite airports are DuPage, Palwaukee, Aurora and Meigs Field.

Traffic into ORD is controlled over 11 fixes (4 for jets, 4 for general aviation, and 3 for tower/enroute traffic) that are located approximately forty miles from ORD.

At C-90, operations are "flow rate driven", not metered, with the primary emphasis on maintaining a high volume of traffic at the fixes to ensure a full utilization of ORD's capacity[18]. ORD utilizes a "four-cornerpost system" with straight-in final approaches to handle the volume of arrivals. Preferences are given to those fixes with the highest count of aircraft in order to handle the "banks of arrivals." C-90 establishes arrival rate restrictions and preferred fixes to ZAU for the streaming of traffic. Normally, in-trail restrictions on ORD arrivals are 10 MIT.

The ASD was installed within C-90 in February, 1988 and is used to monitor traffic flows into the C-90 airspace. C-90 has two ASD monitors and uses multiple windows to monitor traffic into ORD (range of 400 miles), MDW (range of 200 miles), and into the C-90 satellite airports. The Monitor Alert function is used on the second monitor to track current and projected ORD arrivals up to two-hours in advance in intervals at 15 minutes[19].

C-90 traffic managers stated that, with the ASD, ORD arrival restrictions have been reduced and ORD enroute static restrictions are no longer required. The C-90 TMU can now see the stream of ORD arrivals so they do not have to "cover" themselves with restrictions. The utilization of the C-90 terminal airspace has significantly been improved. With ASD, they can more effectively count the aircraft over the various fixes and can give fix preferences to ZAU for directing future traffic flows. C-90 feels that it can now accommodate more traffic with fewer delays as evidenced over the past year in the significant reduction of ORD's airborne holds. C-90 traffic managers also feel that the ASD has helped improve the communications and the coordination of C-90 traffic flows with ZAU's TMU.

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[18] ORD's capacity can range from 80 operations/hour (2-runway configuration) to 100 operations/hour (3-runway configuration). Normal ORD demand ranges from 96-105 operations per hour. Under the Federal Aviation Regulations (part 93, subpart K as amended) High Density Traffic Airports, ORD capacity is limited to the scheduling of slots (88 operations/hour during time period 6:45am-9:15pm). There is significant competition among carriers for ORD slot allocations. Other NAS airports operating under the FAA's "high density rule" are JFK, LGA and DCA.

[19] C-90 utilizes a count of 20 aircraft/15 minute interval, for periods up to two-hours in advance, in establishing a threshold for the ETMS's M/A function.

3.3.8 Miami Center

Miami center (ZMA) has a very restricted airspace with North-South corridors for arrivals and departures and large areas of military airspace (MOAs) within its center boundaries. ZMA is divided into four areas of specialization with a total of 26 sectors, defined as ultra-low, low and high[20] sectors. Ninety-five percent of ZMA's operations (1.8 million per year) are arrivals and departures with the remaining 5% South American and Caribbean overflight traffic. ZMA's primary interface is with Jacksonville center (ZJX) which sets up its arrival streams; 70%-80% of ZMA's traffic is through its northern feeder fixes. ZMA's primary airports are: Miami (MIA), West Palm Beach (PBI), Ft. Lauderdale (FLL), and Ft. Meyers (RSW). ZMA also controls the South departures out of Orlando (MCO) and Tampa (TPA). ZMA does not have any static restrictions; however, 10-15 MIT restrictions on MIA traffic are evaluated daily based on weather, traffic volumes and runway conditions.

The ASD was installed within ZMA center three years ago and Monitor Alert function has been operational for the past year. ZMA utilizes the ETMS system in a multiple window environment. The ASD is used to display MIA arrivals,[21] departures from key pacing airports (MIA, MCO, FLL, TPA), and M/A for all ZMA sectors. ZMA utilizes the ASD to monitor arrivals and departures on established corridors into/out of ZJX. In addition, the MIA TRACON has frequently requested that ZMA establish and monitor ETMS's M/A function on MIA arrivals. This has helped to improve the communications and coordination of activities between ZMA and the MIA TRACON.

ZMA traffic managers feel that the ASD has helped them to improve the flow of traffic in a very confined airspace[22]. By monitoring the traffic streams along their East and West coast corridors, the ASD has helped ZMA to identify slots for arrivals

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[20] ZMA's ultra-low sectors are defined at FL9 and below, low sectors are between FL9-FL23, and high sectors are FL23 and above.

[21] ZMA displays (on 1/2 screen) MIA arrivals in 190 NM range rings covering the entire East and Midwest (i.e traffic from airports as LGA, EWR, DCA, ATL, DTW, ORD etc.).

[22] ZMA operations are also characterized with a high volume of low altitude commuter, corporate and general aviation jet/turbo-prop traffic within its airspace. A significant portion of ZMA's traffic management functions are to segment out this traffic from its air-carrier arrivals and departures, heading North-South, along both Florida's East and West coasts.

and departures and to coordinate traffic flows with their primary first-tier center ZJX. The ASD has also helped to balance traffic volumes over arrival and departure fixes which has, in turn, helped balance ZMA controller workloads. Although most of ZMA's static restrictions were removed prior to the installation of the ASD, ZMA reported that the ETMS has allowed them to eliminate the remaining static restrictions over the past year. Currently, in-trail restrictions are evaluated daily by ZMA based on traffic and weather conditions in their airspace. ZMA also reported that the ETMS has reduced the need for taking delays (arrival, departure, and ground holds) at MIA. Initially, ZMA had problems with the M/A function because they experienced a high number of "false alerts." They attribute these "false alerts" to problems in defining certain ZMA sector boundaries[23] and the update cycle of M/A within ETMS.

3.3.9 Albuquerque Center

Albuquerque center (ZAB) is an overflight enroute center primarily responsible for setting-up traffic flows to (or handling traffic from) Los Angeles center (ZLA). ZAB is divided into six areas of specialization with each area having either 6-7 sectors (lows, highs, and super-highs)[24]. ZAB accepts Los Angeles basin bound traffic from ZDV, ZFW and ZKC and merges this traffic into two streams going into ZLA. Ninety-five percent of ZAB's traffic is East-West bound, 80% of which is in ZAB's northern sectors. ZAB's primary airports are Phoenix (PHX), Albuquerque (ABQ), and Tuscon (TUS). Currently, the only static restriction ZAB has is 10 MIT on ZLA to PHX traffic[25]. At times, ZAB receives in-trail restrictions (20-30 MIT) from ZLA on LA-

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23 ZMA, along with a number of other centers, reported problems in defining sector boundaries or conditioning the ETMS's M/A function to ignore certain traffic conditions around high volume, high density airport terminal airspace areas.

24 ZAB also has a significant amount of military and restricted airspace within its boundaries.

25 ZAB's 10 MIT restriction on ZLA to PHX traffic is initiated (for selected hours of the day) because of the traffic volumes into PHX and the proximity of the PHX arrival fixes to the ZLA center boundary.

basin traffic which may require them to pass-back[26] a portion of the in-trail restriction to other centers (ZDV, ZFW or ZKC).

The ETMS was installed within ZAB approximately 18 months ago and it was slow in evolving into its current operational state. ZAB utilizes the ASD to monitor traffic flows (2400 NM out) from key airports (ORD, PHX, DFW, LAX, DEN), to monitor PHX arrivals, and for Monitor Alerts of the ZAB airspace. ZAB utilizes the MA prediction capability out to a limit of 1.5 hours; they do not feel that the MA projections beyond that are accurate.

ZAB feels that the ASD has significantly expanded the view of its operations and has improved the communications between ATC facilities...."ASD keeps everyone honest." ZAB traffic managers stated that the ASD has helped in the sequencing of arrivals (ASP) into PHX and in keeping in-trail restrictions to a minimum. ZAB feels that there have been reductions in the number of delays reported from the primary CONUS airports (i.e., LAX, PHX, etc.) and that a certain percentage of these delay reductions can be attributed to ETMS operations. ZAB also felt that the ETMS has helped them balance the traffic volumes in their busiest sectors, thus improving overall controller workloads. The only problems reported by ZAB were with ETMS "false alerts." These were due to problems in defining sector boundaries (around PHX), in recognizing aircraft (military) that ZAB was not interested in, and the slow update cycle of the MA function.

3.3.10 Los Angeles Center

The Los Angeles center (ZLA) operations are characterized by a high volume of domestic and international traffic in and out of the Los Angeles basin airports. The ZLA center is divided into five areas of specialization with 5-6 sectors per area. Approximately 54% of ZLA's airspace is restricted for military operations. ZLA center supports five Level-V TRACONS (LAX, ONT, SAN, BUR, LGB), a Level-IV TRACON (LAS), and a nearby PHX TRACON (Level-V). Forty-nine percent of its traffic is

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[26] According to the FAA's Facility Operation and Administration Manual (Manual:7210.3J, July 25, 1991), if the first-tier center is within 150 NM of the restriction's fix/destination, the firs-tier center can only pass-back up to one-half the MIT restriction to its adjacent (first-tier) center.

destined for the Los Angeles TRACON; the remaining 51% is handled by the other TRACONS. One of ZLA's primary functions is to form a single stream of LA-basin traffic, at varying altitudes, depending on whether the traffic is destined for LAX, ONT, or SAN. ZLA also controls North-South traffic streams to/from ZOA of domestic (SFO, OAK, SEA, HNL) and international (Pacific/Mexico) flights.

The ETMS system was installed within ZLA 4 1/2 years ago; the Monitor Alert function has been operational for a year. ZLA utilizes the ETMS in a multiple window environment with screens showing all Los Angeles basin traffic, all PHX/SFO/LAS traffic, and MA on all ZLA airspace.

The ZLA traffic managers feel that the ASD has proved to be effective as a strategic and tactical tool. It has helped them view their long-range traffic volumes and plan traffic management actions. It has also improved the communications between facilities, removed some of the barriers common to many center operations, and allowed TMUs to deal with "blocks of aircraft." With the installation of the ASD, ZLA stated that there has been an overall improvement in the utilization of their airspace and a reduction in the number of their static restrictions. The static restrictions that they had with ZLC, ZDV and ZAB have been eliminated and existing restrictions with ZOA will be removed. With the installation of ASD, ZLA feels they have more informed and more pro-active controllers and area supervisors in traffic management.

3.3.11 Los Angeles TRACON

The Los Angeles TRACON is responsible for the terminal airspace around Los Angeles International Airport (LAX). The TRACON is organized into two arrival and two departure areas (North and East) which parallel the traffic flows over the primary arrival and departure fixes. LAX has four parallel runways and can handle approximately 120 arrivals and departures per hour. Based on LAX's demand, runway configuration, and weather conditions, the LA-TRACON sets the LAX acceptance rate for ZLA. The TRACON usually runs in-trail spacings of aircraft over the fixes and the general procedures are to discourage "airborne holds." The TRACON would delay departures of commuter and general aviation traffic to avoid "airborne holds" on jet traffic and to relieve overall terminal airspace demand.

The ETMS was recently installed (November, 1991) and was not fully operational at the time of this assessment. Prior to the ETMS installation, the LA-TRACON TMU utilized a Plan View Display (PVD) to monitor traffic flows within the terminal airspace. The TRACON will have two ETMS monitors, one to be used for TMU operations and the other to be used by the area supervisor. The ASD within the TMU will display LAX arrivals with M/A, LAS departures, and SFO departures. The area supervisor's ASD will display all traffic in the LA-basin (with range rings 400 NM from LAX) and monitor in-trail spacings of arrivals for use in the scheduling of controller breaks.

Reception of the ETMS system within the LA-TRACON has been enthusiastic. LA-TRACON traffic managers feel that the ASD will improve their communications and coordination with the ZLA TMU. They see the ASD being used to track traffic 200 miles out (as compared to the current 70 mile range on the PVD) and to identify and reserve "slots" for the sequencing/positioning of aircraft arrivals. They also feel that the ASD will provide them with improved information for managing their traffic,[27] and for planning controller work schedules and training during lull periods.

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[27] Currently, LA-TRACON relies on information provided to them by the ZLA TMU on impending traffic flows. With the ASD, they feel that they can see and verify traffic flows that may not be reported by ZLA.

4. ASSESSMENT OF ETMS INDIRECT BENEFITS

4.1 SUMMARY OF INDIRECT BENEFITS

The ETMS operational assessments, as described in Section 3, identified a number of indirect benefits realized by air carriers, airline passengers and the FAA as a result of the utilization of ETMS in NAS traffic management. Primary areas of indirect benefits identified were:

- Improved planning and coordination of NAS traffic management
- Reduced number of NAS traffic restrictions
- Improved and balanced controller workloads.

For each of these areas, Table 4-1 presents a summary of the types of benefits that have been cited at each of the ten FAA ATC facilities interviewed for this assessment. A summary of these areas follows.

4.2 IMPROVED PLANNING/COORDINATION OF NAS TRAFFIC MANAGEMENT

The ETMS has significantly improved the overall planning and coordination of all NAS traffic management actions within the ATCSCC and the individual ARTCC and TRACON traffic management units (TMUs).

The ETMS has helped to improve the overall communications between the ATCSCC and other ATC facilities, as well as between the individual ARTCC/TRACON TMUs and their first-tier centers. Through improved communications, NAS traffic management actions are more readily accomplished; coordination of daily NAS plans with the major air carriers are improved; and overall understanding and trust between various ATC elements is increased in the management of traffic.

	IMPROVED PLANNING/COORDINATION				REDUCED RESTRICTIONS	BALANCED WORKLOADS
FACILITY	Improved Communications	Improved Information	Improved Planning	Improved Airspace Utilization	Restriction and Delay Reduction	ATC Workloads
ATCSCC	Improved communications with ARTCCs and airlines. Able to offer suggestions on increase capacity utilization.	Receive more information much earlier. No need to rely on ARTCCs word on the traffic counts being handled.	Able to monitor traffic and adjust a day's national traffic plan to current projected demands.		Estimated decrease in statics from 10–15 MIT. Reduced "suprise factor" of being over impacted by high traffic volumes.	"Surprise" factor that contributes to stress is eliminated. Large amount of time needed to get "whole" picture reduced. Unstated value in the amount of work time saved. Estimated at 40–50% for controllers, and 3 times the workload for ATCSCC. "More sophisticated equipment produces more sophisticated users".
ZBW					100 mi of airspace saved daily into JFK.	
NY TRACON	Improved communications with other ARTCCs, and Towers.	Info received 1 hr 45 minutes earlier. No need to rely on other facilities for traffic counts.	Able to estimate streams to fixes, and plan configuration changes as needed for their 3 major airports.	Able to balance operations of various airports and handle more traffic.	Static restrictions eliminated. 31.9% dec in delays – mostly do to the TMU and ASD.	Controllers are able to work at a uniform level of traffic. Controllers time can now be utilized more efficiently.
ZKC	Improved communication and coordination with other ARTCCs, Towers, and ATCSCC.	Seeing long range traffic has helped ZKC be more effective in enroute management. Able to identify specific planes to be rerouted when there is a problem.	Able to confirm decisions based on experience. Weather–caused problems can be more easily handled. Other problems can be spotted, and dealt with quickly.	Airspace utilization improved 10–15%.	All static restrictions (up to 25 MIT) eliminated.	

Table 4-1 Summary of ATMS/ETMS Indirect Benefits

	IMPROVED PLANNING/COORDINATION				REDUCED RESTRICTIONS	BALANCED WORKLOADS
FACILITY	Improved Communications	Improved Information	Improved Planning	Improved Airspace Utilization	Restriction and Delay Reduction	ATC Workloads
ZAU	Increase in understanding and trust between facilities. This increase the management of traffic to benefit both parties. Able to talk intelligently to ZDW and ATCSCC now that they are sharing the same information.	Able to check if planes are on correct routes.	Able to enhance flight plans constantly. Able to see what problem is and make their own judgements and evaluations. Able to relieve gridlock problem and get control of it.	30–40% improvement in airspace utilization. ...due to ETMS and TMU actions. An additional 20–30% improvement is expected. Able to accommodate situations to keep ORD busy.	Less requests for the initiation of ATCSCC ground delays on ORD/MDW traffic. Decrease in MIT by 10–20%. Significant reduction in delays at ORD and MDW.	Less aggravation over too many flights coming in at once. Less manual counting of crafts to insure capacity is not exceded.
Chicago TRACON	Improved communication and coordination of C–90 traffic flows with ZAU.	Have clearer picture of what exactly is going on.	Able to give fix preferences to ZAU for directing future traffic flows.	Terminal airspace utilization improved significantly. Capable of accommidating more traffic with less delays. Some factors are eliminated that may restrict total airport capacity use.	Significant reduction in ORD's airborne holds. ORD arrival restrictions reduced. ORD enrounte static restrictions eliminated.	Less manual counting of crafts over a fix. Able to split controller positions if they are predicted to be overloaded.
ZMA	Improved communication with MIA TRACON and ZJX		Slots for arrivals and departures more easily identified.	Traffic volumes over fixes more balanced. Able to handle an increase in demand more easily.	Static restrictions eliminated. Reduced need for taking delays (arrivals, departures, ground holds) at MIA.	Controller workload more balanced.

Table 4-1 Summary of ATMS/ETMS Indirect Benefits (cont'd)

	IMPROVED PLANNING/COORDINATION				REDUCED RESTRICTIONS	BALANCED WORKLOADS
FACILITY	Improved Communications	Improved Information	Improved Planning	Improved Airspace Utilization	Restriction and Delay Reduction	ATC Workloads
ZAB	Improved communication between ARTCC facilities. "Keeps everyone honest" Disputes between facilities, and ctrlrs and supervisors resolved much more easily.	Able to see projected traffic demand...great help to traffic management. No need to rely on the OAG, which is thought to be unreliable for their purposes.	Able to more efficiently sequence arrivals to PHX. Able to forecast and avoid unnecessary problems.	Able to balance traffic volumes in their busiest sectors.	Intrail restrictions kept to a minimum. Automatic pass—back of restrictions to DEN not necessary. Reduced need of shutting down PHX completely because of weather — therefore saving delays.	More efficient use of work time. Tremendous workloads decreased. Able to better plan for center equipment maintenance, and to schedule controller breaks and training.
ZLA	Improved communication and trust with LA TRACON. Increase in communication between facilities on strategic and tactical plans.	Demand now seen instead of estimated from experience.	Planning actions are being taken (realigning airspace) instead of restrictions being implemented when problems occur. Much more intelligent decisions can be made.	Improved airspace utilization.	Static restrictions with ZLC, ZDC, ZAB eliminated. Existing restrictions with ZOA planned to be removed.	Able to staff sectors more efficiently. Able to distribute workloads more evenly. Area supervisors and controllers are more informed and more proactive in traffic management.
LA TRACON	Projected improvement in communication and coordination with ZLA. Improved relations in dealing with foreign (Mexican) flights (i.e., information on foreign plane location and landing times).	No need to rely on ZLA for information. Able to gather information more easily. Able to retrieve statistical data to backup tactical planning. Can identify emergency crafts.	Invaluable planning tool. Able to more efficiently sectorize airspace.	Improved utilization by increasing ability to reserve "slots" for the sequencing/positioning of aircraft arrivals.		Able to more efficiently schedule controller breaks, work schedules, and training periods.

Table 4-1 Summary of ATMS/ETMS Indirect Benefits (cont'd)

The ETMS also provides more current and reliable information to the TMUs on current traffic counts and projected traffic volumes. This information has enabled the TMUs to monitor long-range traffic streams, to identify emergency crafts, and to support ARTCC/TRACON operations and management with an improved information base on NAS activities and events.

The ETMS supports NAS traffic planning by providing advanced information on projected traffic flows (from filed flight plans) and identifying areas of sector overloads, terminal traffic congestion, and adverse weather. With improved traffic planning information, ARTCC/TRACON TMUs can sequence traffic flows more effectively, adjust traffic loads across sectors, routes and fixes, and anticipate and react to potential traffic problems.

The ETMS has also helped to improve the overall utilization of the NAS enroute and terminal airspace. This has been accomplished by reserving and allocating "slots" for the sequencing and positioning of aircraft, by directing traffic flows over less congested routes and sectors, and by balancing traffic volumes over enroute and terminal area fixes. As a result, the FAA and the NAS users have seen improvements in the NAS enroute and terminal airspace and are able to accommodate increased traffic volumes with less delays.

4.3 REDUCTION IN STATIC RESTRICTIONS

One of the primary benefits of the use of ETMS cited by ATC traffic managers, has been the reduction in the number and magnitude of static "miles-in-trail" restrictions within NAS operations.

The FAA's Facilities Operations Manual[1] defines static restrictions as "ongoing restrictions utilized to manage predictable traffic demands." Static restrictions are further defined as "applying to first-tier facilities, limited to miles-in-trail, and restricted to at least 10 MIT and at most 40 MIT." Static restrictions are initiated by the twenty CONUS centers and the New York TRACON and are reviewed and approved on a monthly basis by FAA/ATM. As stated in this manual, "traffic management

[1] Reference: FAA's Facility Operation and Administration Manual (7210.3J); FAA Air Traffic Rules and Procedures Service; July 25, 1991.

restrictions, by varying degree, represent an impact on NAS users. ....If delays are expected to result from a specific traffic management action, every reasonable attempt will be made to distribute those delays equitably among all flights affected. The goal of traffic management is to make all traffic restrictions dynamic in nature and to eliminate any that are characterized as static."

FAA traffic managers feel that the ETMS has been instrumental in FAA/ATM's efforts to eliminate or reduce the number of static restrictions in NAS operations. With the application of the ETMS, the CONUS centers can monitor impending traffic flows, direct traffic streams over less dense routes and sectors, and sequence aircraft more effectively over terminal airspace arrival fixes. The ETMS has significantly reduced all of the center's reliance on static "miles-in-trail" restrictions as a "safety net" for enroute and terminal airspace congestion.

Over the past two years, there has been nearly a 200% reduction in the number of static restrictions within NAS operations. As shown in Figure 4-1[2] the total number of static restrictions dropped from 191 in December 1989 to a total of 63 restrictions in December 1991. The largest decreases were in the 10 and 15 MIT restrictions.

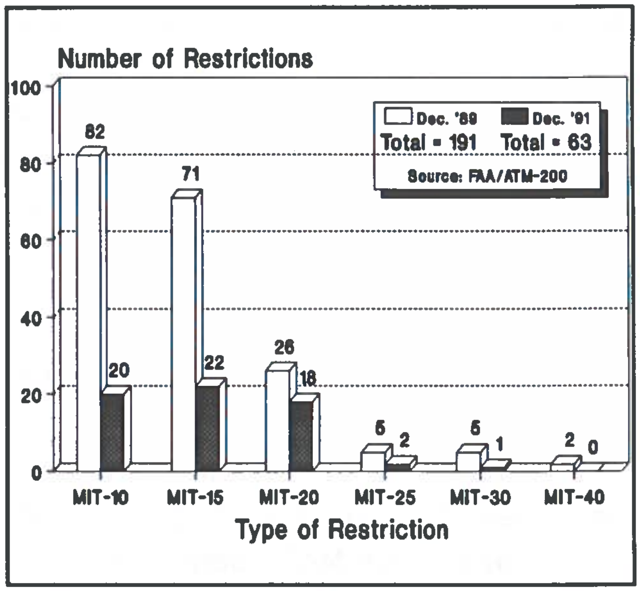

Figure 4-1 FAA/ATM's Static Restrictions

The distribution of the existing static restrictions among the twenty CONUS centers is illustrated in Figure 4-2. As shown, seven centers are the source of all of existing static restrictions (Note: In Fig. 4-2, the ARTCC with the "arrowhead" is the source of the restriction.). Of these seven, 86% of all existing static restrictions originate at four centers (ZAU, ZNY, ZOB and ZID). A summary of the volume and types of static restrictions that exist from the seven CONUS centers is presented in Table D-1 in

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2 Source: FAA Office of Traffic Management (ATM-200). This FAA office served as the source of all static restriction data, as presented in Figures 4-1 and 4-2 and the restrictions data presented in the Appendix D.

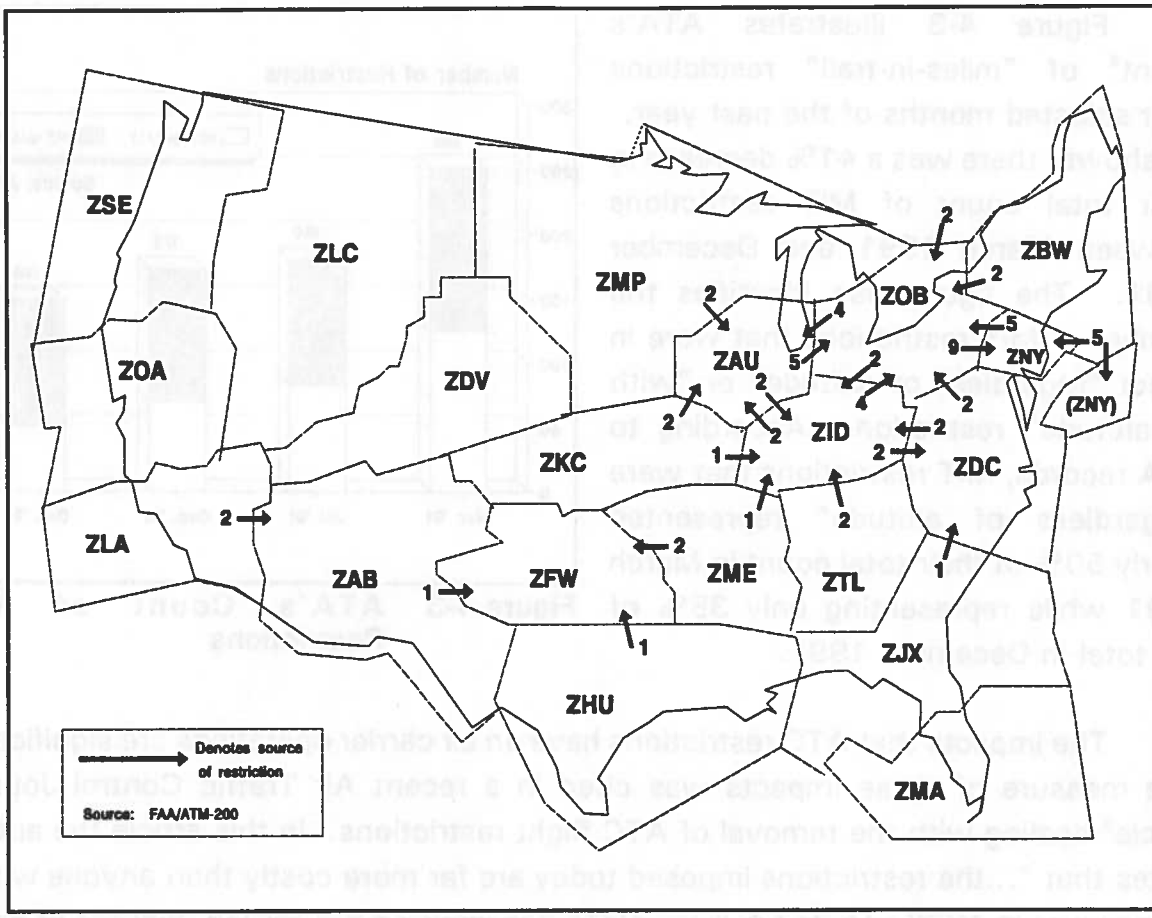

Figure 4-2 Distribution of Current (12/91) FAA Static Restrictions

Appendix D.

The number of static restrictions currently in effect is also of prime concern to the Air Transport Association. The ATA maintains a monthly count of MIT restrictions, approval requests (APREQs), and the number of "no direct flights." There are a number of differences, however, in the manner in which the FAA/ATM and the ATA count "miles-in-trail" restrictions. Primary differences[3] are due to the fact that the ATA records a new restriction count at each occurrence of an altitude change or a time period change when the restriction is in effect.

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[3] As noted from discussions with the ATA, each occurrence of a restriction during the course of a day as a new restriction. For example, if a 20-MIT restriction existed for the time period 0600Z-0900Z and then again from 1300Z-1700Z, this would be counted by the ATA as two 20-MIT restrictions.

Figure 4-3 illustrates ATA's count[4] of "miles-in-trail" restrictions over selected months of the past year. As shown, there was a 41% decrease in their total count of MIT restrictions between March 1991 and December 1991. The figure also identifies the number of MIT restrictions that were in effect "regardless of altitude" or "with an altitude" restriction. According to ATA records, MIT restrictions that were "regardless of altitude" represented nearly 50% of their total count in March 1991 while representing only 35% of the total in December 1991.

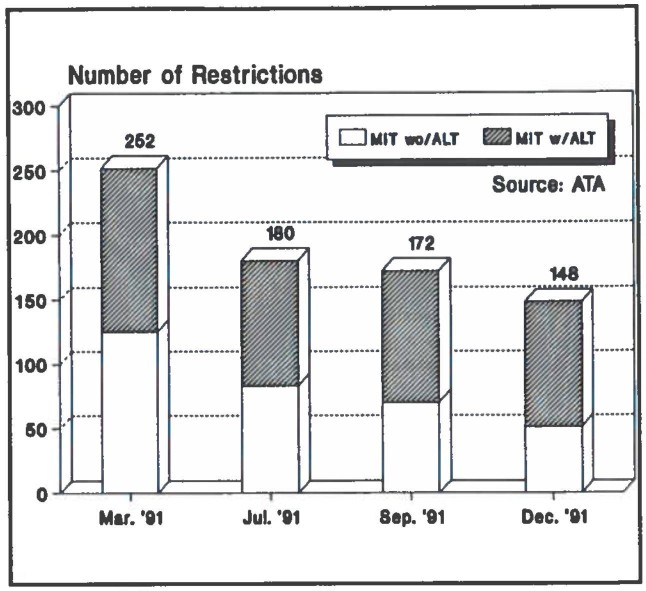

Figure 4-3 ATA's Count of MIT Restrictions

The impacts that ATC restrictions have on air carrier operations are significant. One measure of these impacts was cited in a recent Air Traffic Control Journal article[5] dealing with the removal of ATC flight restrictions. In this article the author states that "...the restrictions imposed today are far more costly than anyone would conceive of in 1968. United Airlines alone has incurred 8.5 million minutes of delay during the last twelve months during taxi and in flight, costing $173 million in direct operating cost. Air traffic imposed an additional 14,600 hours of delay taken at the departure gate. In flight, inefficient routes, altitude assignments and speed restrictions consume an additional $108 million in wasted time and fuels." Further on in the article, the author states that "....."miles-in-trail" restrictions imposed by the Centers form a large part of the total delay picture. As these restrictions are often imposed regardless of altitude, and exist at virtually every Center boundary, the ability of faster aircraft to pass slower ones is frequently lost. This results in inefficient flight for all the aircraft involved - the slow ones are asked to speed up, and the fast ones are taking delay vectors and are often circling to stay behind."

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[4] Source of Data: Air Transport Association. Meeting with D. Schillaci, Director Air Traffic Control System Operations.

[5] "Removing Restrictions to Flight"; Journal of Air Traffic Control, December 1991; William B. Cotton, United Airlines. Article was also presented at the 1991 ATCA conference.

4.4 IMPROVED CONTROLLER WORKLOAD

As a benefit to the FAA, the ETMS has helped FAA traffic managers and area supervisors to manage and balance controller workloads especially within the enroute centers. The ETMS provides the ATC supervisors with projected traffic demands and traffic patterns which enables the supervisors to plan for the reconfiguration or consolidation of sectors for lull periods and to schedule controller breaks and training. During periods of high traffic demand, this advanced information allows ATC supervisors to adjust sector assignments and to staff sectors more efficiently. Benefits derived from ETMS capabilities are improved and balanced controller workloads, the reduction of stress on the controllers, and a more efficient utilization of the controllers' time.

5. ASSESSMENT OF ETMS DIRECT BENEFITS

5.1 ASSESSMENT SCENARIOS

For this assessment, various scenarios were established for evaluating the range of direct benefits of the ETMS system. As cited in Section 2, all direct benefits associated with ETMS operations are referenced to the "baseline scenario," which represents current and projected air carrier operations at the "select-67" airports during the 1990-2005 timeframe. The ETMS evaluation scenarios were established to measure delay savings and the resulting benefits that would be accrued to the airlines and airline passengers as a result of reductions in air carrier delays.

The ETMS evaluation scenarios were structured to address the following two areas:

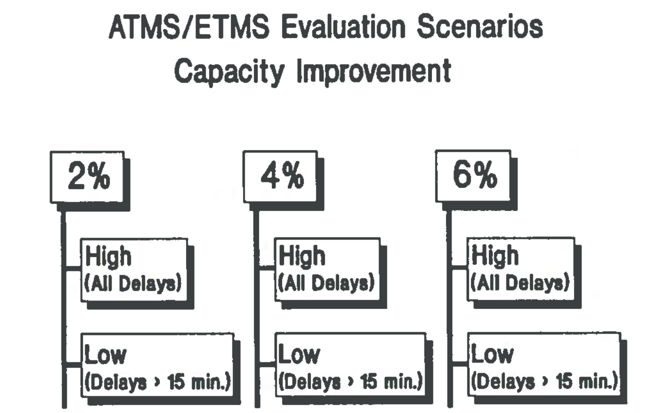
- the expected capacity gains in the terminal and enroute airspace, through improved NAS ETMS traffic management actions.

- and, high and low estimates of the range of direct benefits as they relate to the "value of time" savings for airline passengers.

Table 5-1 illustrates the structure of the ETMS evaluation scenarios considered in this study. Based on the results of the ETMS operational assessments and discussions with NAS traffic managers within the ATCSCC and the various ARTCC/TRACON TMUs, a gain of 2% to 6% in the terminal and enroute airspace capacity was used as the level of improvement in airspace capacity and traffic flow management through ETMS operations. This capacity gain is a direct result of improved ETMS traffic management actions such as reduced static and dynamic "miles in-trail" restrictions, improved metering and sequencing of traffic flows over arrival fixes and within enroute sectors, and through the improved planning and coordination of overall NAS traffic flows between ARTCC and TRACON TMUs and the ATCSCC. The 2%-6% gain in the terminal/enroute airspace capacity was considered, by the NAS traffic managers, to be a conservative estimate of the level of improvement in NAS traffic flows from ETMS operations.

High and low limits were also defined for the ETMS evaluation scenarios based on criteria established on the "value of passenger time savings." A "high estimate" was defined by considering as a benefit the value of passenger time savings on all reductions in passenger delay hours. The "low estimate" considered benefits of passenger time savings on reductions in passenger delay hours for delays that exceed 15 minutes. These high/low limits define an envelope of projected benefits for each of the ETMS evaluation scenarios considered.

Table 5-1 ATMS/ETMS Evaluation Scenarios



5.2 DATA AND METHODOLOGIES

The following subsections identify the principal data, methodologies, and data sources used in this assessment. No attempt is made here to characterize or summarize the results of the analyses performed on this data. Descriptions and summaries of this data are presented in the context of characterizing NAS operations.

5.2.1 Air Travel Forecasts

Forecasts of future air travel demand and operations within the NAS terminal and enroute airspace were obtained from standard FAA aviation forecast documents. The principal sources of this data were:

- FAA Aviation Forecasts; FAA Report FAA-APO-91-1; FAA Office of Policy and Plans; February 1991.
- NAS Terminal Area Forecasts (1991-2005); FAA Report FAA-APO-91-5; FAA Office of Policy and Plans; July 1991.

5.2.2 ATOMS Terminal and Enroute Delays

Data on NAS airport and enroute delays, as reported under the FAA's Air Traffic Operations and Management System (ATOMS), were analyzed and served as the primary source of information on the reported causes and categories of delay within the NAS. The ATOMS data,[1] which is reported daily by controllers and supervisors at 55 major airports and 20 CONUS ARTCCs, represent delays that are incurred on IFR flights in which the reported delay exceeded 15 minutes at the reporting ATC facility. IFR flights that incur delays of less than 15 minutes at any one of the ATC reporting facilities are not recorded under the FAA's ATOMS system.

Within this assessment, the ATOMS data were used to characterize the principal causes and categories of delays. Categories of ATOMS delays include arrival, departure, enroute, and traffic management (TMS) delays. Reported causes of delays are for weather, terminal volume, center volume, equipment, runway closures, and other events. A summary of the 1990 ATOMS data, used in this analysis, is presented in Table A-1 of Appendix A.

5.2.3 ETMS NAS Operations Data

NAS operations data, logged by the ETMS system, were also analyzed and served as the source of data for airport demand/capacity measures, ARTCC enroute sector capacity loads, and flight departure delays. Because of the volume of data and the processing required to condition the ETMS data for analysis, the ETMS logged NAS data were limited to selected airports and for selected time periods. The ETMS data used in this analysis included:

- Airport Demands/Capacities: Data on the number of daily arrivals and departures were analyzed with respect to airport capacities for eleven airports.[2] This data spanned the period from July 1989 - December

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[1] ATOMS data reported by FAA/ATM's select-55 airports and 20 CONUS centers for 1989 and 1990 was used in this analysis. Source of data: FAA Office of Air Traffic Management (ATM).

[2] ETMS logged data was analyzed for eleven airports. The airports were selected, based on geographical location and volume of operations, to be representative of the 67 airports considered in the definition of our "baseline scenario." The airports selected were: Small - Ft.Lauderdale (FLL), Portland (PDX) and Nashville (BNA); Medium - Memphis (MEM), Seattle (SEA), Baltimore (BWI), and Cincinnati (CVG); Large - St.Louis (STL), Dallas/Fort Worth (DFW), Los Angeles (LAX) and Chicago (ORD).

1991. Averages of arrivals and departures were examined with respect to airport capacity threshold limits.

- Airport Departure Delays: Data on airport departure delays that occurred during a period of nine months in 1991 were analyzed for the eleven airports (referenced above). The nature and the time durations of the delayed departures were of primary interest.

- ARTCC Sector Demands/Capacities: Data representing sector track loads and capacity thresholds[3] were analyzed to determine the impact that forecasted ARTCC traffic volumes would have on current sector capacities.

5.2.4 Delay Forecasting Methodology

This assessment utilized an FAA/APO delay forecasting methodology[4] that was formulated based on data reported under the Standardized Delay Reporting System (SDRS)[5] and data reported under the DOT's Airline Service Quality Performance (ASQP)[6] system. The SDRS data define delay as the difference between actual and optimal flight time, as opposed to other measures of delay that represent either the difference between actual and scheduled flight times or delays that are incurred because of problems that are solely under the purview of the airlines (craft

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3 The enroute sector capacities defined within the ETMS logged data represent "alert thresholds" that are defined by the ARTCCs for the Monitor Alert function. These sector capacities may not necessarily represent FAA ATC "Operational Acceptable Level of Traffic (OALT)" capacity thresholds that are established for the various enroute sectors.

4 The development of the FAA/APO delay projection methodology was originally based on work by Safeer and Geisinger. References: "Airfield and Airspace Capacity/Delay Policy Analysis;" Safeer, et.al.; FAA Report APO-81-14. and "Predictions of Airline Delay - 1997;" Geisinger FAA Office of Aviation Policy and Plans; December 1988.

5 The SRDS delay data was reported to the FAA/APO by three airlines for the period 1976-1986. At that time, these airlines represented approximately 25% of all U.S. air carrier operations.

6 The DOT's ASQP delay reporting system captures airline delays since 1987 from almost all U.S. domestic carriers and is reported with respect to operations at over 90 of the largest airports in the U.S.

maintenance, crew availability, etc.). The ASQP data represent airline delays as the difference between actual and scheduled (OAG, CRS) flight times.

The SDRS/ASQP data were used by FAA/APO to develop regression coefficients for airport-specific delay forecasting equations and/or delay projection techniques. This methodology is used and serves as the basis for FAA delay projections, such as those presented in the FAA's Aviation System Capacity Plan[7]

The FAA/APO delay forecasting equations relate an airport's current (or projected) volume of operations to its capacity to service that volume of traffic. Operations are defined as the total number of annual arrivals plus departures at each airport. Capacity is defined by the term "annual service volume (ASV)"[8] which is a composite measure of an airport's capacity to service an annual volume of traffic.

Table 5-2 defines the general forms of the delay forecasting equations. A summary of the delay projections for each of the "select 67" airports of the baseline scenario is presented in Table A-2 of Appendix A.

Table 5-2 Delay Forecasting Equations

form 1 delay_f = delay_w * [(1/(2.13-(OPS/ASV)) / (1/(2.13-(OPS_w/ASV_w))]

form 2 delay_f = delay_w * [(OPS/ASV)/(OPS_w/ASV_w)]

form 3 delay_f = a * [1/(2.13 - (OPS/ASV))] + (b * T) + c

where:

delay_f	= forecasted delay (min./operation)
delay_w	= weighted average delay (1987-1990)
OPS_w	= weighted operations (1987-1990)
ASV_w	= weighted ASV (1987-1990)
OPS	= forecast year annual operations
ASV	= forecast year ASV
T	= year variable
a,b,c	= regression coefficients

Figure 5-1 illustrates the weighted average forecasted delay per operation for all airports within the "baseline scenario." Over a 15 year period (1990-2005), the average delay per operation is projected to increase at an average rate of approximately 2% per year from an average delay of 7.8

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[7] Reference: "1990-1991 Aviation System Capacity Plan;" Report: DOT/FAA/SC -90-1; Federal Aviation Administration's Office of System Capacity (ASC); September 1990.

[8] The term "annual service volume" (ASV) is a composite measure of an airport's capacity. Its value is established by the FAA's Airports Office as defined in FAA Advisory Circular AC 150/5060-5. ASV reflects an airport's capacity to service an annual volume of traffic under varying runway configurations, mix of traffic, and levels of IFR/VFR operations.

minutes/operation in 1990 to 10.1 minutes/operation in 2005.

A comparison was made of the projected annual delay-hours for the "baseline scenario" airports with a similar projection made within the FAA's Aviation System Capacity Plan. The results of which are shown in Figure 5-2. Both the "baseline scenario" projections of this assessment and the projections made within the FAA's Aviation Capacity Plan indicate that the number of airports that will have annual delay hours in excess of a 100 thousand hours will increase from one airport (ORD) in 1990 to four airports (ORD, DFW, ATL and DEN) in the 2000-2005 time period. Also, the number of airports that are projected to have annual delay hours in the range of 50K-99K hours will double in the years 2000-2005 as compared to the number of airports that will experience such delays in the 1990-1995 timeframe. The FAA/APO and the "baseline scenario" projections of annual delay hours also show that approximately 18-20 airports are forecasted to have annual delay hours in the range of 20K-49K hours.

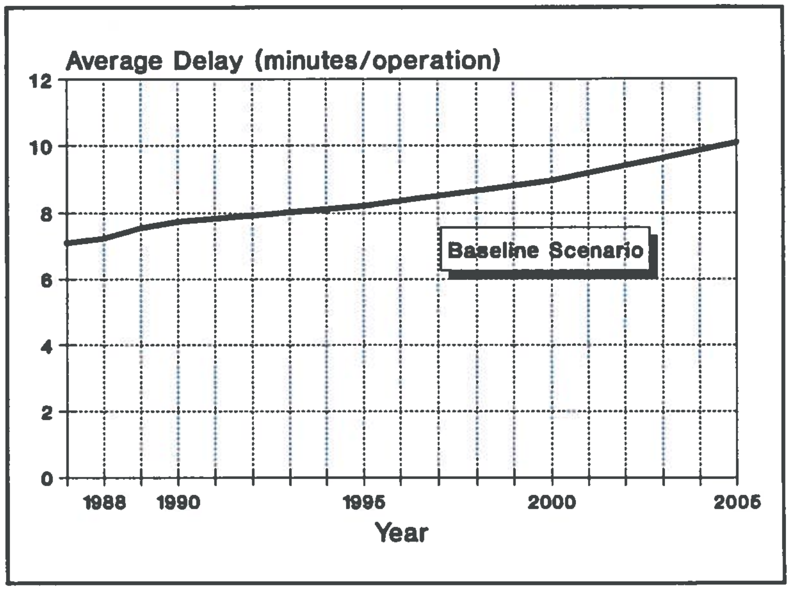

Figure 5-1 Weighted Average Delay

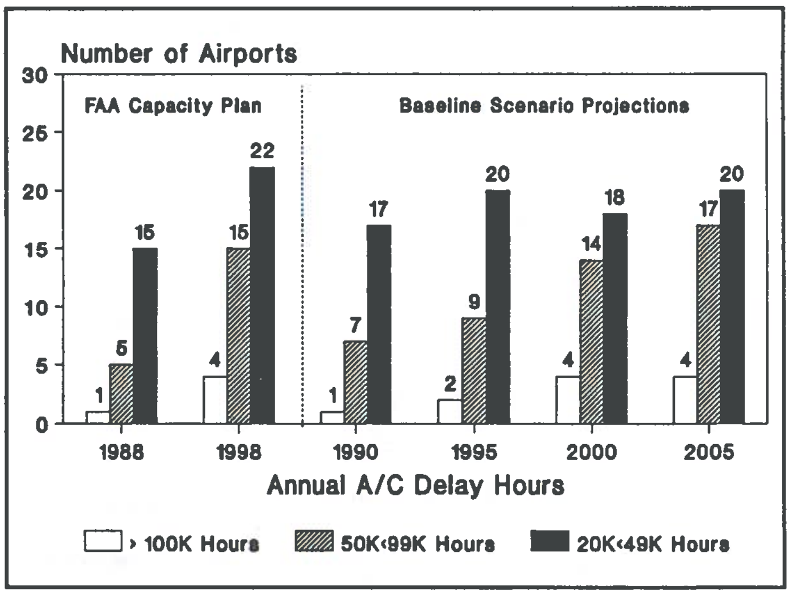

Figure 5-2 Baseline Scenario Projections

5.2.5 Economic Cost Factors

The primary cost factors used in this assessment were measures of passenger time savings and air carrier operating costs for fuel, crews, and aircraft maintenance.

Data representing the value of passenger time savings was obtained from standard FAA economic cost data sources[9] and adjusted to current 1990 dollars. A value of $29 per passenger hour (adjusted 1990-$) was used in this assessment. This value represents a weighted average mix of business and leisure travel on domestic air carriers. Using this value, the passenger value of time savings per craft-hour was determined based on forecasts[10] of the projected domestic air carrier craft sizes, and passenger load factors in the 1990-2005 timeframe. Table 5-3 lists the projected air carrier craft loadings and the corresponding passenger value of time savings per craft-hour for the 1990-2005 timeframe. As shown, passenger loadings per craft are projected to increase by 21% between 1990 and 2005, due primarily to increased travel demand and the utilization of larger aircraft by the airlines to accommodate this demand. The corresponding value of passenger time per craft-hour (in 1990-$) is projected to range from $2.7K/craft-hour in 1990 to $3.3K/craft-hour in 2005.

Table 5-3 Passenger Value of Time

Year	Passenger Loading/Craft	Value PAX Time 1990$/craft-hour
1990	92.2	2,696.
1995	95.9	2,804.
2000	106.4	3,110.
2005	111.3	3,255.

Through ETMS operations, this assessment considered the cost of air carrier operations as one of the principal benefits accrued to the airlines are a result of reductions in NAS delays and improved utilization of the NAS airspace. The primary costs of air carrier operations are costs for fuel, crews, and craft maintenance. Table 5-4 presents these costs per aircraft block-hour (in 1990 dollars) for the various craft

9 "<u>Economic values for the Evaluation of FAA Investment and Regulatory Programs</u>;" FAA Office of Policy and Plans Report FAA-APO-89-10; October 1989.

10 FAA Aviation Forecasts; FAA Report FAA-APO-91-1; FAA Office of Policy and Plans; February 1991.

sizes. These unit costs were obtained from FAA data[11] and reflect US air carrier domestic fleet operations. As shown, the cost per aircraft block hour can more than double depending on the size of the craft. Domestic air carrier operating costs can range from $1.1K/craft-hour for a 2-engine narrow body jet to as high as $3.8K/craft-hour for a 4-engine wide body jet. This assessment considered the projected mix of craft sizes of the US domestic carrier fleet in determining a weighted average operating cost for air carriers for the 1990-2005 time period. These air carrier unit operating costs are also shown in Table 5.4.

Table 5-4 Air Carrier Operating Costs

	($1990/A-C Block-hour)			
Craft Type	**Fuel**	**Crew**	**Maint.**	**Total**
4 engine-wide	2093.	905.	791.	3790.
3 engine-wide	1371.	722.	687.	2779.
2 engine-wide	902.	559.	424.	1885.
4 engine-narrow	790.	556.	371.	1718.
3 engine-narrow	752.	514.	247.	1513.
2 engine-narrow	489.	366.	209.	1064.
	Weighted A/C Operating Costs (all craft) ($1990/craft block-hour)			
	Fuel	**Crew**	**Maint.**	**Total**
1990	742.	481.	302.	1525.
1995	706.	461.	293.	1460.
2000	700.	454.	295.	1449.
2005	700.	453.	299.	1452.

5.3 DELAY SAVINGS

Delay savings, as a result of terminal and enroute airspace gains through ETMS operations, were measured as reductions in annual air carrier delay hours with respect to the "baseline scenario" within the 1990-2005 timeframe. Reductions in annual delay hours from the "baseline scenario" were developed by adjusting the "annual service volume" of the "select -67" airports to represent the projected capacity gain in the terminal and enroute airspace. Through the delay forecasting process (defined within Section 5.2.4), reductions in average delays per air carrier operation were developed. These average delays (measured in minutes/air carrier operation), when applied to the projected volume of future air carrier operations, represent the annual delay hours for the scenario under consideration.

[11] Data source: see reference in footnote 18.

Figure 5-3 illustrates the projected annual air carrier delay hours of the "baseline scenario" and a representative reduction in annual delay hours, assuming a 4% capacity gain in the terminal/enroute airspace. As shown for the "baseline scenario," air carrier delay hours are projected to increase by 89%, over the fifteen year period, from a level of 1.437 million delay-hours in 1990 to 2.716 million delay-hours in the year 2005. During this period, air carrier delay hours of the "baseline scenario" increased at an average annual rate of 6% between 1990-1995 and an average annual rate of 4.5% between 1995 and 2005. The average delay per air carrier operation, under the "baseline scenario," ranged from 7.8 minutes/operation in 1990 to 10.1 minutes/operation in the year 2005.

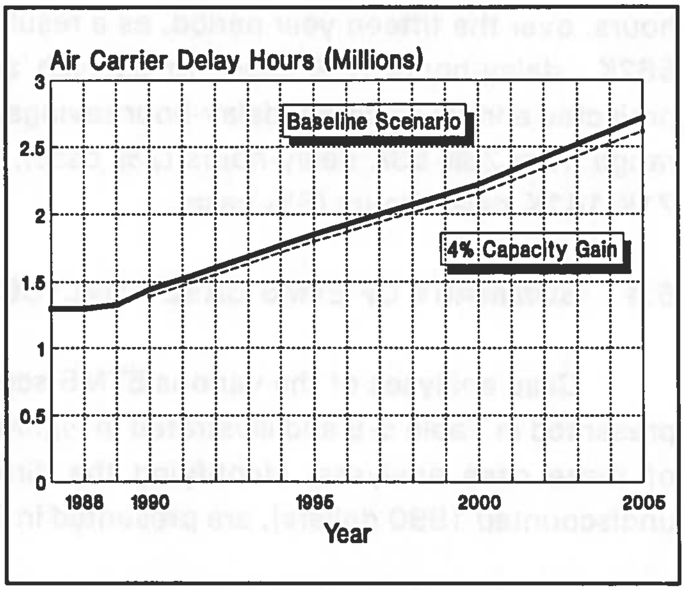

Figure 5-3 Projected Delay Hours for Baseline Scenario

As shown in Figure 5-3, an assumed 4% capacity gain in the terminal/enroute airspace yields an approximate 3.1% reduction in annual delay-hours over the "baseline scenario." Using this assumption, the annual delay-hour savings ranged from 49.1K delay-hours in 1990 to 101.3K delay-hours in 2005. The average delay per air carrier operation ranged from 7.5 minutes/operation in 1990 to 9.7 minutes/operation in the year 2005.

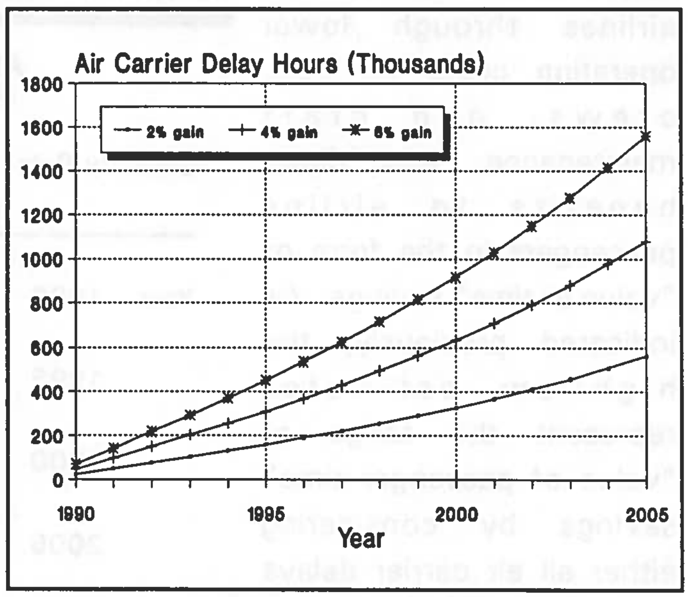

Figure 5-4 ETMS Cumulative Delay Hour Savings

Figure 5-4 presents the cumulative savings in air carrier delay hours over the 1990-2005 period for the ETMS scenarios representing airspace capacity gains of 2%, 4%, and 6%. As shown, the projected cumulative savings in air carrier delay hours, over the fifteen year period, as a result of ETMS operations would range from 562K delay-hours (2% case) to as high as 1.6M delay-hours (6% case). The projected annual air carrier delay-hour savings, for each of the ETMS scenarios, would range from 26K-53K delay-hours (2% case), 49K-101K delay-hours (4% case), and 71K-141K delay-hours (6% case).

5.4 SUMMARY OF ETMS CASE ANALYSES

Case analyses of the various ETMS scenarios were conducted. The results are presented in Table 5-5 and illustrated in Figures 5-5 through 5-7. Detailed summaries of these case analyses, identifying the direct ETMS benefits (in discounted and undiscounted 1990 dollars), are presented in Tables C-1, C-2 and C-3 of Appendix C.

These cases represent the direct ETMS benefits, as a result of reductions in air carrier delay hours, under the projected terminal and enroute capacity gains of 2%, 4%, and 6% from the "baseline scenario." These benefits, measured in undiscounted 1990 dollars, represent direct cost savings to airlines through lower operating costs for fuel, crews, and craft maintenance, and direct benefits to airline passengers in the form of "value of time" savings. As indicated previously, the high/low estimates represent the range of "value of passenger time" savings by considering either all air carrier delays (high estimate) or only air carrier delays that exceed 15 minutes of delay (low estimate).

Table 5-5 Summary of ETMS Annual Direct Benefits

ATMS/ETMS Direct Benefits
(Millions 1990 $, undiscounted)

Capacity Gain		2 %		4 %		6 %	
		Low	High	Low	High	Low	High
Year	1990	63.2	108.0	121.2	207.1	174.8	298.8
	1995	69.0	120.3	133.6	233.2	194.5	339.5
	2000	93.7	168.1	180.3	323.6	260.8	468.1
	2005	138.4	251.0	262.8	476.9	376.1	682.8

Table 5-5 presents a summary of the annual direct benefits, as measured in undiscounted 1990 dollars, for each of the ETMS scenarios for selected years in the 1990-2005 timeframe. The cumulative direct benefits for each of the ETMS scenarios over the fifteen year analysis period are shown in Table 5-6.

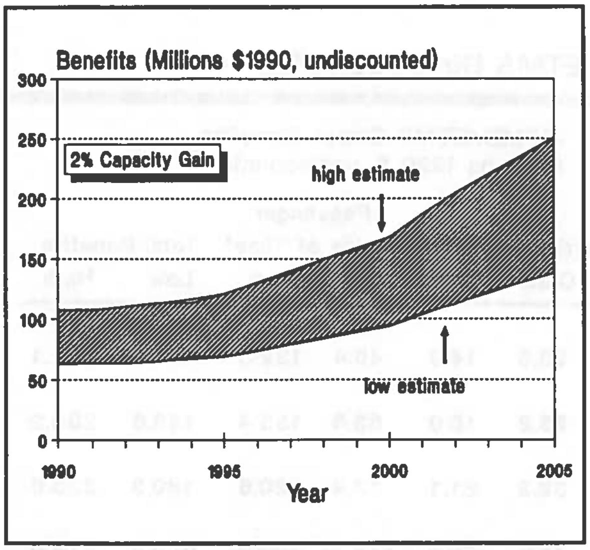

Figure 5-5 ETMS 2% Capacity Gain Direct Benefits

Table 5-6 ETMS Cumulative Direct Benefits

Cumulative Direct Benefits 1990-2005 (Millions 1990$, undiscounted)			
Capacity Gain:	2 %	4 %	6 %
Low	$1,417.6	$2,720.6	$3,928.1
High	$2,517.7	$4,833.2	$6,979.8

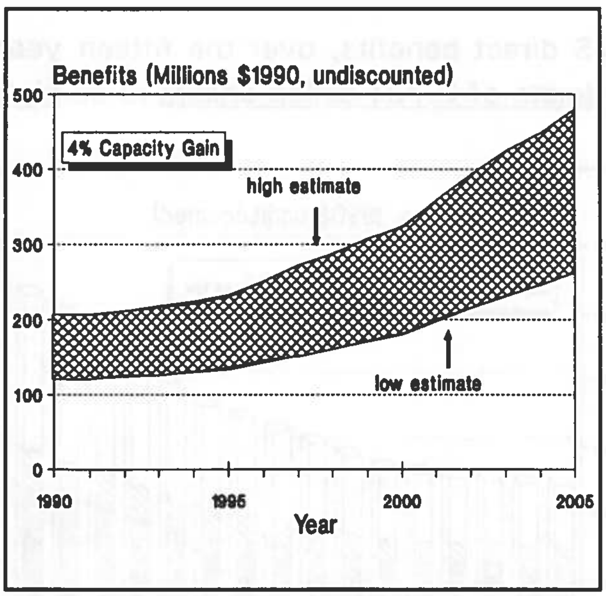

Figure 5-6 ETMS 4% Capacity Gain Direct Benefits

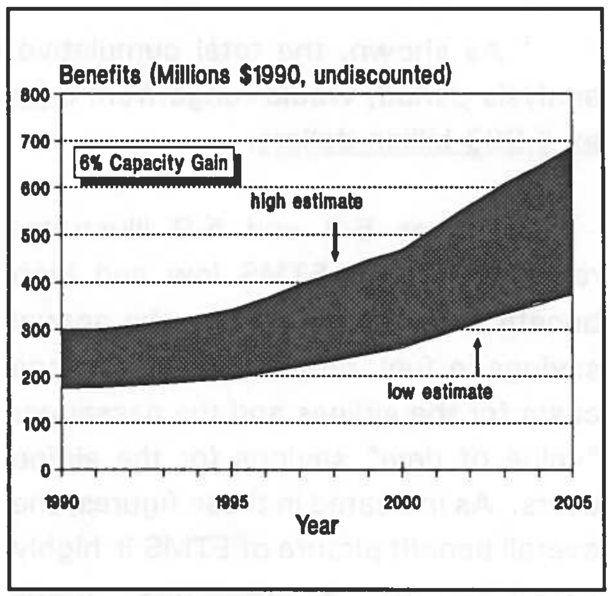

Figure 5-7 ETMS 6% Capacity Gain Direct Benefits

5.5 ESTIMATED ETMS DIRECT BENEFITS

For this assessment, the ETMS scenario, representing a 4% capacity gain in the terminal and enroute airspace, was selected as the most likely range of direct benefits to be accrued by ETMS operations. Table 5-7 presents a summary breakdown of the direct benefits to be realized by the airlines and airline passengers over the 1990-2005 timeframe as a result of ETMS operations.

Table 5-7 ETMS Direct Benefits

ATMS/ETMS Direct Benefits
(Millions 1990 $, undiscounted)

	Air Carrier Benefits			Passenger "Value of Time"		Total Benefits	
	Fuel	Crew	Maint.	Low	High	Low	High
1990	36.4	23.6	14.8	46.4	132.3	121.2	207.1
1995	38.6	25.2	16.0	53.8	153.4	133.6	233.2
2000	49.6	32.2	21.1	77.4	220.6	180.3	323.6
2005	70.9	45.9	30.3	115.7	329.8	262.8	476.9
				Cumulative 1990-2005		2,720.6	4,833.2

As shown, the total cumulative ETMS direct benefits, over the fifteen year analysis period, would range from a <u>low estimate of 2.721 billion dollars</u> to as <u>high as 4.883 billion dollars</u>.

Figures 5-8 and 5-9 illustrate, respectively, the ETMS low and high benefit estimates indicating the annual savings in fuel, crew and maintenance costs for the airlines and the passenger "value of time" savings for the airline users. As indicated in these figures, the overall benefit picture of ETMS is highly sensitive to assumptions made concerning the "value of time" savings. Within the low estimate of ETMS benefits, benefits accrued by the air carriers account for approximately 58% of the total accumulated benefits with the remaining 42% representing

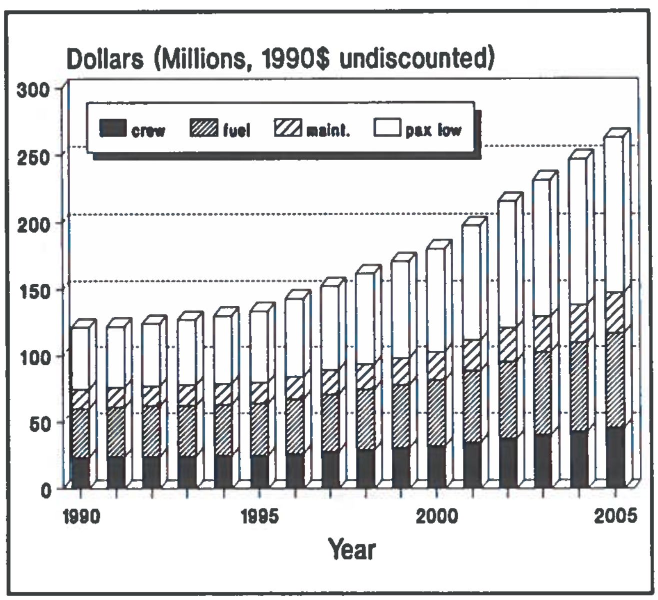

Figure 5-8 ETMS Direct Benefits - low estimate

benefits to airline passengers in "value of time" savings. For the ETMS high benefit estimate, air carrier benefits represent only 33%, while the "value of time" savings for airline passengers represent 67% of the total accumulated direct benefits.

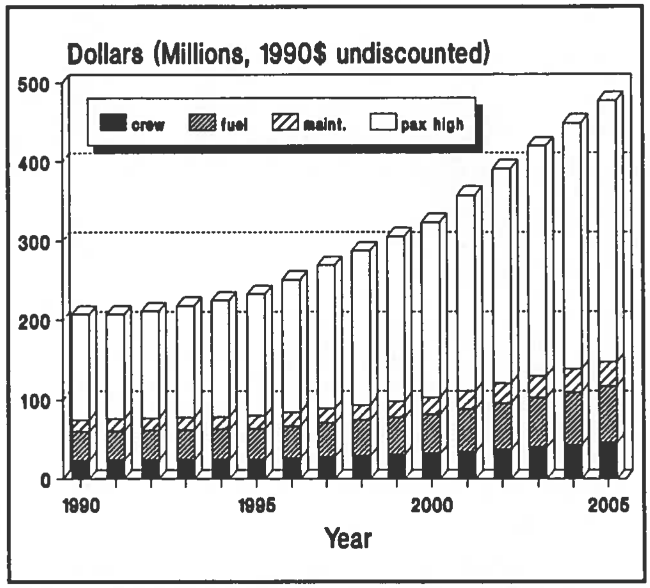

Figure 5-9 ETMS Direct Benefits - high estimate

Figure 5-10 illustrates the annual ETMS benefit stream over the 1990-2005 time period, as expressed in constant, discounted 1990 dollars. These benefit values were discounted to current year (1990) dollars using the OMB recommended discount rate of 10%.

As shown, the total accumulated direct benefits of ETMS, as expressed in constant 1990, discounted dollars over the fifteen year analysis period, would range from $1.192 billion (for the low estimate) to $2.095 billion (for the high estimate).

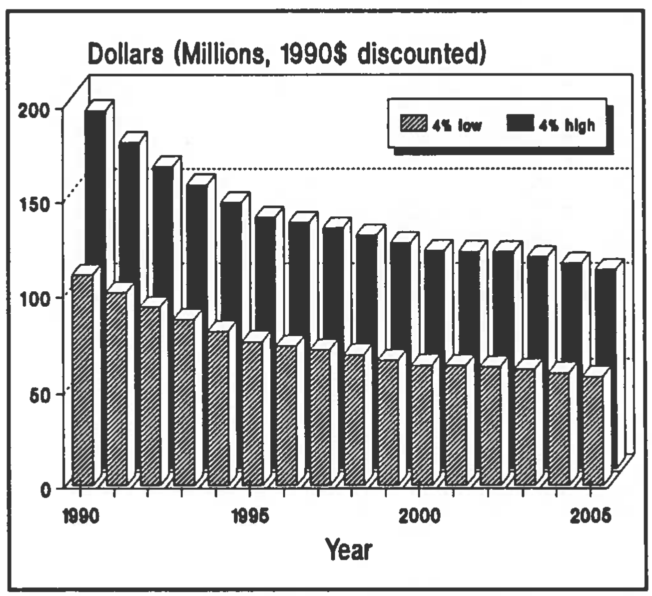

Figure 5-10 ETMS Direct Benefits (Annual, discounted 1990$)

APPENDIX A

	Categories of Delays				Causes of Delays						Total Delays per Air Carrier Operation		
Airport	Arrival	Departure	Enroute	TMS	Weather	Term. Volume	Center Volume	Equip.	Rwy/Clsr	Other	Total 90 Delays	A/C Operations	Delays/ (K)AC Opns.
1 ABQ	60	99	0	77	165	55	0	4	3	9	236	70,055	3.4
2 ANC	86	104	0	243	176	247	0	4	0	6	433	96,518	4.5
3 ATL	10,557	6469	0	17,739	27,210	6,733	2	290	357	180	34,765	581,709	59.8
4 BDL	119	420	6	146	462	118	0	53	41	17	691	68,234	10.1
5 BNA	112	245	0	91	292	93	0	16	38	9	448	111,050	4.0
6 BOS	1,887	4103	0	8,479	9,502	3,649	0	254	57	1,007	14,469	246,067	58.8
7 BWI	166	4459	3	689	1,453	2,499	12	164	996	193	5,317	156,774	33.9
8 CLE	165	612	0	511	812	244	4	13	145	70	1,288	153,543	8.4
9 CLT	1,100	1377	0	3,198	3,405	2,016	0	162	31	59	5,675	243,829	23.3
10 CVG	100	1476	0	1,735	1,712	1,444	12	36	34	75	3,313	136,166	24.3
11 DAY	28	174	0	90	163	67	0	9	15	18	292	102,419	2.9
12 DCA	266	2379	0	369	1,785	902	5	158	119	65	3,034	195,766	15.5
13 DEN	3,615	3982	0	6,409	11,482	2,108	0	198	22	191	14,006	305,807	45.8
14 DFW	2,346	14061	0	7,014	14,504	8,385	0	153	251	146	23,441	546,513	42.9
15 DTW	1,360	2408	0	3,938	4,321	2,477	8	199	622	79	7,706	276,825	27.8
16 EWR	1,939	19337	0	11,676	16,226	13,507	13	200	1,214	1,792	32,952	276,541	119.2
17 FAI	12	0	0	39	24	26	0	0	1	0	51	13,663	3.7
18 FLL	47	486	0	149	513	85	47	31	0	6	682	98,870	6.9
19 HNL	21	35	0	111	9	102	0	0	54	2	167	194,429	0.9
20 HOU	162	947	0	151	1,156	69	3	8	7	17	1,260	123,217	10.2
21 HPN	92	307	0	71	353	72	0	2	24	19	470	6,154	76.4
22 IAD	146	1045	0	636	1,043	618	1	119	34	12	1,827	125,520	14.6
23 IAH	354	3168	0	445	2,420	1,191	0	64	253	59	3,987	216,232	18.4
24 IND	35	54	0	89	98	50	0	24	4	2	178	114,465	1.6
25 JFK	1,408	15447	0	6,050	11,671	9,197	7	337	508	1,185	22,905	215,161	106.5
26 LAS	5	344	0	136	128	215	4	21	108	9	485	202,737	2.4
27 LAX	68	1339	0	3,430	1,569	2,928	3	210	33	94	4,837	452,248	10.7
28 LGA	2,345	19856	0	9,127	12,172	17,634	6	266	703	547	31,328	272,274	115.1
29 MCI	30	274	0	71	283	68	4	16	1	3	375	110,272	3.4
30 MCO	333	1332	0	390	1,747	202	0	27	0	79	2,055	183,951	11.2
31 MDW	430	2753	0	1,927	2,777	1,738	7	118	41	429	5,110	130,781	39.1
32 MEM	138	492	0	349	708	205	21	6	33	4	979	182,058	5.4
33 MIA	247	3638	0	223	2,674	1,121	2	67	83	141	4,108	280,315	14.7
34 MSP	1,781	7514	0	2,633	4,126	824	0	7	1,699	5,272	11,928	228,499	52.2
35 MSY	112	118	0	62	223	61	0	2	5	1	292	98,319	3.0
36 OGG	5	22	0	1	5	1	0	0	4	18	28	56,476	0.5
37 ONT	5	168	3	17	94	88	2	3	2	4	193	89,263	2.2
38 ORD	4,683	9988	0	37,578	28,174	21,353	32	517	444	1,731	52,249	627,682	83.2
39 PBI	37	167	0	126	239	52	0	31	0	8	330	57,790	5.7
40 PDX	105	212	0	43	216	21	0	101	16	6	360	97,955	3.7
41 PHL	1,913	5204	2	7,470	7,940	4,794	66	136	1,186	467	14,589	229,965	63.4
42 PHX	51	3262	0	1,602	1,174	2,653	97	94	837	60	4,915	295,360	16.6
43 PIT	425	889	0	1,983	1,564	1,361	0	187	151	34	3,297	257,902	12.8
44 RDU	173	285	0	214	484	134	10	14	12	18	672	123,709	5.4
45 SAN	20	1237	0	107	423	867	0	1	37	36	1,364	132,708	10.3
46 SAT	45	89	0	22	133	29	1	0	2	1	166	81,467	2.0
47 SEA	1,886	3167	0	5,724	7,667	1,982	40	70	748	290	10,777	192,426	56.0
48 SFO	1,984	4021	0	14,195	13,471	5,956	4	212	242	301	20,200	318,687	63.4
49 SJC	27	1312	0	2,253	404	3,038	0	48	19	83	3,592	95,938	37.4
50 SJU	0	58	1	14	15	30	11	8	6	3	73	67,622	1.1
51 SLC	266	226	0	462	676	154	0	15	89	20	954	150,700	6.3
52 STL	1,620	1599	0	7,840	8,525	2,247	0	86	82	119	11,059	281,125	39.3
53 TPA	134	746	0	266	1,018	104	0	15	0	9	1,146	134,683	8.5
Total	45,071	153,558	15	168,410	209,586	125,836	424	4,798	11,413	15,005	367,054	10,108,441	36.3
% of Total Delays	12.3%	41.8%	0.004%	45.9%	57.1%	34.3%	0.1%	1.3%	3.1%	4.1%			

Table A-1 Summary of 1990 ATOMS Data

	AIRPORT			AVERAGE DELAY per AIR CARRIER OPERATION (minutes/operation) 1987	1988	1989	1990	1995	2000	2005
1	Albuquerque	ABQ	form2	5.70	5.60	5.80	6.45	8.72	9.94	11.79
2	Anchorage	ANC	form3	7.80	7.40	7.30	7.22	6.97	6.87	6.91
3	Atlanta	ATL	form3	7.50	7.90	8.00	8.45	10.44	11.97	13.79
4	Austin	AUS	form2	3.60	3.50	3.60	3.32	4.59	3.45	3.89
5	Windsor Locks	BDL	form2	6.70	6.80	7.20	7.52	11.19	12.64	14.06
6	Nashville	BNA	form3	6.30	6.70	7.10	6.10	6.44	7.32	8.80
7	Boston	BOS	form3	8.60	8.80	9.10	9.33	10.64	11.95	13.26
8	Buffalo	BUF	form2	4.00	4.10	4.40	4.46	5.07	5.51	5.98
9	Burbank	BUR	form3	6.00	5.80	5.90	5.80	5.82	5.84	5.86
10	Baltimore	BWI	form2	6.70	6.60	7.20	7.34	7.15	9.21	10.38
11	Cleveland	CLE	form3	4.90	5.30	5.80	5.77	7.14	8.31	9.64
12	Charlotte	CLT	form2	5.40	5.70	6.30	6.29	5.44	5.32	5.77
13	Columbus	CMH	form2	5.20	5.40	5.70	5.88	6.78	6.80	7.38
14	Cincinnati	CVG	form2	6.30	6.40	6.80	7.41	10.50	10.53	11.89
15	Dayton	DAY	form2	6.60	6.80	7.30	7.53	9.24	10.39	11.54
16	Washington	DCA	form1	7.20	7.20	7.70	7.84	9.08	9.96	10.84
17	Denver	DEN	form3	8.60	8.60	8.50	11.83	7.60	9.51	11.37
18	Dallas/Ft.Worth	DFW	form3	8.30	8.40	8.80	8.77	7.96	9.64	12.32
19	Detroit	DTW	form2	6.60	6.80	7.50	7.34	7.25	7.68	8.11
20	El Paso	ELP	form1	4.00	3.90	3.90	4.26	5.62	5.18	6.46
21	Newark	EWR	form2	10.00	10.90	11.10	11.21	12.37	12.89	13.44
22	Ft Lauderdale	FLL	form2	5.40	5.70	6.00	5.96	6.83	7.53	8.46
23	Honolulu	HNL	form2	9.50	9.20	8.50	9.32	10.45	7.57	8.00
24	Houston	HOU	form3	5.80	5.40	5.50	5.64	6.31	7.05	7.92
25	Washington	IAD	form2	7.70	7.80	8.40	8.74	11.75	13.01	14.11
26	Houston	IAH	form3	6.30	6.20	6.30	6.40	6.52	7.08	7.76
27	Indianapolis	IND	form2	5.40	5.60	6.00	5.75	5.83	6.83	7.83
28	Jacksonville	JAX	form1	4.20	4.30	4.40	4.52	4.10	4.23	4.36
29	New York	JFK	form1	11.80	12.50	14.00	13.73	14.85	16.18	17.85
30	Las Vegas	LAS	form3	5.00	4.80	4.90	7.38	5.85	8.07	10.70
31	Los Angeles	LAX	form3	8.20	7.80	8.00	7.91	8.09	8.19	8.57
32	New York	LGA	form2	9.30	10.00	11.50	11.51	11.51	11.51	11.51
33	Kansas City	MCI	form2	6.30	6.30	6.40	7.04	6.42	7.91	9.39
34	Orlando	MCO	form3	6.30	6.70	6.90	7.25	9.01	9.76	11.58
35	Memphis	MEM	form2	5.30	5.30	5.50	5.40	5.53	5.64	6.15
36	Miami	MIA	form3	6.40	6.70	7.00	7.27	8.66	10.07	11.48
37	Milwaukee	MKE	form3	5.80	5.80	6.40	6.33	7.22	8.22	9.24
38	Minneapolis	MSP	form1	7.40	7.60	7.90	6.31	7.15	8.01	9.15
39	New Orleans	MSY	form2	4.60	4.70	4.80	4.81	4.85	5.27	5.97
40	Oakland	OAK	form2	4.40	4.30	4.40	4.50	5.16	5.72	6.29
41	Kahului	OGG	form2	5.10	4.30	3.80	4.44	5.29	5.67	6.00
42	Oklahoma City	OKC	form3	4.50	4.50	4.60	4.72	5.41	6.14	6.92
43	Ontario	ONT	form3	5.90	5.60	5.60	5.20	5.54	5.17	5.18
44	Chicago	ORD	form3	9.50	10.20	11.10	10.95	12.92	14.89	16.86
45	Norfolk	ORF	form2	4.50	4.80	5.00	4.88	5.94	6.02	6.77
46	W. Palm Beach	PBI	form2	5.30	5.80	6.00	5.94	6.29	5.91	6.11
47	Portland	PDX	form2	5.50	5.60	5.60	5.75	5.60	5.96	6.31
48	Philadelphia	PHL	form2	7.60	8.00	8.20	8.97	8.78	9.22	10.53
49	Phoenix	PHX	form2	6.20	6.10	6.20	6.37	7.16	7.78	8.41
50	Pittsburgh	PIT	form3	6.20	6.50	6.70	6.80	7.75	8.72	9.69
51	Raleigh-Durham	RDU	form3	6.30	6.50	7.00	6.86	7.87	6.38	6.62
52	Reno	RNO	form2	5.20	5.00	5.00	5.60	7.70	10.33	12.34
53	Rochester	ROC	form2	5.30	5.30	5.60	5.90	5.53	6.44	7.32
54	Fort Myers	RSW	form2	3.50	4.00	4.20	4.11	4.56	5.50	6.51
55	San Diego	SAN	form2	5.90	5.70	5.80	5.99	6.79	7.52	8.20
56	San Antonio	SAT	form3	4.00	4.10	4.40	4.24	4.39	4.78	5.29
57	Seattle	SEA	form2	6.90	6.90	7.10	7.01	7.65	8.26	8.71
58	San Francisco	SFO	form2	8.60	8.10	8.40	8.36	9.18	9.33	9.87
59	San Jose	SJC	form3	5.20	5.10	5.50	5.77	8.64	12.05	17.08
60	Salt Lake City	SLC	form2	6.60	6.80	6.70	6.91	4.50	4.96	5.40
61	Sacramento	SMF	form2	4.30	4.20	4.40	4.81	3.83	4.27	4.70
62	Santa Ana	SNA	form3	7.60	7.50	7.40	7.85	8.52	9.18	9.85
63	St Louis	STL	form3	8.10	8.40	8.70	8.68	9.50	10.32	11.14
64	Syracuse	SYR	form2	4.90	4.80	5.10	5.26	5.30	5.95	6.61
65	Tampa	TPA	form2	4.80	5.10	5.30	4.95	4.34	4.83	5.31
66	Tulsa	TUL	form2	4.40	4.30	4.40	4.57	5.39	6.26	7.16
67	Tucson	TUS	form2	4.10	4.00	4.10	4.47	6.79	6.71	8.20

Table A-2 Summary of Delay Projections for "Select 67" Airports

APPENDIX B

TABLE **PAGE**

PROJECTED ARTCC ANNUAL OPERATIONS
(THOUSANDS)

CENTER		FY 1990 AC	FY 1990 AT	FY 1990 GA	FY 1990 MIL	FY 1990 TOTAL	FY 1995 AC	FY 1995 AT	FY 1995 GA	FY 1995 MIL	FY 1995 TOTAL	FY 2000 AC	FY 2000 AT	FY 2000 GA	FY 2000 MIL	FY 2000 TOTAL	FY 2005 AC	FY 2005 AT	FY 2005 GA	FY 2005 MIL	FY 2005 TOTAL
1 ALBUQUERQUE	ZAB	740	67	189	498	1,494	930	72	265	498	1,765	1,017	76	303	498	1,894	1,040	80	332	498	1,950
2 CHICAGO	ZAU	1,403	429	629	117	2,578	1,519	558	628	117	2,822	1,584	678	643	117	3,022	1,609	768	638	117	3,132
3 BOSTON	ZBW	783	357	331	228	1,699	817	423	430	228	1,898	823	501	587	228	2,139	830	527	817	228	2,402
4 WASHINGTON	ZDC	1,161	224	450	405	2,240	1,271	323	460	405	2,459	1,396	421	491	405	2,713	1,465	515	512	405	2,897
5 DENVER	ZDV	674	215	253	334	1,476	948	246	321	334	1,849	1,188	257	349	334	2,128	1,450	261	361	334	2,406
6 FORT WORTH	ZFW	933	263	364	388	1,948	1,204	283	391	388	2,266	1,414	296	423	388	2,521	1,575	312	462	388	2,737
7 HOUSTON	ZHU	705	159	479	420	1,763	967	168	611	420	2,166	1,174	174	630	420	2,398	1,325	180	642	420	2,567
8 INDIANAPOLIS	ZID	982	368	575	171	2,096	1,044	410	609	171	2,234	1,064	430	609	171	2,274	1,080	450	609	171	2,310
9 JACKSONVILLE	ZJX	838	171	521	312	1,842	1,056	241	622	312	2,231	1,375	340	698	312	2,725	1,767	461	761	312	3,301
10 KANSAS CITY	ZKC	793	232	509	262	1,796	848	304	591	262	2,005	851	304	660	262	2,077	851	304	675	262	2,092
11 LOS ANGELES	ZLA	957	267	254	304	1,782	1,320	311	362	304	2,297	1,739	330	379	304	2,752	2,204	350	381	304	3,239
12 SALT LAKE CITY	ZLC	506	228	151	395	1,280	536	340	202	395	1,473	541	505	273	395	1,714	546	730	377	395	2,048
13 MIAMI	ZMA	858	293	358	179	1,688	880	345	406	179	1,810	890	374	449	179	1,892	901	390	487	179	1,957
14 MEMPHIS	ZME	766	167	482	351	1,766	1,043	218	563	351	2,175	1,064	225	614	351	2,254	1,075	230	664	351	2,320
15 MINNEAPOLIS	ZMP	647	303	465	206	1,621	746	371	522	206	1,845	822	477	556	206	2,061	881	580	556	206	2,223
16 NEW YORK	ZNY	1,100	247	346	178	1,871	1,191	322	374	178	2,065	1,299	414	459	178	2,350	1,477	521	550	178	2,726
17 OAKLAND	ZOA	830	273	226	370	1,699	1,141	367	254	370	2,132	1,530	405	274	370	2,579	1,967	430	285	370	3,052
18 CLEVELAND	ZOB	1,342	299	581	156	2,378	1,418	369	666	156	2,609	1,476	408	704	156	2,744	1,536	450	772	156	2,914
19 SEATTLE	ZSE	516	370	251	199	1,336	584	415	279	199	1,477	621	504	320	199	1,644	645	554	352	199	1,750
20 ATLANTA	ZTL	1,165	359	593	159	2,276	1,348	377	746	159	2,630	1,387	413	820	159	2,779	1,400	437	874	159	2,870
Total		17,701	5,291	8,007	5,632	36,631	20,811	6,463	9,302	5,632	42,208	23,255	7,532	10,241	5,632	46,660	25,624	8,530	11,107	5,632	50,893
% of Total		48.3%	14.4%	21.9%	15.4%	100.0%	49.3%	15.3%	22.0%	13.3%	100.0%	49.8%	16.1%	21.9%	12.1%	100.0%	50.3%	16.8%	21.8%	11.1%	100.0%

Table B-1 Summary of Projected ARTCC Operations 1990-2005

Center: ZAB Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZAB15	LOW	15	15.0%	19.5%
ZAB16	LOW	15	7.8%	10.2%
ZAB17	LOW	17	13.9%	18.1%
ZAB19	LOW	14	7.8%	10.1%
ZAB20	LOW	15	14.6%	19.0%
ZAB21	LOW	14	8.2%	10.7%
ZAB23	HIGH	15	12.6%	16.4%
ZAB39	HIGH	15	17.0%	22.2%
ZAB40	HIGH	99	3.8%	5.0%
ZAB42	LOW	12	13.4%	17.5%
ZAB43	LOW	15	24.6%	32.1%
ZAB45	LOW	15	14.8%	19.3%
ZAB46	LOW	12	20.3%	26.4%
ZAB47	LOW	15	7.6%	10.0%
ZAB49	LOW	16	4.5%	5.9%
ZAB63	HIGH	17	15.6%	20.4%
ZAB65	SUPER	20	16.5%	21.6%
ZAB67	SUPER	18	18.0%	23.5%
ZAB68	HIGH	15	20.1%	26.2%
ZAB70	HIGH	18	16.1%	21.0%
ZAB71	HIGH	18	9.8%	12.8%
ZAB72	SUPER	18	13.1%	17.1%
ZAB78	SUPER	17	15.8%	20.6%
ZAB80	SUPER	18	18.8%	24.5%
ZAB87	HIGH	17	9.4%	12.2%
ZAB89	HIGH	15	9.4%	12.3%
ZAB90	HIGH	17	14.0%	18.3%
ZAB91	HIGH	18	12.0%	15.6%
ZAB92	HIGH	16	18.7%	24.5%
ZAB93	HIGH	17	29.6%	38.7%
ZAB94	HIGH	15	21.7%	28.3%
ZAB95	HIGH	15	10.8%	14.1%
ZAB96	SUPER	16	18.7%	24.5%
ZAB97	HIGH	17	29.6%	38.7%
ZAB98	SUPER	15	21.7%	28.3%
ZAB99	LOW	15	10.3%	13.5%

Center: ZAU Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZAU24	HIGH	14	1.4%	1.7%
ZAU25	HIGH	13	10.3%	12.3%
ZAU26	LOW	12	12.4%	14.9%
ZAU27	LOW	13	14.4%	16.5%
ZAU28	LOW	13	26.8%	30.7%
ZAU29	SUPER	12	12.4%	15.1%
ZAU34	HIGH	13	13.7%	15.7%
ZAU35	LOW	12	13.3%	16.1%
ZAU36	HIGH	13	13.5%	15.4%
ZAU37	LOW	12	18.7%	21.4%
ZAU38	LOW	12	15.8%	19.2%
ZAU39	LOW	13	15.7%	18.0%
ZAU41	LOW	11	1.8%	2.2%
ZAU42	LOW	12	24.6%	28.2%
ZAU43	LOW	14	20.0%	24.3%
ZAU44	LOW	13	46.4%	53.2%
ZAU45	HIGH	12	13.8%	15.8%
ZAU46	HIGH	12	16.5%	18.9%
ZAU50	LOW	13	7.9%	9.6%
ZAU51	LOW	12	33.5%	38.4%
ZAU52	HIGH	13	14.2%	16.2%
ZAU53	SUPER	12	7.1%	8.2%
ZAU54	LOW	12	23.1%	26.5%
ZAU55	LOW	12	26.8%	30.7%
ZAU56	LOW	12	25.7%	29.5%
ZAU60	HIGH	13	11.7%	13.4%
ZAU61	SUPER	13	15.2%	17.4%
ZAU63	LOW	12	52.7%	60.4%
ZAU64	LOW	12	18.4%	21.1%
ZAU65	LOW	12	17.0%	19.5%
ZAU66	LOW	12	2.9%	3.3%
ZAU73	LOW	12	24.1%	27.7%
ZAU74	LOW	12	18.3%	20.9%
ZAU75	HIGH	13	20.5%	24.9%
ZAU76	HIGH	13	17.6%	20.2%
ZAU77	LOW	13	33.3%	38.2%
ZAU78	SUPER	12	27.5%	33.4%
ZAU79	SUPER	14	21.9%	26.6%
ZAU80	LOW	12	29.7%	34.0%
ZAU81	LOW	15	29.9%	34.3%
ZAU82	HIGH	12	17.0%	19.4%
ZAU83	SUPER	12	19.2%	23.3%
ZAU84	HIGH	10	15.0%	17.2%

Center: ZBW Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZBW01H	HIGH	13	14.3%	20.3%
ZBW02H	HIGH	13	20.7%	29.2%
ZBW05L	LOW	17	10.1%	14.2%
ZBW06L	LOW	17	7.4%	10.4%
ZBW07L	LOW	17	10.5%	14.8%
ZBW08H	HIGH	13	2.7%	3.8%
ZBW08L	LOW	17	0.0%	0.0%
ZBW09H	HIGH	13	10.8%	15.2%
ZBW09L	HIGH	13	0.0%	0.0%
ZBW10H	HIGH	13	12.0%	17.0%
ZBW15L	LOW	17	12.2%	17.2%
ZBW16L	LOW	17	13.7%	19.4%
ZBW17H	HIGH	13	15.2%	21.5%
ZBW17L	LOW	17	1.7%	2.4%
ZBW18H	HIGH	13	9.8%	13.8%
ZBW18L	LOW	17	13.0%	18.4%
ZBW19H	HIGH	13	9.8%	13.9%
ZBW19L	HIGH	13	11.5%	16.2%
ZBW19S	SUPER	10	14.7%	20.7%
ZBW20L	LOW	17	41.2%	58.3%
ZBW21L	LOW	17	7.7%	10.8%
ZBW22H	HIGH	13	3.8%	5.3%
ZBW22L	LOW	17	10.3%	14.5%
ZBW23L	LOW	17	7.8%	11.0%
ZBW24H	HIGH	13	6.6%	9.4%
ZBW31H	HIGH	13	17.5%	24.8%
ZBW31S	SUPER	10	24.2%	34.2%
ZBW32L	LOW	17	4.3%	6.1%
ZBW33L	LOW	17	4.1%	5.9%
ZBW34L	LOW	17	11.1%	15.7%
ZBW36L	LOW	17	10.3%	14.5%
ZBW37L	LOW	17	22.6%	31.9%
ZBW38H	HIGH	13	17.1%	24.2%
ZBW39H	HIGH	13	14.7%	20.8%
ZBW46H	HIGH	13	19.9%	28.1%
ZBW47H	LOW	17	1.4%	2.0%
ZBW47L	LOW	17	5.5%	7.8%
ZBW52H	HIGH	13	2.7%	3.8%
ZBW52L	LOW	17	4.6%	6.5%
ZBW53H	HIGH	13	3.6%	5.1%
ZBW53L	LOW	17	10.5%	14.9%

Center: ZDC Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZDC01	LOW	13	5.4%	6.9%
ZDC02	LOW	13	4.2%	5.4%
ZDC03	HIGH	18	23.3%	30.1%
ZDC04	HIGH	15	22.8%	29.4%
ZDC05	LOW	12	5.3%	6.9%
ZDC06	LOW	12	5.2%	6.7%
ZDC09	SUPER	10	19.8%	25.6%
ZDC10	HIGH	13	15.8%	20.5%
ZDC11	LOW	14	5.2%	6.8%
ZDC12	HIGH	14	7.5%	9.8%
ZDC15	LOW	13	9.9%	12.8%
ZDC16	HIGH	13	45.7%	59.1%
ZDC17	LOW	13	13.6%	17.6%
ZDC18H	HIGH	12	1.5%	2.0%
ZDC18L	LOW	12	0.9%	1.2%
ZDC19H	HIGH	13	9.5%	12.2%
ZDC19L	LOW	13	5.0%	6.5%
ZDC20	LOW	13	15.9%	20.6%
ZDC21	LOW	13	3.9%	5.0%
ZDC22	LOW	13	9.4%	12.2%
ZDC23	LOW	13	7.7%	10.0%
ZDC24	LOW	13	10.3%	13.3%
ZDC25	LOW	13	5.2%	6.7%
ZDC26	LOW	13	7.9%	10.3%
ZDC27	LOW	13	12.6%	16.3%
ZDC28	LOW	13	9.6%	12.4%
ZDC29	LOW	13	4.2%	5.4%
ZDC30	LOW	13	4.8%	6.2%
ZDC31	LOW	13	17.6%	22.7%
ZDC32	HIGH	13	12.9%	16.7%
ZDC34	HIGH	18	11.5%	14.9%
ZDC35	HIGH	15	15.6%	20.1%
ZDC36	HIGH	14	15.0%	19.4%
ZDC37	HIGH	13	13.1%	16.9%
ZDC38	HIGH	14	14.4%	18.6%
ZDC50	SUPER	17	19.9%	25.7%
ZDC51	LOW	12	12.4%	16.1%
ZDC52	HIGH	15	11.5%	14.9%
ZDC53	LOW	13	12.7%	16.4%
ZDC54	HIGH	13	15.4%	20.0%
ZDC58	HIGH	13	13.6%	17.6%
ZDC59	HIGH	13	12.2%	15.7%
ZDC72	SUPER	17	27.6%	35.7%

Table B-2 Summary of ARTCC Sector Data

Center: ZDV

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZDV03	HIGH	15	14.7%	23.9%
ZDV04	HIGH	14	14.4%	23.5%
ZDV05	HIGH	11	15.8%	25.7%
ZDV06	LOW	7	3.5%	5.7%
ZDV07	LOW	10	4.6%	7.5%
ZDV08	HIGH	13	16.4%	26.8%
ZDV09	HIGH	15	17.3%	28.2%
ZDV11	LOW	7	8.8%	14.3%
ZDV12	LOW	8	11.3%	18.4%
ZDV13	LOW	11	7.9%	12.9%
ZDV14	HIGH	13	16.9%	27.6%
ZDV15	LOW	8	14.9%	24.3%
ZDV16	HIGH	14	17.8%	29.1%
ZDV17	HIGH	12	14.6%	23.8%
ZDV18	SUPER	13	15.9%	26.0%
ZDV19	LOW	11	26.1%	42.5%
ZDV21	LOW	7	12.3%	20.1%
ZDV22	LOW	12	17.8%	29.0%
ZDV23	HIGH	19	14.6%	23.9%
ZDV24	HIGH	16	17.0%	27.7%
ZDV25	HIGH	13	11.7%	19.1%
ZDV26	LOW	10	11.8%	19.2%
ZDV27	LOW	11	10.8%	17.6%
ZDV28	HIGH	13	13.2%	21.5%
ZDV29	HIGH	13	17.3%	28.3%
ZDV30	SUPER	14	16.4%	26.7%
ZDV31	LOW	12	13.7%	22.3%
ZDV32	HIGH	15	18.2%	29.7%
ZDV33	HIGH	15	17.2%	28.1%
ZDV34	HIGH	15	16.6%	27.0%
ZDV35	HIGH	13	19.4%	31.7%
ZDV36	HIGH	13	14.7%	23.9%
ZDV37	HIGH	14	13.7%	22.3%
ZDV38	LOW	10	9.8%	16.0%
ZDV39	SUPER	14	13.9%	22.7%
ZDV41	LOW	9	17.0%	27.8%
ZDV42	LOW	5	13.8%	22.5%
ZDV99	LOW	43	14.4%	23.4%

Center: ZFW

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZFW20	LOW	25	15.7%	22.0%
ZFW23	LOW	17	37.3%	52.4%
ZFW24	LOW	14	7.6%	10.7%
ZFW25	LOW	14	9.9%	13.9%
ZFW26	LOW	14	3.8%	5.4%
ZFW27	LOW	14	8.8%	12.4%
ZFW28	LOW	14	4.7%	6.7%
ZFW29	HIGH	14	13.6%	19.1%
ZFW30	LOW	13	17.0%	23.9%
ZFW32	HIGH	17	8.4%	11.8%
ZFW34	LOW	12	15.3%	21.5%
ZFW35	LOW	14	9.4%	13.2%
ZFW36	LOW	14	8.7%	12.2%
ZFW37	HIGH	19	11.9%	16.7%
ZFW38	LOW	17	13.3%	18.7%
ZFW39	SUPER	15	9.6%	13.6%
ZFW40	LOW	17	4.4%	6.2%
ZFW42	SUPER	19	13.7%	19.3%
ZFW43	LOW	13	8.2%	11.5%
ZFW46	SUPER	18	11.8%	16.6%
ZFW47	SUPER	16	16.3%	22.8%
ZFW48	SUPER	19	13.7%	19.2%
ZFW49	SUPER	19	10.9%	15.3%
ZFW50	SUPER	14	13.0%	18.3%
ZFW53	LOW	16	8.5%	12.0%
ZFW62	HIGH	17	8.6%	12.1%
ZFW63	LOW	13	5.4%	7.6%
ZFW64	LOW	15	11.1%	15.6%
ZFW65	SUPER	19	8.3%	11.7%
ZFW75	HIGH	14	10.3%	14.4%
ZFW82	SUPER	23	15.0%	21.1%
ZFW83	HIGH	19	8.7%	12.3%
ZFW86	SUPER	19	15.3%	21.4%
ZFW89	SUPER	14	13.6%	19.1%
ZFW90	SUPER	19	16.2%	22.8%
ZFW92	SUPER	18	12.2%	17.2%
ZFW93	SUPER	19	12.4%	17.4%
ZFW94	SUPER	14	8.1%	11.4%
ZFW96	LOW	18	26.1%	36.6%
ZFW97	LOW	17	6.9%	9.7%
ZFW98	LOW	14	9.5%	13.3%
ZFW99	LOW	85	10.0%	14.0%

Center: ZHU

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZHU23	LOW	17	3.4%	5.0%
ZHU24	LOW	10	6.8%	9.8%
ZHU25	HIGH	13	16.0%	23.2%
ZHU26	HIGH	15	12.3%	18.0%
ZHU27	LOW	12	8.5%	12.3%
ZHU28	LOW	17	0.6%	0.8%
ZHU30	LOW	13	7.8%	11.4%
ZHU36	LOW	12	6.1%	8.9%
ZHU38	LOW	10	12.7%	18.5%
ZHU40	LOW	12	9.4%	13.7%
ZHU42	HIGH	19	14.1%	20.5%
ZHU43	LOW	12	8.3%	12.1%
ZHU46	LOW	17	2.1%	3.0%
ZHU50	LOW	10	3.0%	4.3%
ZHU53	LOW	13	5.3%	7.8%
ZHU56	LOW	13	5.0%	7.2%
ZHU58	LOW	13	4.6%	6.7%
ZHU59	LOW	17	3.8%	5.5%
ZHU63	HIGH	15	10.8%	15.7%
ZHU65	HIGH	15	13.0%	18.9%
ZHU68	HIGH	19	11.5%	16.8%
ZHU70	HIGH	19	11.4%	16.5%
ZHU74	HIGH	15	8.6%	12.5%
ZHU78	HIGH	17	11.6%	16.9%
ZHU79	HIGH	13	15.3%	22.3%
ZHU80	LOW	10	7.5%	10.9%
ZHU82	HIGH	15	9.0%	13.1%
ZHU83	LOW	10	13.9%	20.2%
ZHU84	HIGH	12	7.4%	10.8%
ZHU85	LOW	17	3.1%	4.6%
ZHU86	LOW	12	14.7%	21.4%
ZHU87	LOW	10	10.0%	14.5%
ZHU92	LOW	17	2.7%	3.9%
ZHU93	LOW	13	2.4%	3.5%
ZHU97	HIGH	19	14.3%	20.7%
ZHU98	LOW	10	11.3%	16.4%

Center: ZID

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZID17	LOW	12	9.5%	10.4%
ZID18	LOW	13	9.6%	10.6%
ZID19	LOW	13	9.7%	10.7%
ZID20	LOW	12	16.7%	18.4%
ZID21	LOW	13	10.8%	11.8%
ZID22	LOW	12	13.4%	14.8%
ZID23	LOW	13	11.7%	12.9%
ZID24	LOW	13	7.2%	7.9%
ZID25	LOW	12	12.7%	14.0%
ZID29	LOW	12	6.7%	7.3%
ZID30	LOW	12	9.1%	10.1%
ZID31	LOW	12	8.3%	9.1%
ZID32	LOW	12	12.0%	13.3%
ZID33	LOW	12	10.8%	11.9%
ZID34	LOW	11	13.4%	14.7%
ZID35	LOW	12	15.9%	17.5%
ZID80	HIGH	13	18.1%	19.9%
ZID81	HIGH	13	16.8%	18.6%
ZID82	HIGH	13	19.5%	21.4%
ZID83	HIGH	13	18.5%	20.4%
ZID84	HIGH	13	18.0%	19.9%
ZID85	HIGH	14	18.3%	20.2%
ZID86	HIGH	13	16.6%	18.3%
ZID87	HIGH	13	13.8%	15.2%
ZID88	HIGH	13	21.8%	24.0%
ZID89	HIGH	13	13.6%	15.0%
ZID90	SUPER	11	23.0%	25.3%
ZID91	SUPER	12	10.2%	11.3%
ZID92	SUPER	13	13.7%	15.1%
ZID93	SUPER	11	25.0%	27.6%
ZID94	SUPER	12	13.0%	14.4%
ZID95	SUPER	14	18.6%	20.5%
ZID96	SUPER	13	12.2%	13.5%
ZID97	SUPER	13	11.3%	12.4%
ZID98	SUPER	13	17.7%	19.5%
ZID99	SUPER	13	13.0%	14.4%

Table B-2 (Contin) Summary of ARTCC Sector Data

Center: ZJX Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZJX10	LOW	10	17.0%	30.5%
ZJX11	HIGH	14	10.3%	18.5%
ZJX12	LOW	12	5.5%	9.9%
ZJX13	LOW	13	9.4%	16.9%
ZJX14	LOW	13	10.8%	19.4%
ZJX15	LOW	12	15.1%	27.0%
ZJX16	HIGH	14	16.8%	30.0%
ZJX17	HIGH	13	20.7%	37.1%
ZJX28A	LOW	11	8.5%	15.2%
ZJX28B	LOW	12	2.1%	3.7%
ZJX29	LOW	13	21.2%	37.9%
ZJX30A	HIGH	17	11.8%	21.2%
ZJX30B	HIGH	13	11.4%	20.4%
ZJX33	HIGH	11	11.8%	21.1%
ZJX34	HIGH	18	13.5%	24.2%
ZJX35	HIGH	14	15.0%	26.8%
ZJX47	SUPER	13	28.0%	50.1%
ZJX48	HIGH	13	13.4%	23.9%
ZJX49	HIGH	15	7.2%	12.9%
ZJX50	SUPER	12	19.9%	35.7%
ZJX51	LOW	10	8.4%	15.0%
ZJX52	LOW	9	5.1%	9.1%
ZJX53	LOW	13	10.7%	19.2%
ZJX54	LOW	10	29.9%	53.6%
ZJX57	LOW	11	7.1%	12.7%
ZJX58A	HIGH	10	17.1%	30.6%
ZJX58B	HIGH	10	1.3%	2.3%
ZJX65	SUPER	13	18.7%	33.5%
ZJX66	HIGH	15	8.3%	14.9%
ZJX67	HIGH	17	6.6%	11.8%
ZJX68	SUPER	13	19.7%	35.2%
ZJX69	HIGH	13	13.6%	24.3%
ZJX70E	HIGH	21	14.6%	26.1%
ZJX70W	HIGH	21	2.3%	4.1%
ZJX71	LOW	8	12.9%	23.1%
ZJX72	LOW	12	9.7%	17.3%
ZJX73A	LOW	17	7.5%	13.5%
ZJX73B	LOW	12	17.7%	31.7%
ZJX75	SUPER	11	24.9%	44.6%
ZJX76	HIGH	12	11.7%	21.0%
ZJX77	LOW	12	33.5%	60.1%
ZJX78	LOW	13	4.9%	8.8%
ZJX79	LOW	17	8.8%	15.7%
ZJXJAXA	LOW	0	0.0%	0.0%
ZJXMCO	LOW	0	0.0%	0.0%
ZJXMCO1	LOW	22	12.6%	22.5%
ZJXSAVA	LOW	0	0.0%	0.0%
ZJXTPA	LOW	0	0.0%	0.0%
ZJXW57A	LOW	0	0.0%	0.0%

Center: ZKC Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZKC02	HIGH	17	22.1%	25.7%
ZKC08	HIGH	17	15.0%	17.5%
ZKC12	HIGH	13	15.9%	18.6%
ZKC14	HIGH	15	12.9%	15.0%
ZKC18	HIGH	15	12.3%	14.4%
ZKC20	HIGH	15	14.9%	17.3%
ZKC22	HIGH	15	14.6%	17.0%
ZKC23	HIGH	15	14.8%	17.2%
ZKC24	HIGH	17	16.8%	19.5%
ZKC26	HIGH	17	19.7%	23.0%
ZKC27	HIGH	15	16.8%	19.6%
ZKC28	HIGH	17	16.5%	19.2%
ZKC29	HIGH	17	18.9%	22.0%
ZKC30	HIGH	15	24.1%	28.1%
ZKC32	HIGH	15	17.6%	20.5%
ZKC40	LOW	13	8.6%	10.0%
ZKC42	LOW	13	6.6%	7.7%
ZKC46	LOW	14	4.5%	5.2%
ZKC48	LOW	13	7.4%	8.6%
ZKC50	LOW	14	7.6%	8.9%
ZKC52	LOW	15	10.0%	11.6%
ZKC53	LOW	15	8.5%	9.9%
ZKC54	LOW	14	6.9%	8.0%
ZKC56	LOW	15	8.6%	10.2%
ZKC58	LOW	14	11.3%	13.1%
ZKC59	LOW	13	5.8%	6.7%
ZKC62	LOW	12	6.3%	7.3%
ZKC63	LOW	13	4.7%	5.5%
ZKC66	LOW	13	6.2%	7.2%
ZKC67	LOW	13	5.7%	6.6%
ZKC68	LOW	14	4.3%	5.0%
ZKC72	LOW	13	7.4%	8.6%
ZKC74	LOW	13	7.2%	8.4%
ZKC84	HIGH	15	22.0%	25.7%
ZKC92	SUPER	15	13.7%	15.9%
ZKC94	SUPER	17	13.3%	15.4%

Center: ZLA Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZLA03	LOW	11	8.9%	16.2%
ZLA04	LOW	11	15.2%	27.6%
ZLA06	LOW	11	8.7%	15.8%
ZLA07	LOW	13	3.9%	7.0%
ZLA08	LOW	13	9.4%	17.1%
ZLA09	LOW	13	6.9%	12.6%
ZLA10	LOW	13	5.8%	10.6%
ZLA12	LOW	12	8.6%	15.6%
ZLA13	LOW	12	12.1%	22.0%
ZLA14	LOW	13	9.1%	16.5%
ZLA15	LOW	13	15.0%	27.2%
ZLA16	HIGH	13	12.3%	22.3%
ZLA17E	LOW	13	2.2%	4.0%
ZLA17W	LOW	13	3.9%	7.1%
ZLA18	LOW	13	3.8%	7.0%
ZLA19	LOW	13	12.3%	22.4%
ZLA20	LOW	10	9.7%	17.6%
ZLA21	LOW	10	6.9%	12.5%
ZLA22	LOW	10	3.0%	5.5%
ZLA25	HIGH	13	21.3%	38.7%
ZLA26	HIGH	12	13.9%	25.2%
ZLA27	HIGH	13	18.3%	33.3%
ZLA28	HIGH	8	9.0%	16.3%
ZLA30	HIGH	12	6.8%	12.4%
ZLA31	HIGH	13	20.9%	37.9%
ZLA33	HIGH	13	25.6%	46.5%
ZLA34	HIGH	13	14.3%	26.1%
ZLA35	HIGH	15	24.1%	43.9%
ZLA37	HIGH	13	24.4%	44.3%
ZLA38	HIGH	13	12.0%	21.7%
ZLA39	HIGH	13	24.5%	44.5%
ZLA40	HIGH	12	23.2%	42.1%
ZLA99	LOW	10	26.7%	48.5%

Center: ZLC Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZLC03	LOW	13	16.2%	17.5%
ZLC04	HIGH	17	13.6%	21.7%
ZLC05	HIGH	16	15.8%	24.6%
ZLC06	HIGH	17	11.8%	18.8%
ZLC07	LOW	11	14.0%	22.4%
ZLC08	HIGH	17	13.0%	20.8%
ZLC15	HIGH	16	8.7%	9.4%
ZLC16	HIGH	15	11.9%	19.0%
ZLC17	HIGH	18	14.3%	22.9%
ZLC19	LOW	17	13.9%	22.2%
ZLC20	HIGH	19	9.3%	14.9%
ZLC28	HIGH	13	13.2%	21.1%
ZLC30	LOW	13	9.6%	15.4%
ZLC31	LOW	15	6.6%	10.6%
ZLC32	LOW	9	22.3%	35.7%
ZLC33	LOW	17	11.5%	18.4%
ZLC40	LOW	10	13.4%	21.4%
ZLC41	HIGH	18	19.6%	31.4%
ZLC42	HIGH	17	13.9%	22.3%
ZLC43	LOW	16	8.2%	13.2%
ZLC44	HIGH	17	12.6%	20.1%
ZLC45	HIGH	17	17.2%	27.5%
ZLC46	HIGH	13	16.9%	27.0%
ZLC47	LOW	14	8.6%	13.7%

Table B-2 (Contin) Summary of ARTCC Sector Data

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
Center: ZMA				
ZMA01H	HIGH	17	16.3%	18.9%
ZMA01L	LOW	17	0.0%	0.0%
ZMA02	HIGH	13	24.4%	28.3%
ZMA03	LOW	26	0.7%	0.8%
ZMA04	LOW	17	3.9%	4.5%
ZMA05	HIGH	10	7.5%	8.6%
ZMA06	HIGH	10	2.5%	2.9%
ZMA07	LOW	17	3.6%	4.2%
ZMA08	HIGH	10	22.4%	26.0%
ZMA20	LOW	11	13.2%	15.3%
ZMA21	LOW	17	5.3%	6.2%
ZMA22	LOW	17	8.3%	9.6%
ZMA24	LOW	10	10.7%	12.4%
ZMA25	HIGH	10	20.1%	23.3%
ZMA40	HIGH	17	6.4%	7.4%
ZMA41	LOW	17	10.6%	12.3%
ZMA45	LOW	10	7.8%	9.0%
ZMA46	LOW	10	8.2%	9.5%
ZMA47	LOW	11	8.8%	10.2%
ZMA60	HIGH	17	12.8%	14.8%
ZMA61	LOW	15	10.9%	12.6%
ZMA62	HIGH	17	12.2%	14.1%
ZMA63	HIGH	17	6.0%	6.9%
ZMA66	LOW	10	12.6%	14.6%
ZMA67	LOW	17	3.9%	4.5%
ZMA68	HIGH	13	10.5%	12.2%
ZMA69	HIGH	13	8.0%	9.3%
ZMA98	HIGH	85	1.3%	1.5%
ZMA99	LOW	85	0.0%	0.0%

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
Center: ZME				
ZME01	LOW	12	10.3%	13.6%
ZME02	LOW	12	17.4%	22.9%
ZME03	LOW	12	9.1%	12.0%
ZME04	LOW	12	11.3%	14.9%
ZME05	LOW	12	10.5%	13.8%
ZME06	LOW	13	8.8%	11.6%
ZME07	LOW	12	5.9%	7.8%
ZME08	SUPER	15	11.4%	14.9%
ZME09	LOW	12	7.6%	10.0%
ZME12	LOW	15	14.4%	18.9%
ZME13	LOW	17	17.4%	22.8%
ZME14	LOW	13	9.8%	12.9%
ZME15	LOW	13	6.3%	8.3%
ZME20	SUPER	15	16.6%	21.8%
ZME21	HIGH	15	16.6%	21.7%
ZME22	HIGH	15	21.0%	27.6%
ZME23	SUPER	15	13.3%	17.5%
ZME24	SUPER	15	11.7%	15.4%
ZME25	HIGH	15	15.0%	19.8%
ZME26	HIGH	15	18.0%	23.6%
ZME30	HIGH	15	7.9%	10.4%
ZME31	HIGH	15	9.1%	11.9%
ZME32	LOW	13	8.8%	11.6%
ZME40	LOW	13	7.4%	9.7%
ZME41	LOW	13	22.5%	29.6%
ZME42	LOW	13	14.5%	19.0%
ZME44	HIGH	15	15.2%	19.9%
ZME45	HIGH	15	18.9%	24.9%
ZME46	HIGH	15	13.9%	18.3%
ZME60	LOW	13	24.8%	32.6%
ZME61	SUPER	15	15.7%	20.7%
ZME62	HIGH	15	9.0%	11.8%
ZME63	HIGH	15	16.5%	21.6%
ZME64	LOW	12	4.8%	6.3%
ZME65	LOW	12	15.8%	20.7%
ZME66	LOW	12	17.8%	23.4%
ZME67	LOW	12	10.6%	13.9%

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
Center: ZMP				
ZMP01	LOW	10	7.2%	9.8%
ZMP02	LOW	11	17.0%	23.4%
ZMP03	LOW	13	11.4%	15.7%
ZMP04	LOW	11	15.3%	20.9%
ZMP05	LOW	13	9.5%	13.0%
ZMP06	LOW	13	17.7%	24.3%
ZMP07	LOW	13	14.9%	20.4%
ZMP09	LOW	13	15.2%	20.8%
ZMP10	LOW	13	21.3%	29.2%
ZMP11	HIGH	13	9.0%	12.4%
ZMP13	HIGH	14	16.5%	22.6%
ZMP14	HIGH	15	12.0%	16.5%
ZMP16	HIGH	15	13.9%	19.0%
ZMP17	HIGH	15	20.5%	28.1%
ZMP19	HIGH	15	16.2%	22.2%
ZMP20	HIGH	17	18.5%	25.4%
ZMP23	HIGH	15	15.3%	21.0%
ZMP24H	HIGH	10	7.6%	10.4%
ZMP24L	LOW	11	15.6%	21.4%
ZMP25	HIGH	14	12.3%	16.9%
ZMP26	LOW	14	14.2%	19.5%
ZMP27	LOW	14	18.0%	24.6%
ZMP29	HIGH	15	18.3%	25.1%
ZMP30	HIGH	15	16.8%	23.1%
ZMP34	LOW	13	14.0%	19.2%
ZMP36	LOW	13	12.8%	17.6%
ZMP37	LOW	13	10.5%	14.4%
ZMP38	HIGH	16	15.1%	20.7%
ZMP39	HIGH	20	18.1%	24.9%
ZMP40	SUPER	17	14.3%	19.6%

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
Center: ZNY				
ZNY10	HIGH	10	29.2%	42.6%
ZNY11	LOW	10	4.2%	6.1%
ZNY25	LOW	12	8.5%	12.5%
ZNY26	LOW	11	8.6%	12.5%
ZNY27	LOW	14	6.5%	9.5%
ZNY34	HIGH	15	17.9%	26.1%
ZNY35H	LOW	13	0.0%	0.0%
ZNY35L	LOW	13	1.5%	2.1%
ZNY36H	LOW	10	3.6%	5.2%
ZNY36L	LOW	10	12.8%	18.7%
ZNY39	LOW	10	18.5%	26.9%
ZNY42	HIGH	10	25.8%	37.6%
ZNY49	HIGH	12	12.9%	18.8%
ZNY50H	LOW	13	1.9%	2.8%
ZNY50L	LOW	13	4.6%	6.6%
ZNY51H	LOW	13	2.0%	2.9%
ZNY51L	LOW	13	5.0%	7.3%
ZNY55	LOW	10	20.6%	30.0%
ZNY56	HIGH	12	10.6%	15.5%
ZNY65	LOW	10	3.5%	5.1%
ZNY66	LOW	14	7.8%	11.4%
ZNY67	LOW	13	7.4%	10.8%
ZNY68	LOW	10	9.2%	13.4%
ZNY73	HIGH	15	7.4%	10.8%
ZNY74	LOW	13	10.7%	15.6%
ZNY75	HIGH	15	25.4%	37.0%
ZNY86	HIGH	10	14.6%	21.3%
ZNY87	LOW	8	15.1%	22.0%
ZNY88	LOW	8	8.9%	12.9%
ZNY89	LOW	8	24.2%	35.3%
ZNY9	HIGH	13	12.8%	18.6%
ZNY90	LOW	8	10.9%	15.8%
ZNY93	LOW	14	8.5%	12.4%
ZNY97	LOW	5	2.0%	2.9%
ZNY98	LOW	5	1.9%	2.7%
ZNY99	LOW	11	1.3%	1.9%

Table B-2 (Contin) Summary of ARTCC Sector Data

Center: ZOA

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZOA11	LOW	13	4.9%	8.8%
ZOA12	LOW	13	8.1%	14.6%
ZOA13	HIGH	17	17.5%	31.4%
ZOA14	HIGH	13	17.7%	31.8%
ZOA15	HIGH	14	16.1%	29.0%
ZOA16	LOW	14	6.0%	10.9%
ZOA17	LOW	11	6.2%	11.2%
ZOA18	LOW	13	6.5%	11.6%
ZOA21	LOW	13	9.9%	17.9%
ZOA23	LOW	13	7.2%	13.0%
ZOA24	LOW	15	4.8%	8.6%
ZOA31	HIGH	17	18.4%	33.1%
ZOA32	HIGH	15	17.6%	31.6%
ZOA33	HIGH	17	24.1%	43.2%
ZOA34	HIGH	15	19.2%	34.5%
ZOA35H	HIGH	13	3.5%	6.3%
ZOA35L	LOW	17	2.2%	4.0%
ZOA36	HIGH	11	16.2%	29.0%
ZOA41	LOW	13	10.7%	19.2%
ZOA42	LOW	11	6.3%	11.3%
ZOA43	HIGH	14	16.0%	28.7%
ZOA44	LOW	11	8.7%	15.6%
ZOA45	LOW	13	6.8%	12.2%
ZOA46	LOW	13	5.9%	10.6%
ZOA98	LOW	85	0.4%	0.8%
ZOA99	HIGH	85	0.0%	0.1%

Center: ZOB

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZOB10	LOW	13	13.0%	15.9%
ZOB11	LOW	13	33.8%	41.4%
ZOB12	LOW	13	29.0%	35.6%
ZOB13	LOW	13	26.3%	32.3%
ZOB14	LOW	13	20.9%	25.6%
ZOB15	LOW	13	26.7%	32.7%
ZOB16	HIGH	17	17.7%	21.7%
ZOB20	LOW	15	9.5%	11.6%
ZOB21	LOW	15	20.2%	24.8%
ZOB22	LOW	13	19.7%	24.1%
ZOB23	LOW	15	15.0%	18.4%
ZOB27	HIGH	17	10.7%	13.1%
ZOB28	HIGH	17	7.7%	9.4%
ZOB29	SUPER	19	15.4%	18.9%
ZOB31	LOW	14	13.5%	16.6%
ZOB33	LOW	14	30.3%	37.2%
ZOB34	LOW	14	26.0%	31.9%
ZOB36	HIGH	14	15.0%	18.4%
ZOB37	HIGH	14	7.4%	9.0%
ZOB38	SUPER	16	27.2%	33.3%
ZOB39	SUPER	14	30.6%	37.6%
ZOB42	LOW	14	15.3%	18.8%
ZOB43	LOW	14	19.4%	23.7%
ZOB44	LOW	12	20.3%	24.9%
ZOB46	HIGH	17	10.9%	13.4%
ZOB47	SUPER	14	15.6%	19.1%
ZOB48	HIGH	14	10.9%	13.4%
ZOB49	SUPER	17	21.5%	26.3%
ZOB51	LOW	14	20.3%	24.8%
ZOB52	LOW	14	8.5%	10.5%
ZOB53	LOW	14	11.5%	14.0%
ZOB54	LOW	13	5.4%	6.6%
ZOB57	HIGH	13	9.6%	11.7%
ZOB59	SUPER	13	23.2%	28.4%
ZOB61	LOW	13	15.0%	18.4%
ZOB62	LOW	13	23.7%	29.0%
ZOB63	LOW	15	21.7%	26.6%
ZOB66	HIGH	13	17.6%	21.5%
ZOB67	HIGH	13	14.0%	17.2%
ZOB68	SUPER	13	15.0%	18.3%
ZOB69	SUPER	13	13.5%	16.6%

Center: ZSE

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZSE1	LOW	7	9.5%	12.5%
ZSE10	LOW	12	4.3%	5.6%
ZSE12	LOW	8	11.5%	15.0%
ZSE13	HIGH	11	17.5%	22.9%
ZSE14	HIGH	10	15.6%	20.4%
ZSE15	HIGH	11	16.8%	21.9%
ZSE16	HIGH	10	3.3%	4.3%
ZSE18	LOW	10	13.2%	17.3%
ZSE2	LOW	8	18.3%	23.9%
ZSE3	LOW	8	15.6%	20.4%
ZSE30	LOW	10	5.9%	7.7%
ZSE31	LOW	6	13.8%	18.1%
ZSE32	LOW	9	10.6%	13.8%
ZSE33	LOW	6	2.3%	3.0%
ZSE34	LOW	8	5.9%	7.7%
ZSE36	LOW	9	7.7%	10.1%
ZSE4	LOW	6	7.8%	10.2%
ZSE42	HIGH	0	0.0%	0.0%
ZSE46	HIGH	11	26.6%	34.7%
ZSE47	HIGH	9	21.7%	28.4%
ZSE5	LOW	10	6.1%	8.0%
ZSE6	LOW	9	13.2%	17.3%
ZSE7	HIGH	13	17.4%	22.7%
ZSE8	LOW	10	13.9%	18.2%
ZSE9	LOW	11	14.1%	18.4%

Center: ZTL

Sector ID	Type	Avg Sector % Cap	Actual 1991 % Cap	Projected 2005 % Cap
ZTL02	SUPER	19	10.7%	13.5%
ZTL03	HIGH	17	12.0%	15.1%
ZTL04	LOW	18	5.7%	7.2%
ZTL05	LOW	17	7.2%	9.1%
ZTL06	HIGH	17	9.7%	12.2%
ZTL07	HIGH	17	9.3%	11.6%
ZTL08	LOW	18	7.4%	8.9%
ZTL09	LOW	18	10.9%	13.8%
ZTL10	HIGH	20	7.9%	10.0%
ZTL11	HIGH	17	9.6%	11.7%
ZTL12	LOW	16	5.4%	6.8%
ZTL13	LOW	17	5.4%	6.5%
ZTL14	LOW	17	5.3%	6.7%
ZTL15	SUPER	17	16.8%	21.2%
ZTL16	LOW	17	9.1%	11.5%
ZTL17	LOW	15	6.5%	8.1%
ZTL18	LOW	15	6.8%	8.6%
ZTL19	SUPER	17	7.9%	9.9%
ZTL20	LOW	17	5.0%	6.3%
ZTL21	LOW	18	7.4%	9.3%
ZTL22	HIGH	18	13.1%	16.5%
ZTL24	SUPER	16	15.9%	20.0%
ZTL28	SUPER	16	13.6%	17.2%
ZTL29	LOW	15	7.7%	9.7%
ZTL30	LOW	15	8.5%	10.8%
ZTL31	LOW	15	7.2%	9.1%
ZTL33	HIGH	16	11.3%	14.2%
ZTL34	HIGH	17	15.5%	19.5%
ZTL36	SUPER	17	6.7%	8.4%
ZTL37	HIGH	18	8.3%	10.5%
ZTL38	LOW	18	5.3%	6.7%
ZTL39	HIGH	16	12.8%	16.2%
ZTL40	SUPER	18	8.6%	10.8%
ZTL41	LOW	17	6.0%	7.6%
ZTL43	HIGH	19	14.6%	18.4%
ZTL44	LOW	15	10.5%	13.2%
ZTL45	LOW	18	5.0%	6.3%
ZTL46	LOW	17	3.4%	4.3%
ZTL47	LOW	16	5.7%	7.1%
ZTL49	LOW	17	12.5%	15.8%
ZTL50	HIGH	15	10.2%	12.9%

Table B-2 (Contin) Summary of ARTCC Sector Data

ORGANIZATION	CONTACTS
FAA Headquarters	S. Alvania, ARD-100
....	R. Davis, ATM-200
....	W. Marx, ATM-200
....	A. Brieltler, ATM-300
....	C. Wine, APO-130
....	A. Kondo, APO-130
FAA/ATCSCC	D. Chomitz, ETMS Specialist
....	G. Rhoades, CFC Traffic Specialist
Boston Center (ZBW)	K. Acker, Assistant Traffic Manager
....	D. Kipson, Traffic Management Supervisor
....	R. Leboie, Traffic Management Coordinator
New York TRACON	R. Tamburro, Assistant TMU Supervisor
....	L. Pruzak, Traffic Management Coordinator
Kansas City Center (ZKC)	M. Brown, Assistant Traffic Manager
....	M. Wolfe, Traffic Management Supervisor
....	D. O'Neil, Traffic Management Coordinator
....	J. Hamilton, Traffic Management Coordinator
Chicago Center (ZAU)	V. Volpe, Assistant Traffic Manager
....	J. Hurd, Traffic Management Supervisor
....	R. Schultz, Traffic Management Supervisor
....	T. Rucker, Traffic Management Coordinator
Chicago TRACON	W. Brewner, Assistant Manager TMU
....	T. Murcher, Traffic Management Supervisor
Miami Center (ZMA)	P. Worley, Assistant Traffic Manager
....	G. Rivera, Traffic Management Supervisor
....	F. Christianson, TMU Data Analyst
Albuquerque Center (ZAB) ...	D. Cloyd, Assistant Traffic Manager
....	A. Garcia, Traffic Management Supervisor
....	C. Minnich, Traffic Management Supervisor
....	H. Johnson, TMU Data Analyst
Los Angeles Center (ZLA)	T. Savage, Assistant Traffic Manager
....	W. Beavely, Traffic Management Supervisor
Los Angeles TRACON	W. Brenner, Assistant Traffic Manager
....	P. Dempster, Traffic Management Supervisor
Air Transport Association	D. Schillaci, Director Air Traffic Control
....	System Operations

Table B-3 Benefits Assessment Contacts

APPENDIX C

TABLE | **PAGE**

2% CAPACITY GAIN RESULTS

Undiscounted 1990 Constant Dollars:

Annual Delay Savings

Year	Annual Delay Hrs. Saved (Ks)	Cumulative Delay Hrs. Saved (Ks)	Air Carrier Operating Costs (1990 Dollars, K's) Crew	Fuel/Oil	Maintenance	Total	High Estimate Passenger Value Time Costs (1990 $, K's) (all delays)	High Estimate Total (1990 $, K's)	Low Estimate Passenger Value Time Costs (1990 $, K's) (delays>15min)	Low Estimate Total (1990 $, K's) (delays>15min)
1990	25.57	25.57	$12,307	$18,963	$7,711	$38,981	$68,969	$107,950	$24,214	$63,195
1991	26.10	51.66	$12,456	$19,231	$7,845	$39,532	$68,284	$107,816	$23,974	$63,506
1992	26.63	78.30	$12,590	$19,383	$7,935	$39,908	$69,664	$109,571	$24,458	$64,366
1993	27.16	105.46	$12,739	$19,584	$8,064	$40,387	$72,461	$112,848	$25,440	$65,827
1994	27.68	133.14	$12,857	$19,708	$8,152	$40,717	$75,417	$116,134	$26,478	$67,195
1995	28.21	161.35	$13,010	$19,911	$8,266	$41,187	$79,105	$120,292	$27,773	$68,960
1996	29.94	191.29	$13,737	$21,012	$8,760	$43,510	$86,382	$129,892	$30,328	$73,838
1997	31.67	222.97	$14,514	$22,267	$9,309	$46,091	$93,506	$139,597	$32,829	$78,920
1998	33.40	256.37	$15,237	$23,405	$9,823	$48,465	$100,714	$149,179	$35,360	$83,825
1999	35.14	291.51	$15,985	$24,625	$10,384	$50,995	$107,793	$158,788	$37,845	$88,840
2000	36.87	328.38	$16,723	$25,800	$10,943	$53,466	$114,674	$168,139	$40,261	$93,727
2001	40.16	368.54	$18,157	$28,033	$11,965	$58,155	$128,373	$186,527	$45,071	$103,225
2002	43.45	411.99	$19,672	$30,405	$13,002	$63,079	$141,430	$204,509	$49,655	$112,734
2003	46.74	458.73	$21,162	$32,708	$13,987	$67,857	$152,145	$220,002	$53,417	$121,274
2004	50.03	508.76	$22,652	$35,012	$14,972	$72,636	$162,859	$235,495	$57,178	$129,814
2005	53.33	562.09	$24,143	$37,315	$15,957	$77,414	$173,573	$250,987	$60,940	$138,354

Cumulative Delay Savings

Year	Low Estimate A/C Operating Costs (1990 $,K's)	Low Estimate Passenger Value Time (1990 $,K's)	Low Estimate Total (1990 $,K's)	High Estimate A/C Operating Costs (1990 $,K's)	High Estimate Passenger Value Time (1990 $,K's)	High Estimate Total (1990 $,K's)
1990	$38,981	$24,214	$63,195	$38,981	$68,969	$107,950
1991	$78,513	$48,188	$126,701	$78,513	$137,253	$215,766
1992	$118,420	$72,647	$191,067	$118,420	$206,917	$325,337
1993	$158,807	$98,087	$256,894	$158,807	$279,378	$438,185
1994	$199,524	$124,565	$324,090	$199,524	$354,794	$554,319
1995	$240,711	$152,338	$393,050	$240,711	$433,899	$674,610
1996	$284,221	$182,666	$466,887	$284,221	$520,281	$804,502
1997	$330,312	$215,496	$545,807	$330,312	$613,788	$944,099
1998	$378,777	$250,855	$629,632	$378,777	$714,501	$1,093,278
1999	$429,772	$288,700	$718,472	$429,772	$822,294	$1,252,066
2000	$483,238	$328,961	$812,199	$483,238	$936,968	$1,420,205
2001	$541,392	$374,032	$915,424	$541,392	$1,065,340	$1,606,733
2002	$604,471	$423,687	$1,028,158	$604,471	$1,206,771	$1,811,242
2003	$672,328	$477,104	$1,149,432	$672,328	$1,358,915	$2,031,244
2004	$744,964	$534,282	$1,279,246	$744,964	$1,521,774	$2,266,738
2005	$822,379	$595,222	$1,417,601	$822,379	$1,695,347	$2,517,726

Discounted 1990 Constant Dollars:

Annual Delay Savings

Year	Annual Delay Hrs. Saved (Ks)	Cumulative Delay Hrs. Saved (Ks)	Air Carrier Operating Costs (1990 Dollars, K's) Crew	Fuel/Oil	Maintenance	Total	High Estimate Passenger Value Time Costs (1990 $, K's) (all delays)	High Estimate Total (1990 $, K's)	Low Estimate Passenger Value Time Costs (1990 $, K's) (delays>15min)	Low Estimate Total (1990 $, K's) (delays>15min)
1990	25.57	25.57	$11,188	$17,239	$7,010	$35,437	$62,699	$98,136	$22,013	$57,450
1991	26.10	51.68	$10,294	$15,893	$6,483	$32,671	$56,433	$89,104	$19,813	$52,484
1992	26.63	78.30	$9,459	$14,563	$5,961	$29,983	$52,339	$82,322	$18,376	$48,359
1993	27.16	105.46	$8,701	$13,376	$5,508	$27,585	$49,492	$77,077	$17,376	$44,961
1994	27.68	133.14	$7,983	$12,237	$5,062	$25,282	$46,828	$72,110	$16,441	$41,723
1995	28.21	161.35	$7,344	$11,239	$4,666	$23,249	$44,653	$67,902	$15,677	$38,926
1996	29.94	191.29	$7,049	$10,783	$4,495	$22,327	$44,328	$66,655	$15,563	$37,890
1997	31.67	222.97	$6,771	$10,388	$4,343	$21,502	$43,621	$65,123	$15,315	$36,817
1998	33.40	256.37	$6,462	$9,926	$4,166	$20,554	$42,712	$63,266	$14,996	$35,550
1999	35.14	291.51	$6,163	$9,494	$4,004	$19,661	$41,559	$61,220	$14,591	$34,252
2000	36.87	328.38	$5,861	$9,043	$3,836	$18,739	$40,192	$58,932	$14,111	$32,851
2001	40.16	368.54	$5,786	$8,932	$3,812	$18,530	$40,903	$59,433	$14,361	$32,891
2002	43.45	411.99	$5,698	$8,807	$3,766	$18,272	$40,967	$59,239	$14,383	$32,655
2003	46.74	458.73	$5,573	$8,613	$3,683	$17,869	$40,064	$57,933	$14,066	$31,935
2004	50.03	508.76	$5,423	$8,362	$3,584	$17,368	$38,987	$56,376	$13,688	$31,076
2005	53.33	562.09	$5,254	$8,121	$3,473	$16,848	$37,775	$54,622	$13,262	$30,110

Cumulative Delay Savings

Year	Low Estimate A/C Operating Costs (1990 $,K's)	Low Estimate Passenger Value Time (1990 $,K's)	Low Estimate Total (1990 $,K's)	High Estimate A/C Operating Costs (1990 $,K's)	High Estimate Passenger Value Time (1990 $,K's)	High Estimate Total (1990 $,K's)
1990	$35,437	$22,013	$57,450	$35,437	$62,699	$98,136
1991	$68,108	$41,826	$109,935	$68,108	$119,132	$187,240
1992	$98,091	$60,202	$158,294	$98,091	$171,471	$269,563
1993	$125,676	$77,578	$203,254	$125,676	$220,963	$346,639
1994	$150,958	$94,019	$244,977	$150,958	$267,791	$418,749
1995	$174,207	$109,696	$283,904	$174,207	$312,444	$486,651
1996	$196,535	$125,259	$321,794	$196,535	$356,771	$553,306
1997	$218,036	$140,575	$358,611	$218,036	$400,393	$618,429
1998	$238,590	$155,570	$394,161	$238,590	$443,105	$681,695
1999	$258,251	$170,161	$428,412	$258,251	$484,664	$742,915
2000	$276,990	$184,273	$461,263	$276,990	$524,856	$801,847
2001	$295,520	$198,634	$494,154	$295,520	$565,760	$861,280
2002	$313,792	$213,017	$526,809	$313,792	$606,727	$920,519
2003	$331,661	$227,083	$556,744	$331,661	$646,792	$978,453
2004	$349,049	$240,771	$589,821	$349,049	$685,779	$1,034,828
2005	$365,897	$254,033	$619,930	$365,897	$723,553	$1,089,450

Table C-1 Summary of 2% Capacity Gain Case Analysis

4% CAPACITY GAIN RESULTS

Undiscounted 1990 Constant Dollars:

			Annual Delay Savings								Cumulative Delay Savings					
							High Estimate		Low Estimate		Low Estimate			High Estimate		
	Annual Delay Hrs. Saved (Ks)	Cumulative Delay Hrs. Saved (Ks)	Air Carrier Operating Costs (1990 Dollars, K's) Crew	Fuel/Oil	Maintenance	Total	Passenger Value Time Costs (1990 $, K's) (all delays)	Total (1990 $, K's)	Passenger Value Time Costs (1990 $, K's) (delays>15min)	Total (1990 $, K's) (delays>15min)	A/C Operating Costs (1990 $,K's)	Passenger Value Time (1990 $,K's)	Total (1990 $,K's)	A/C Operating Costs (1990 $,K's)	Passenger Value Time (1990 $,K's)	Total (1990 $,K's)
1990	49.06	49.06	$23,608	$36,377	$14,792	$74,777	$132,302	$207,079	$46,412	$121,189	$74,777	$46,412	$121,189	$74,777	$132,302	$207,079
1991	50.18	99.24	$23,949	$36,975	$15,083	$76,007	$131,289	$207,295	$46,056	$122,063	$150,784	$92,468	$243,251	$150,784	$263,590	$414,374
1992	51.31	150.55	$24,259	$37,350	$15,289	$76,897	$134,234	$211,131	$47,089	$123,987	$227,681	$139,557	$367,238	$227,681	$397,824	$625,505
1993	52.44	202.99	$24,598	$37,816	$15,571	$77,984	$139,917	$217,902	$49,083	$127,068	$305,665	$188,640	$494,306	$305,665	$537,741	$843,407
1994	53.56	256.55	$24,877	$38,131	$15,772	$78,781	$145,919	$224,699	$51,188	$129,969	$384,446	$239,829	$624,275	$384,446	$683,660	$1,068,106
1995	54.69	311.24	$25,220	$38,600	$16,024	$79,844	$153,351	$233,195	$53,796	$133,640	$464,290	$293,625	$757,915	$464,290	$837,011	$1,301,301
1996	57.94	369.17	$26,582	$40,660	$16,952	$84,194	$167,155	$251,349	$58,638	$142,832	$548,484	$352,263	$900,747	$548,484	$1,004,166	$1,552,650
1997	61.19	430.36	$28,041	$43,019	$17,984	$89,044	$180,647	$269,691	$63,371	$152,415	$637,528	$415,634	$1,053,162	$637,528	$1,184,813	$1,822,341
1998	64.44	494.81	$29,394	$45,151	$18,950	$93,495	$194,289	$287,783	$68,157	$161,652	$731,023	$483,791	$1,214,814	$731,023	$1,379,102	$2,110,125
1999	67.69	562.50	$30,797	$47,443	$20,006	$98,247	$207,673	$305,920	$72,852	$171,099	$829,270	$556,643	$1,385,913	$829,270	$1,586,774	$2,416,044
2000	70.95	633.44	$32,179	$49,647	$21,058	$102,884	$220,666	$323,550	$77,410	$180,294	$932,154	$634,053	$1,566,206	$932,154	$1,807,441	$2,739,594
2001	77.02	710.46	$34,823	$53,762	$22,946	$111,531	$246,198	$357,729	$86,366	$197,898	$1,043,685	$720,419	$1,764,104	$1,043,685	$2,053,638	$3,097,323
2002	83.09	793.56	$37,620	$58,145	$24,864	$120,629	$270,465	$391,094	$94,880	$215,509	$1,164,314	$815,299	$1,979,613	$1,164,314	$2,324,104	$3,488,418
2003	89.17	882.73	$40,370	$62,396	$26,682	$129,448	$290,238	$419,686	$101,816	$231,264	$1,293,762	$917,115	$2,210,877	$1,293,762	$2,614,342	$3,908,104
2004	95.24	977.97	$43,120	$66,647	$28,500	$138,267	$310,011	$448,278	$108,752	$247,019	$1,432,028	$1,025,867	$2,457,896	$1,432,028	$2,924,353	$4,356,381
2005	101.32	1,079.29	$45,870	$70,898	$30,317	$147,085	$329,784	$476,869	$115,689	$262,774	$1,579,114	$1,141,556	$2,720,670	$1,579,114	$3,254,136	$4,833,250

Discounted 1990 Constant Dollars:

			Annual Delay Savings								Cumulative Delay Savings					
							High Estimate		Low Estimate		Low Estimate			High Estimate		
	Annual Delay Hrs. Saved (Ks)	Cumulative Delay Hrs. Saved (Ks)	Air Carrier Operating Costs (1990 Dollars, K's) Crew	Fuel/Oil	Maintenance	Total	Passenger Value Time Costs (1990 $, K's) (all delays)	Total (1990 $, K's)	Passenger Value Time Costs (1990 $, K's) (delays>15min)	Total (1990 $, K's) (delays>15min)	A/C Operating Costs (1990 $,K's)	Passenger Value Time (1990 $,K's)	Total (1990 $,K's)	A/C Operating Costs (1990 $,K's)	Passenger Value Time (1990 $,K's)	Total (1990 $,K's)
1990	49.06	49.06	$21,461	$33,070	$13,448	$67,979	$120,274	$188,254	$42,192	$110,172	$67,979	$42,192	$110,172	$67,979	$120,274	$188,254
1991	50.18	99.24	$19,793	$30,558	$12,465	$62,815	$108,503	$171,318	$38,063	$100,878	$130,794	$80,255	$211,050	$130,794	$228,777	$359,572
1992	51.31	150.55	$18,226	$28,061	$11,487	$57,774	$100,852	$158,626	$35,379	$93,153	$188,569	$115,634	$304,203	$188,569	$329,629	$518,198
1993	52.44	202.99	$16,801	$25,829	$10,635	$53,264	$95,565	$148,830	$33,524	$86,789	$241,833	$149,159	$390,992	$241,833	$425,194	$667,028
1994	53.56	256.55	$15,447	$23,677	$9,793	$48,917	$90,604	$139,521	$31,784	$80,701	$290,750	$180,943	$471,692	$290,750	$515,799	$806,548
1995	54.69	311.24	$14,236	$21,789	$9,045	$45,070	$86,563	$131,632	$30,366	$75,436	$335,819	$211,309	$547,129	$335,819	$602,361	$938,181
1996	57.94	369.17	$13,641	$20,865	$8,699	$43,205	$85,777	$128,982	$30,091	$73,295	$379,024	$241,400	$620,424	$379,024	$688,138	$1,067,162
1997	61.19	430.36	$13,081	$20,069	$8,390	$41,540	$84,273	$125,813	$29,563	$71,103	$420,564	$270,963	$691,527	$420,564	$772,411	$1,192,975
1998	64.44	494.81	$12,466	$19,149	$8,037	$39,651	$82,397	$122,048	$28,905	$68,556	$460,215	$299,868	$760,083	$460,215	$854,809	$1,315,024
1999	67.69	562.50	$11,874	$18,291	$7,713	$37,878	$80,067	$117,945	$28,088	$65,966	$498,093	$327,956	$826,049	$498,093	$934,875	$1,432,969
2000	70.95	633.44	$11,279	$17,401	$7,381	$36,060	$77,342	$113,402	$27,132	$63,192	$534,153	$355,087	$889,241	$534,153	$1,012,218	$1,546,371
2001	77.02	710.46	$11,096	$17,130	$7,311	$35,537	$78,446	$113,983	$27,519	$63,056	$569,691	$382,606	$952,297	$569,691	$1,090,664	$1,660,355
2002	83.09	793.56	$10,897	$16,843	$7,202	$34,942	$78,344	$113,286	$27,483	$62,425	$604,633	$410,090	$1,014,722	$604,633	$1,169,008	$1,773,641
2003	89.17	882.73	$10,631	$16,431	$7,026	$34,088	$76,429	$110,516	$26,811	$60,899	$638,720	$436,901	$1,075,621	$638,720	$1,245,437	$1,884,157
2004	95.24	977.97	$10,323	$15,955	$6,823	$33,100	$74,214	$107,314	$26,034	$59,134	$671,820	$462,935	$1,134,756	$671,820	$1,319,651	$1,991,471
2005	101.32	1,079.29	$9,963	$15,429	$6,598	$32,010	$71,771	$103,781	$25,177	$57,187	$703,830	$488,113	$1,191,943	$703,830	$1,391,421	$2,095,252

Table C-2 Summary of 4% Capacity Gain Case Analysis

6% Capacity Gain Results

Undiscounted 1990 Constant Dollars:

	Annual Delay Hrs. Saved (Ks)	Cumulative Delay Hrs. Saved (Ks)	Air Carrier Operating Costs (1990 Dollars, K's) Crew	Fuel/Oil	Maintenance	Total	Annual Delay Savings: High Estimate Passenger Value Time Costs (1990 $, K's) (all delays)	Total (1990 $, K's)	Low Estimate Passenger Value Time Costs (1990 $, K's) (delays>15min)	Total (1990 $, K's) (delays>15min)	Cumulative Delay Savings: Low Estimate A/C Operating Costs (1990 $,K's)	Passenger Value Time (1990 $,K's)	Total (1990 $,K's)	High Estimate A/C Operating Costs (1990 $,K's)	Passenger Value Time (1990 $,K's)	Total (1990 $,K's)
1990	70.79	70.79	$34,065	$52,491	$21,345	$107,901	$190,908	$298,809	$66,921	$174,823	$107,901	$66,921	$174,823	$107,901	$190,908	$298,809
1991	72.56	143.35	$34,625	$53,458	$21,806	$109,890	$189,817	$299,707	$66,539	$176,429	$217,791	$133,461	$351,252	$217,791	$380,725	$598,516
1992	74.32	217.67	$35,139	$54,101	$22,146	$111,386	$194,438	$305,824	$68,159	$179,545	$329,178	$201,620	$530,797	$329,178	$575,163	$904,340
1993	76.09	293.76	$35,693	$54,874	$22,595	$113,162	$203,033	$316,195	$71,172	$184,334	$442,340	$272,791	$715,131	$442,340	$778,196	$1,220,536
1994	77.86	371.61	$36,160	$55,427	$22,926	$114,513	$212,103	$326,616	$74,351	$188,865	$556,853	$347,143	$903,996	$556,853	$990,299	$1,547,152
1995	79.62	451.23	$36,719	$56,199	$23,330	$116,249	$223,271	$339,519	$78,266	$194,515	$673,102	$425,409	$1,098,511	$673,102	$1,213,569	$1,886,671
1996	84.23	535.46	$38,643	$59,108	$24,644	$122,395	$242,998	$365,392	$85,181	$207,576	$795,497	$510,590	$1,306,087	$795,497	$1,456,567	$2,252,064
1997	88.83	624.29	$40,708	$62,453	$26,108	$129,269	$262,254	$391,523	$91,931	$221,200	$924,766	$602,521	$1,527,287	$924,766	$1,718,821	$2,643,586
1998	93.44	717.73	$42,620	$65,468	$27,477	$135,564	$281,711	$417,275	$98,752	$234,316	$1,060,330	$701,273	$1,761,603	$1,060,330	$2,000,532	$3,060,861
1999	98.04	815.77	$44,605	$68,714	$28,976	$142,296	$300,782	$443,079	$105,437	$247,733	$1,202,626	$806,711	$2,009,336	$1,202,626	$2,301,314	$3,503,940
2000	102.65	918.42	$46,560	$71,833	$30,469	$148,861	$319,279	$468,140	$111,921	$260,782	$1,351,487	$918,632	$2,270,119	$1,351,487	$2,620,593	$3,972,080
2001	111.13	1,029.56	$50,247	$77,575	$33,110	$160,932	$355,245	$516,177	$124,529	$285,460	$1,512,418	$1,043,160	$2,555,579	$1,512,418	$2,975,838	$4,488,256
2002	119.62	1,149.18	$54,155	$83,703	$35,793	$173,651	$389,347	$562,998	$136,483	$310,134	$1,686,069	$1,179,644	$2,865,713	$1,686,069	$3,365,185	$5,051,255
2003	128.10	1,277.28	$57,996	$89,640	$38,332	$185,968	$416,964	$602,932	$146,164	$332,132	$1,872,037	$1,325,807	$3,197,845	$1,872,037	$3,782,149	$5,654,186
2004	136.59	1,413.87	$61,838	$95,577	$40,871	$198,285	$444,580	$642,865	$155,845	$354,130	$2,070,322	$1,481,652	$3,551,974	$2,070,322	$4,226,728	$6,297,051
2005	145.07	1,558.94	$65,679	$101,514	$43,409	$210,602	$472,196	$682,798	$165,525	$376,127	$2,280,924	$1,647,177	$3,928,102	$2,280,924	$4,698,924	$6,979,849

Discounted 1990 Constant Dollars:

	Annual Delay Hrs. Saved (Ks)	Cumulative Delay Hrs. Saved (Ks)	Air Carrier Operating Costs (1990 Dollars, K's) Crew	Fuel/Oil	Maintenance	Total	Annual Delay Savings: High Estimate Passenger Value Time Costs (1990 $, K's) (all delays)	Total (1990 $, K's)	Low Estimate Passenger Value Time Costs (1990 $, K's) (delays>15min)	Total (1990 $, K's) (delays>15min)	Cumulative Delay Savings: Low Estimate A/C Operating Costs (1990 $,K's)	Passenger Value Time (1990 $,K's)	Total (1990 $,K's)	High Estimate A/C Operating Costs (1990 $,K's)	Passenger Value Time (1990 $,K's)	Total (1990 $,K's)
1990	70.79	70.79	$30,968	$47,719	$19,404	$98,092	$173,553	$271,645	$60,838	$158,930	$98,092	$60,838	$158,930	$98,092	$173,553	$271,645
1991	72.56	143.35	$28,616	$44,181	$18,022	$90,818	$156,874	$247,692	$54,991	$145,809	$188,910	$115,829	$304,739	$188,910	$330,426	$519,336
1992	74.32	217.67	$26,400	$40,647	$16,639	$83,686	$146,084	$229,770	$51,209	$134,895	$272,596	$167,038	$439,634	$272,596	$476,510	$749,107
1993	76.09	293.76	$24,379	$37,480	$15,433	$77,291	$138,674	$215,965	$48,611	$125,903	$349,888	$215,649	$565,537	$349,888	$615,184	$965,072
1994	77.86	371.61	$22,453	$34,416	$14,235	$71,104	$131,699	$202,803	$46,166	$117,270	$420,992	$261,815	$682,807	$420,992	$746,884	$1,167,875
1995	79.62	451.23	$20,727	$31,723	$13,169	$65,619	$126,031	$191,650	$44,179	$109,799	$486,611	$305,994	$792,605	$486,611	$872,914	$1,359,525
1996	84.23	535.46	$19,830	$30,332	$12,646	$62,808	$124,696	$187,504	$43,711	$106,519	$549,419	$349,706	$899,125	$549,419	$997,610	$1,547,029
1997	88.83	624.29	$18,991	$29,135	$12,180	$60,305	$122,343	$182,648	$42,887	$103,192	$609,724	$392,592	$1,002,316	$609,724	$1,119,954	$1,729,677
1998	93.44	717.73	$18,075	$27,765	$11,653	$57,492	$119,473	$176,965	$41,880	$99,373	$667,216	$434,473	$1,101,689	$667,216	$1,239,427	$1,906,643
1999	98.04	815.77	$17,197	$26,492	$11,172	$54,861	$115,965	$170,826	$40,651	$95,512	$722,077	$475,124	$1,197,201	$722,077	$1,355,391	$2,077,469
2000	102.65	918.42	$16,319	$25,177	$10,679	$52,175	$111,905	$164,080	$39,228	$91,403	$774,252	$514,351	$1,288,604	$774,252	$1,467,297	$2,241,549
2001	111.13	1,029.56	$16,010	$24,718	$10,550	$51,278	$113,192	$164,470	$39,679	$90,956	$825,530	$554,030	$1,379,560	$825,530	$1,580,489	$2,406,019
2002	119.62	1,149.18	$15,687	$24,246	$10,368	$50,301	$112,780	$163,081	$39,534	$89,835	$875,831	$593,564	$1,469,395	$875,831	$1,693,269	$2,569,099
2003	128.10	1,277.28	$15,272	$23,605	$10,094	$48,971	$109,800	$158,771	$38,490	$87,461	$924,802	$632,054	$1,556,856	$924,802	$1,803,068	$2,727,870
2004	136.59	1,413.87	$14,803	$22,880	$9,784	$47,468	$106,429	$153,897	$37,308	$84,776	$972,270	$669,362	$1,641,631	$972,270	$1,909,497	$2,881,767
2005	145.07	1,558.94	$14,294	$22,092	$9,447	$45,833	$102,764	$148,597	$36,023	$81,856	$1,018,103	$705,385	$1,723,488	$1,018,103	$2,012,261	$3,030,363

Table C-3 Summary of 6% Capacity Gain Case Analysis

APPENDIX D

From/on -> Ldng/over

ZAB STATIC RESTRICTIONS

TO ZLA:			
	10 MIT	/DRK	-> ALL
	15 MIT	/BLH,BZA	(2 time periods)

ZAU STATIC RESTRICTIONS

TO ZOB:			
	10 MIT		-> MSP
	15 MIT	/PMM-HI	-> ORD
	20 MIT	/PMM	-> DTW
	30 MIT	/FWA-HI	-> ORD
TO ZID:			
	20 MIT (15 MIT other time periods)	/OKK	-> ORD
	25 MIT		-> DTW
TO ZMP:			
	10 MIT		-> JFK
	15 MIT	/KRENA	-> ORD
TO ZKC:			
	20 MIT	/BDF J26	-> ORD
	20 MIT (15 MIT others)	/BDF J105	-> ORD

ZDC STATIC RESTRICTIONS

TO ZID:			
	10 MIT	J147	-> BWI
	10 MIT	J213	-> DCA,IAD,ADW
TO ZJX:			
	15 MIT		-> RDU

ZFW STATIC RESTRICTIONS

TO ZAB:			
	10 MIT	/AMA-HI	-> DFW
TO ZHU:			
	10 MIT	J58	-> DFW
TO ZME:			
	10 MIT	/ELD-HI	-> DFW
	10 MIT	/DECOD-H	-> DFW

ZID STATIC RESTRICTIONS

TO ZKC:			
	10 MIT	/KNG	-> ALL TRFC
TO ZAU:			
	15 MIT	/KNG	-> ALL TRFC
	20 MIT	/OLK	-> DAY
TO ZOB:			
	15 MIT		-> CVG,LUK
	20 MIT	/MNN,TOL	-> DAY
TO ZDC:			
	15 MIT		-> CVG
	20 MIT	J149	-> ORD
TO ZTL:			
	10 MIT		-> CVG
	20 MIT		-> ORD
TO ZME:			
	10 MIT		-> CVG

From/on -> Ldng/over

ZNY STATIC RESTRICTIONS

TO PHL:			
	15 MIT	/PHL	->/DITCH (2 time periods)
TO ZOB:			
	15 MIT	/SLT	-> EWR
	15 MIT	/SLT	-> BWI
	15 MIT		-> IAD
	15 MIT	J70	-> JFK
	15 MIT	J70	-> EWR,STLTS
	20 MIT	/PSB	-> CARIBBEAN
	20 MIT	J152	-> PHL
	20 MIT		-> RDU
TO ZBW:			
	15/20 MIT	/HNK	-> PIT (2 time periods)
	15 MIT	/CMK	-> BWI (2 time periods)
	15/20 MIT	/SAX	-> IAD (2 time periods)
	15 MIT		-> PHL,STLTS
	15 MIT	/MANTA-L(	-> ALL (2 time periods)
	15 MIT	/SPA	-> IAD (2 time periods)

ZOB STATIC RESTRICTIONS

TO ZAU:			
	10 MIT	/MKG	-> DTW
	10 MIT	/ALL	
	15 MIT	/LFD	-> DTW
	15 MIT		-> JFK
	25 MIT	/FWA	-> DTW
TO ZBW:			
	10/20 MIT		-> ORD
	20 MIT		-> DTW
TO ZID:			
	10 MIT	J29,APE,CXR	
	10 MIT	/RITZ	-> CLE
	20 MIT		-> DTW
	20 MIT	/CTW,PKB	-> PIT
TO YYZ (Canada):			
	10 MIT	/BUF-HI,ROC-HI	
	15 MIT		-> ORD
TO ZNY:			
	10 MIT	J80	
	15 MIT	J36	-> ORD
	15 MIT	/NESTO,GRACE	-> PIT,AGC
	20 MIT		-> DTW
TO ZDC:			
	10 MIT	J211/J518	
	15 MIT		-> PIT

Table D-1 Summary of FAA Static MIT Restrictions Effective 12/01/91