
October 1994

NEW DENVER AIRPORT

Impact of the Delayed Baggage System



**Resources, Community, and
Economic Development Division**

B-258641

October 14, 1994

The Honorable Hank Brown
United States Senate

Dear Senator Brown:

This briefing report responds to certain issues in your May 5, 1994, letter concerning delays in the opening of the new Denver International Airport. It documents the briefing we provided to your office on September 22, 1994, and specifically addresses three areas regarding the new airport: (1) problems with the baggage handling system that delayed the airport's opening, (2) the added costs resulting from the delay, and (3) the adequacy of expected revenues at the new airport to cover the cost of operating the facility and to service its debt. This report addresses issues you identified as requiring an immediate response. We will meet with your staff to discuss the other, longer-term, issues raised in your letter.

Background

The new Denver International Airport was built to replace Stapleton International Airport, a facility that has experienced serious air traffic congestion and noise problems.¹ The new airport is the first major airport to be built in the United States since 1974. Spread out over 50 square miles, it has the capacity to expand eventually to 12 runways. On opening, the airport will have a terminal building and three concourses, the farthest of which will be about 1 mile from the terminal. Concourse A will serve Continental Airlines, Continental Express, GP Express, and a variety of international carriers. Concourse B will serve United Airlines and United Express. American, Delta, Frontier, Markair, Northwest, TWA, and USAir will use Concourse C.

On the basis of cost estimates as of September 1, 1994, the total cost to build the new airport will be about \$4.9 billion, of which the Federal Aviation Administration (FAA) has committed \$685 million from the Airport and Airway Trust Fund. Most of the money needed to build the airport has come from revenue bonds issued by the Denver Airport System.² (See sec. 1 for details on the total cost of the airport and sec. 2 for a breakdown of federal funds.)

¹We addressed other issues relating to the new airport in two prior reports: *New Denver Airport: Safety, Construction, Capacity, and Financing Considerations* (GAO/RCED-91-240, Sept. 17, 1991) and *New Denver Airport Followup* (GAO/RCED-92-285R, Sept. 14, 1992).

²Denver Airport System is headed by the Manager of the Department of Aviation, who reports directly to the Mayor of the City of Denver.

Because the airport is so large, airport planners decided that a state-of-the-art automated baggage handling system, capable of moving bags much more quickly than conventional tug-and-cart/conveyor belt systems, would be needed. BAE Automated Systems Incorporated was awarded a \$193 million contract to design, build, and test an automated baggage handling system. This system was designed to move baggage from the check-in areas to the aircraft within 20 minutes. However, the baggage handling system installed at the new airport has had many problems and does not yet work satisfactorily. Originally, the airport was scheduled to open in October 1993, but problems with the baggage handling system have caused several postponements.

Results in Brief

The automated baggage handling system has had serious mechanical and software problems and has yet to successfully pass the tests necessary for it to be certified operational. In previous tests of the system, bags were misloaded, were misrouted, or fell out of telecarts, causing the system to jam. BAE is modifying the automated system to correct these problems. However, the airport is installing an alternative, conventional baggage handling system using conveyor belts, tugs, and carts that will be used at the airport at least until the automated system is operating. The alternative system is estimated to cost about \$51 million.

Although Denver airport officials believe that this alternative system can be completed in time to allow the airport to open by February 28, 1995, the airport cannot open until an operating baggage system has been successfully tested. In addition, the contractor responsible for the conventional system has only recently started to make the structural modifications necessary to operate the system. Airport officials hope that Concourse B, serving United, will have the automated system operating at the targeted opening date. If the automated system is not yet operational, United will also be served by the conventional system. Whether the automated system will eventually serve all areas of the airport or whether some parts will continue to be served by the conventional system is yet to be resolved.

The airport was originally scheduled to open in October 1993; however, debt service did not begin until January 1, 1994. Up to that date, revenues from Stapleton were sufficient to cover the operating costs at Stapleton as well as the costs associated with the new airport. After January 1, 1994, the costs of operating both airports, combined with the debt service requirements, exceeded the revenues generated by Stapleton. The deficit

currently is between \$18 million and \$19 million each month. If all the costs of delay are counted, including foregone net income, the total cost of the delay will be about \$360 million if the airport opens at the end of February 1995.

The airport should be able to meet its financial obligations once it opens if current traffic forecasts are realized and if cost estimates are correct. Traffic projections are based on current levels at Stapleton, which has about 16 million enplanements annually, and are expected to increase to 18.3 million in 2000. The agreement between the airport and the airlines limits the amount that the airlines pay in user fees to \$20 per enplaned passenger (in 1990 dollars). These user fees are calculated after all other revenues are applied to cover operating costs and debt service. If current traffic, revenue, and cost projections are accurate, the airlines' user fees should be several dollars under the cap.

The accuracy of the Denver Airport System's forecasts depends on several assumptions: (1) savings from bond refinancing, (2) Continental Airlines' revenues at projected levels, (3) FAA discretionary funds' being awarded, and (4) an operational baggage system in place.

Problems With the Baggage Handling System Have Delayed the Opening of the New Airport

Significant mechanical and software problems have plagued the automated baggage handling system. Denver airport officials are still uncertain of how long it will take to correct all the problems. In a recent report, BAE listed 72 tasks that must be completed before the system is ready for testing. Then, the baggage system will be put through a series of tests before it is certified as operational. It is possible that these tests could reveal additional problems.

To open the airport by the end of February 1995, Denver has decided to install a conventional baggage system to serve as an alternative to the automated system. The alternative system, using conveyors, tugs, and carts, will handle baggage between the terminal and all three concourses until the automated system is operating properly. The automated system will be operating first at Concourse B, which will serve United, and within 6 months at Concourse A, which will serve Continental and international carriers. When the system for Concourse A becomes operational, airport system officials will decide whether Concourse C will receive the automated system or whether airlines on that concourse will continue to use the conventional system. The alternative system is scheduled to be ready by January 1995.

In addition to developing the alternative system, Denver has negotiated with BAE to make substantial modifications to the automated system. These modifications include changing the routing of the telecarts so that more of them serve United at Concourse B. As part of this agreement, United will contract directly with BAE for these modifications. On September 29, 1994, BAE, United, and the City reached agreement on the modifications to be made to the automated system. The estimated cost to Denver for the modifications is about \$35 million.

Excessive time to move baggage can affect the efficiency of an airline's operations by creating scheduling problems and disrupting the efficient use of its aircraft fleet. The original automated baggage system was designed to deliver bags from the terminal to the aircraft within 20 minutes. Recent Denver Airport System studies indicate that transit times will only be moderately longer with the alternative system—up to 5 minutes longer. The airlines have challenged this estimate as being overly optimistic. United believes it could take up to 50 minutes for baggage to reach the most remote gates on Concourse B. Airlines on Concourse C claim that transit times to and from Concourse C will be 27 to 31 minutes. Transit times for the modified automated system are not yet available. (See sec. 3 for more detailed information on the automated and alternative baggage systems.)

The Delayed Opening Has Caused Sizeable Increases in Total Costs of the New Airport

The Denver Airport System began to experience operating deficits after January 1, 1994, when debt payments began. By the end of February 1995, the operating deficit will total about \$230 million. The Denver Airport System has used the 1993 operating surplus from Stapleton, contributions from the airlines, bond proceeds, and other moneys set aside in various reserve accounts to cover the deficit. As of September 1, 1994, the Denver Airport System had about \$467 million available—including proceeds from its recent bond issue—to cover the airport system's future deficits. However, according to bond analysts to whom we spoke, not all of these funds, especially those in the bond reserve fund, could be committed to debt coverage without compromising the new airport's credit rating. Precisely how much could be spent from these funds before the credit rating could be affected is not known.

Operating deficits are only part of the cost of the delayed opening. The total cost of the delays to the airport and the airlines might reach \$360 million by February 1995. In addition to the deficit, other costs are \$37 million in lost income that the new airport would have generated if it

opened on January 1, 1994, \$86 million for the alternative baggage system and the modifications to the automated system, and \$8 million in fees associated with issuing the additional bonds. (See sec. 4 for additional details on the costs of the delay and available revenues.)

The New Airport's Ability to Meet Operating and Debt Service Costs Is Linked to Current Traffic Projections

To evaluate whether the current delays and added costs would materially affect the airport's ability to meet operating and debt service costs when it opens, we reviewed current projections of the airport's traffic, revenues, and costs. A simulation model, developed by Hickling Corporation,³ was employed to identify how different traffic forecasts affected the airport's financial situation. The model included recent information on the traffic forecasts, project costs, financing plan, and financial statements for the airport.

Air traffic at Denver has recovered from the depressed level of 13.7 million enplanements in 1989. Traffic at Stapleton has grown to 16.3 million enplanements in 1993. The 1993 traffic level was used as a base for projecting future airport revenues in the most recent bond prospectus, and traffic was projected to increase to 18.3 million in 2000. If these forecasts materialize, the new airport should produce sufficient revenues to cover expenses and service the debt. Projected traffic would have to be 20-25 percent lower than what is now forecast for the airport to experience a high probability of sustained revenue shortfalls.

The new airport will be a relatively expensive facility, as airline user fees will be about 3 times higher than those at Stapleton. The agreement between the airport and the airlines limits the amount that the airlines will pay in user fees to \$20 per enplaned passenger (in 1990 dollars). These user fees are calculated after all other revenues are applied to cover operating costs and debt service. If traffic, revenue, and cost estimates are accurate, airlines' user fees should be below the cap—about \$14.50 in 1990 dollars.⁴ (See sec. 5 for more information on the financial outlook of the new airport.)

³Hickling Corporation, a consulting firm that specializes in risk assessment for airport investment projects, assisted us in our evaluation. Hickling also provided assistance during our 1991 review of the Denver airport project. Hickling has developed a risk analysis model applicable to a wide range of subjects; the model has been used for airport infrastructure projects in Minneapolis/St. Paul, Minn., and in Vancouver and Toronto, Canada.

⁴Because the cap is in 1990 dollars it rises over time. The cap in current 1994 dollars is about \$22.50 and actual fees per enplanement are estimated to be \$17-\$18.

The accuracy of the Denver Airport System's revenue and cost projections is dependent on several important assumptions: (1) that \$121 million will be saved from 1995 through 1999 by restructuring and refinancing 1984/85 bonds, (2) that Continental Airlines will provide \$273 million from 1995 through 1999 for use of the airport, (3) that the airport will receive \$95 million from 1995 through 1998 in discretionary funds from FAA's letter of intent, and (4) that the airport will achieve an operational baggage system.

We performed our review between May 1994 and September 1994 in accordance with generally accepted government auditing standards. Because the analyses presented in this report are based on traffic, revenue, and cost forecasts that depend on key assumptions, caution must be used in arriving at conclusions regarding the experience of the airport in the first few years of operation. The extent to which these assumptions materialize will be important ingredients in the near-term financial experience of the new airport. The details of our scope and methodology are contained in appendix I.

At the end of our field work, we discussed the facts contained in this briefing report with senior officials from the Department of Transportation, including the Department's General Counsel, and the City of Denver, including the City's Director of Public Works and the Denver Airport System Finance Director. They generally agreed with the information presented, and we have incorporated their comments as appropriate.

Unless you publicly release its contents earlier, we plan no further distribution of this briefing report until 3 days from the date of this letter. At that time, we will send copies of this briefing report to the Secretary of Transportation; the Director, Office of Management and Budget; the City of Denver; and interested congressional committees. We will also make copies available to others on request.

Please contact me at (202) 512-2834 if you or your staff have any questions concerning this briefing report. Major contributors to this briefing report are listed in appendix II.

Sincerely yours,

A handwritten signature in black ink, reading "Kenneth M. Mead". The signature is written in a cursive style with a large, stylized initial 'K'.

Kenneth M. Mead
Director, Transportation Issues

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Abbreviations

AIP	Airport Improvement Program
DIA	Denver International Airport
FAA	Federal Aviation Administration
F&E	facilities and equipment
O&M	operations and maintenance
PFC	passenger facility charge
RAP	risk analysis process
SIA	Stapleton International Airport

Total Cost of Denver International Airport

Table 1.1: Cost of Denver International Airport

Dollars in millions	
Cost category	Cost
Costs to Denver Airport System	
Airport planning, land, and construction	\$3,214
Capitalized interest	919
Bond discounts and issuance expense	136
Total costs to Denver Airport System	4,269
Costs to others	
FAA facilities	224
United Airline's special facilities	261
Continental Airline's special facilities	73
Rental car facilities	66
Total costs to others	624
Grand total costs of Denver International Airport	\$4,893

Legend

FAA = Federal Aviation Administration.

Section 1
Total Cost of Denver International Airport

If Denver International Airport (DIA) opens by February 28, 1995, we estimate that the costs of the airport, including facilities funded by airlines, rental car companies, and FAA will be about \$4.9 billion. Of this amount, the Denver Airport System (airport system) has funded \$4.269 billion, including capitalized interest and Airport Improvement Program (AIP) grants. Details on AIP grants and FAA facilities and equipment funds are in table 2.1, page 12. FAA, the airlines, and rental car companies have contributed another \$624 million for their facilities.

The total cost encompasses all projects approved as of September 1, 1994. It excludes costs for a sixth runway, which has not yet been authorized, and other potential costs or recoveries arising from future legal settlements between the airport system and its contractors. Since September 1, 1994, Denver has agreed to build an alternative baggage system estimated to cost \$51 million and has agreed to further modifications to the automated baggage system, which will cost an estimated \$35 million.

Federal Funds for DIA

Table 2.1: Summary of Federal Funds for DIA

Dollars in millions

Fiscal year	Airport Improvement Program funds			Facilities and equipment funds	Total
	Entitlement funds	Discretionary funds	Total		
1988	\$ 0.2	\$ 0	\$ 0.2	\$ 0	\$ 0.2
1989	34.2	25.8	60.0	4.2	64.2
1990	31.0	59.0	90.0	39.2	129.2
1991	0	25.0	25.0	60.0	85.0
1992	2.2	42.3	44.5	41.7	86.2
1993	5.9	42.0	47.9	24.0	71.9
1994	2.9	32.0	34.9	1.2	36.1
1995	6.0	31.0	37.0	0	37.0
1996	6.0	25.0	31.0	12.4	43.4
1997	6.0	25.0	31.0	19.2	50.2
1998	6.0	25.0	31.0	18.0	49.0
1999	6.0	22.9	28.9	1.3	30.2
2000	0	0	0	2.4	2.4
Total	\$106.4	\$355.0	\$461.4	\$223.6	\$685.0

In 1988, the federal government began funding DIA through the Airport and Airway Trust Fund. As of September 1, 1994, FAA planned to spend \$685 million from the Trust Fund; \$472.8 million has already been transferred to DIA. Moneys for DIA have come from two major Trust Fund accounts—the Airport Improvement Program (AIP) and Facilities and Equipment (F&E).

The majority of the federal funding, \$461.4 million, for DIA comes from the AIP. Not all of this amount has been transferred to DIA. As of September 1, 1994, about \$302.5 million had been transferred—\$132.1 million under a letter of intent and \$170.4 million in other AIP grants.¹ The remainder will be distributed by the end of 1999. The AIP moneys have been used at DIA for such things as land acquisition, the construction of runways, taxiways, and aprons, and installation of a rail passenger transportation system. Federal funds will not be used to fund the automated baggage system. In 1990, FAA gave DIA a letter of intent for \$351 million;² however, this was significantly reduced because the airport system imposed a passenger facility charge in January 1992. By law, a portion of certain AIP moneys must be turned back if airports impose a passenger facility charge.

In addition to the AIP moneys received under the letter of intent, DIA received \$170.4 million in other AIP moneys. Most of this amount—\$150.2 million—was granted prior to the 1990 letter of intent. In fiscal years 1992 and 1993, DIA also received separate AIP grants (not under the letter of intent) totaling \$20.2 million to procure incursion lighting, conduct a light rail study, and begin work on a sixth runway. DIA expects to receive an additional \$50 million in AIP funds to complete the sixth runway. An FAA official told us, however, that FAA has not yet formally committed this amount. On September 22, 1994, congressional appropriators approved an amendment to the 1995 Department of Transportation Appropriations bill to prohibit the planning, engineering, design, and construction of a sixth runway at DIA unless the runway is needed to improve safety or performance.

DIA will receive about \$223.6 million of F&E moneys through 2000. Since 1989, the Congress has appropriated \$170.3 million in F&E funds for DIA.³ This money has been used for new air traffic control facilities; equipment such as an airport surveillance radar system, instrument landing systems, approach lights, weather sensors, and navigational aids; and transition operations from Stapleton International Airport (SIA) to DIA.

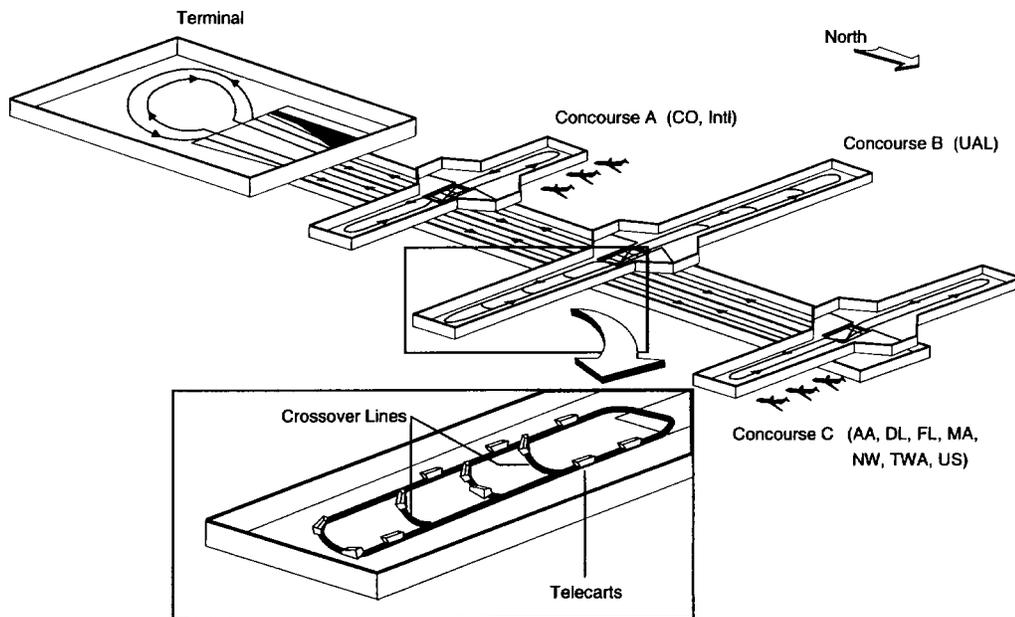
¹A letter of intent is a mechanism used to support projects at primary and reliever airports that will significantly enhance systemwide airport capacity. Typically, letters of intent allow airports to begin project development sooner and receive multiyear funding.

²These funds are not guaranteed. They must be appropriated each year.

³The congressional appropriation was \$170.3 million; however, FAA has reprogrammed about \$2 million to other projects.

DIA's Automated Baggage Handling System

GAO DIA's Automated Baggage Handling System



Key:

AA - American Airlines
CO - Continental Airlines
DL - Delta Airlines

FL - Frontier Airlines
INTL - International Carriers
MA - Markair

NW - Northwest Airlines
UAL - United Airlines
US - US Air

The automated baggage handling system, with a contract price of \$193 million, will be one of the largest and most sophisticated systems of its type in the world. It was designed to provide the high-speed transfer of baggage to and from aircraft, thereby facilitating quick turnaround times for aircraft and improved services to passengers. Baggage will travel between the terminal and concourses through interconnecting tunnels. The most distant concourse is located about a mile from the terminal.

Even after modifications are complete, the automated baggage handling system will have two main components: (1) high-speed, bag-carrying telecarts mounted on tracks and (2) connecting conveyor belts to load and off-load baggage. The tracks are suspended from the basement ceilings of the terminal and concourses. Electric motors and synchronous drives move the telecarts along the tracks at varying speeds. Photocells and radio frequency reading devices direct each telecart to the right location. In total, the original system included over 17 miles of track; 5.5 miles of conveyors; 4,000 telecarts; 5,000 electric motors; 2,700 photocells; 59 laser bar code reader arrays; 311 radio frequency readers; and over 150 computers, workstations, and communication servers. The automated system was originally designed to carry up to 70 bags per minute to and from the baggage check-in and baggage claim areas at speeds of up to 24 miles per hour. This would allow the airlines to receive checked baggage at their aircraft within 20 minutes.

GAO Problems with DIA's Automated
Baggage Handling System

- Baggage jams undetected
 - Double loading of telecars
 - Conveyor belts not synchronized with telecars
 - Telecars lock together when they collide
 - Empty car management
-

Problems With DIA's Automated Baggage Handling System

Significant mechanical and software problems have plagued the automated baggage handling system. In tests of the system, bags were misloaded, were misrouted, or fell out of telecarts, causing the system to jam. Video cameras were installed at several known trouble spots to document problems, such as the following:

- The baggage system continued to unload bags even though they were jammed on the conveyor belt. This problem occurred because the photo eye at this location could not detect the pile of bags on the belt and hence could not signal the system to stop.
- The baggage system loaded bags into telecarts that were already full. Hence, some bags fell onto the tracks, again causing the telecarts to jam. This problem occurred because the system had lost track of which telecarts were loaded or unloaded during a previous jam. When the system came back on-line, it failed to show that the telecarts were loaded.
- The timing between the conveyor belts and the moving telecarts was not properly synchronized, causing bags to fall between the conveyor belt and the telecarts. The bags became wedged under the telecarts. This occurred because telecarts were bumping into each other near the load point.

Although the contractor—BAE Automated Systems Incorporated—believes that these problems have been resolved, other problems remain. To resolve these problems and make the system operational, a number of critical tasks must be completed. A recent BAE system status report listed 72 hardware, software, and testing activities that must be completed, such as the following:

- The telecarts' front bumpers have to be replaced so that they will not slip under the back bumpers when telecarts collide. These collisions have caused telecarts to lock together.
- Additional track, synchronous drives, and related software changes must be installed to improve "empty car management," that is, allocating the correct number of telecarts to specific locations at appropriate times.

BAE and City of Denver officials recognize that the system's testing might uncover additional problems.

GAO Modifications to DIA's Baggage Handling System

- Build an Alternative System
 - Conventional system
 - Could serve all concourses
 - Estimated costs—\$51 million

 - Changes to Automated System
 - United Airlines may oversee
 - Phased in service to concourses
 - Estimated costs—\$35 million
-

Modifications to DIA's Baggage Handling System

Because of continuing problems with the automated system, the City decided to build an alternative (i.e., conventional) baggage handling system and make substantial modifications to the automated system. The alternative system will use conveyor belts, tugs, and carts to move bags to and from the terminal and concourses. The alternative system will be the primary system until the automated system comes on-line. Once the automated system is operational, the alternative system will serve as a backup system if the automated system malfunctions.

With facility modifications and equipment, the alternative system is currently projected to cost over \$51 million, which includes the cost to procure tugs and carts. The system is scheduled to be completed by January 15, 1995, and testing completed about February 15, 1995.

To build the alternative system, major modifications to the physical structures must be made. Five areas of the third floor parking garage will be enclosed and converted into staging areas for airlines' baggage. The terminal building will be modified by the cutting of holes in walls at the third level to allow conveyor belts to enter from ticket counters and from curbside check-in to the staging areas.

Extensive use of tugs and carts to transport bags will be necessary. Tugs and carts will move bags from the terminal through existing tunnels to the concourses. To do this, the ventilation systems in tunnels will have to be modified to keep the level of exhaust fumes from the tugs at acceptable levels. The City plans to purchase tugs powered by natural gas to minimize exhaust emissions. Inbound baggage will be transported from the aircraft on carts to the terminal basement, where they will be loaded onto conveyors leading up to the baggage claim area. Bags for passengers on connecting flights will be transferred between aircraft on carts operating via the tarmac.

The automated system also will undergo substantial modifications. The City and United entered into an agreement that allows United to contract directly with BAE to modify portions of the automated system to provide a separate outbound automated baggage system for United by February 28, 1995. These modifications include changing the routing of the telecarts so that more of them serve United at Concourse B. The inbound portions will not be completed until later. The agreement also includes a requirement for BAE to complete an automated baggage system for Concourse A by August 31, 1995. The City will evaluate the need for an automated system for Concourse C carriers within 6 months after the airport opens.

On September 29, 1994, BAE, United, and the City reached agreement on the modifications to be made to the automated baggage handling system. These modifications are estimated to cost the City about \$35 million. BAE will be paid \$17.5 million on February 28, 1995, assuming that the system is operational, and the remainder after the system is substantially completed. If the automated system is not operational by opening day, United will be served by the conventional baggage system.

GAO Remaining Uncertainties

- Timing
 - Performance
 - Final System Configuration
 - Resource Requirements
 - Unresolved Claims
-

Remaining Uncertainties

A number of outstanding, unanswered questions surround the baggage handling system. Among the remaining uncertainties are the following:

- Timing. The automated system is undergoing modifications, and construction of the alternative system is just getting under way. Both systems must still be tested before the airport can open. Prior tests have not gone well.
- Performance. The original automated system was designed to transport outbound baggage from the terminal to the aircraft within 20 minutes. It is not yet known whether the modified automated system will meet design standards. The City estimates that bags can be delivered using the alternative system in 20 to 25 minutes. United and carriers on Concourse C have expressed concern about whether the conventional system can deliver bags in the times estimated by the airport system. United believes that using the alternative system may take up to 50 minutes to deliver bags to aircraft at DIA's most remote gates. Airlines at Concourse C believe that it will take 27 to 31 minutes to deliver bags using this system.
- Final system configuration. It has not been decided whether Concourse C will eventually be reconnected to the automated system. This could result in lower levels of baggage service to airlines and their passengers on Concourse C.
- Resource requirements. The conventional system is much more labor-intensive than the automated system. United told us that it currently has about 1,100 employees working the baggage system at SIA; an additional 600 people would be needed to handle baggage using DIA's alternative system. The usefulness of the conventional tug-and-cart operation as a backup system after the automated system becomes operational is also in question because of the additional standby employees required.
- Unresolved claims. The final cost of the baggage system is uncertain because of the potential for litigation after the baggage system is completed. The City has not paid BAE \$22 million of the \$193 million contract for the automated baggage system. On September 29, 1994, BAE, United, and the City reached an agreement for modifying the automated baggage system. The agreement calls for the City to pay BAE \$17.75 million of the unpaid \$22 million but reserves the rights of both parties to assert claims for alleged damages. They agreed to attempt to resolve their claims through mediation, but if unsuccessful, they agreed to file any unresolved claims in court.

Cost of DIA's Delayed Opening

GAO Cumulative Deficit Through
February 28, 1995

Total Deficit (in Millions)	\$230
•Actual (1/94-6/94)	80
•Projected (7/94-2/95)	150

**Cumulative Deficit
Through February 28,
1995**

On the basis of current monthly deficits, the total operating deficit incurred by the airport system from January 1, 1994, through February 28, 1995, will be \$230 million. Financial data are available through June 30, 1994. For the period after July 1, 1994, the deficits must be estimated. Our projection of the total deficit included the \$80 million through June 30, 1994, and the projected deficit of \$150 million for the period July 1, 1994, through February 28, 1995.

Section 4
Cost of DIA's Delayed Opening

Table 4.1: Actual Deficit of the Denver Airport System—January 1, 1994, Through June 30, 1994

Dollars in millions		
Deficit	Revenue and cost breakdown	Revenue and cost
Operating revenues generated at SIA		
Landing fees	\$ 23.64	
Terminal complex rentals	22.33	
Concessions	24.24	
Aviation fuel taxes	6.06	
Other	2.66	
Total SIA operating revenues		78.93
Less: SIA's operating costs		
Personnel & professional svcs.	16.28	
Cleaning & utilities	9.62	
Maintenance, supplies, materials	6.70	
Other	3.42	
Total SIA operating costs		36.02
SIA's operating surplus		42.91
Less: SIA's net debt service		17.19
Surplus produced by SIA		25.72
DIA's costs		
Operating costs		
Personnel & professional svcs.	10.86	
Cleaning & utilites	6.41	
Maintenance, supplies, materials	4.47	
Baggage system maintenance	1.83	
Other	2.28	
Total DIA operating costs		25.85
Debt service requirements on bonds	122.35	
Less: passenger facility charges	(20.89)	
Interest income	(16.51)	
Continental's payments	(5.00)	
Net debt service costs		79.95
Total DIA costs		105.80
Net deficit		80.08
Average monthly deficit, Jan. through June 1994		\$ 13.35

Actual Deficit of the Denver Airport System—January 1, 1994, Through June 30, 1994

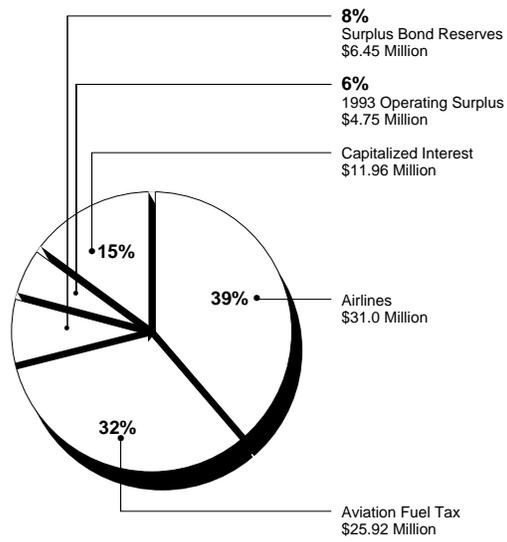
The airport system incurred a net operating deficit of \$80.08 million from January 1, 1994, through June 30, 1994—an average of \$13.35 million each month. This deficit occurred because the revenues generated by SIA did not cover the debt servicing requirements and operations and maintenance (O&M) costs at both airports. For this same period, DIA officials had earlier estimated a net monthly deficit of \$16.4 million; however, they took a conservative approach that led to the understating of SIA revenues and the overstating of operations costs at the two airports. Our calculations were based on actual monthly deficits. There was no deficit prior to January 1, 1994.

The following were key elements of our calculations:

- Operating costs at SIA and DIA are based on total obligations recorded in the airport system's accounting records for January 1 through June 30, 1994. The airport system's accountants allocated costs between the two airports according to which airport benefitted from the expenditure of those funds.
- Passenger facility charges (PFC) are generated from a special \$3 fee that was added to the price of a ticket for each enplaned passenger at Denver airport starting in July 1, 1992. The airport system's bond ordinance requires that PFCs be used to pay debt service requirements.
- Interest income is generated from several investment pools managed by the airport system, principally the bond reserve fund.
- Depreciation was excluded as a cost category because SIA will not be an airport after DIA opens, and depreciation is an expense requiring no cash outlay.

Section 4
Cost of DIA's Delayed Opening

GAO Sources of Funds Used to
Cover \$80.08 Million Deficit



Sources of Funds
Used to Cover \$80.08
Million Deficit—
January 1, 1994,
Through June 30, 1994

The airport system used funds from five sources to cover the \$80.08 million operating deficit for the first 6 months of 1994, as follows:

Payments from airlines. During the 6-month period, United and Continental airlines paid \$36.53 million to the airport system to cover delay costs. The airport system applied \$31 million of this amount against the \$80.08 million deficit. United's \$23.9 million contribution came from special facility bond funds that remained from a construction project for its maintenance hangar at DIA. The airport system's agreement with United stipulated that these funds would be used to offset facility upgrades to Concourse B requested by United.

In April and May 1994, both United and Continental paid \$6.63 million and \$6 million, respectively, to help offset delay costs from March 9 to May 15, 1994. United also agreed to pay an additional \$9.9 million and Continental an additional \$1.4 million before December 31, 1994. The airport system does not plan to compensate the airlines for these payments.

Aviation fuel tax fund. On January 1, 1994, the airport system had about \$36.6 million in the aviation fuel tax fund, a special purpose fund established to retire SIA's portion of 1984 and 1985 revenue bonds. The airport system used \$25.92 million from this fund to cover the net operating deficit; \$10.8 million from the proceeds of the 1994A bond issue has been transferred back into this fund.

Capitalized interest. Capitalized interest is money from the original bond proceeds set aside to pay debt service payments during the airport's construction period; \$11.96 million was used to cover part of the deficit.

Surplus in bond reserve fund. Under the bond ordinance, the airport system is required to set aside enough money in a bond reserve fund to pay debt service requirements for a full year. The funding requirement for Denver's bond reserve fund was \$304.63 million, excluding the 1994A bonds. On January 1, 1994, the airport system had \$315.11 million in the fund, leaving a surplus of about \$10.5 million; \$6.45 million of this surplus was used to cover the deficit.

Operating surplus from 1993 SIA operations. Net revenues from operations at SIA are held in an operating fund, which had a balance of \$7.65 million on January 1, 1994. During the first 6 months of 1994, \$4.75 million was used to cover the deficit.

Section 4
Cost of DIA's Delayed Opening

Table 4.2: Projected Deficit of the Denver Airport System—July 1, 1994, Through February 28, 1995

Dollars in millions		
Deficit	Revenue and cost breakdown	Revenue and cost
Operating revenues generated at SIA		
Landing fees	\$31.0	
Terminal complex rentals	29.0	
Concessions	32.0	
Aviation fuel taxes	8.0	
Other	4.0	
Total operating revenues		104.0
Less: SIA's operating costs		
Personnel & professional svcs.	26.2	
Cleaning & utilities	15.5	
Maintenance, supplies, materials	10.8	
Other	5.5	
Total operating costs		58.0
SIA's operating surplus		46.0
Less: SIA's debt service		23.0
Surplus produced by SIA		23.0
DIA's costs		
Operating costs		
Personnel & professional svcs.	17.6	
Cleaning & utilities	10.4	
Maintenance, supplies, materials	7.3	
Other	3.7	
Total operating costs		39.0
Debt service requirements on bonds	182.0	
Less		
Passenger facility charges	(27.0)	
Interest income	(17.0)	
Continental's payments	(4.0)	
Net debt service costs		134.0
Total DIA costs		173.0
Net deficit		150.0
Average monthly deficit, July 1994 through Feb. 1995		18.75

**Projected Deficit of
the Denver Airport
System—July 1, 1994,
Through February 28,
1995**

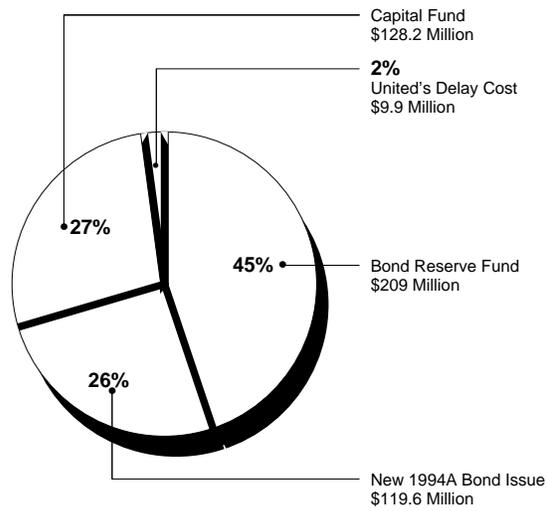
We estimate that the net deficit projected from July 1, 1994, through February 28, 1995, will be about \$150 million—an average of \$18.75 million each month. The monthly deficit increased from \$13.35 million for the first 6 months of 1994 because of increased O&M costs and debt service requirements from the \$257 million 1994A bond issue.

The following were key elements of our calculations:

- We assumed that the pattern of revenues for 1994 will follow the pattern of revenues experienced in 1993, when the revenues were split evenly between the first and second halves of the year. Total revenues at SIA for the first half of 1994 were \$78.9 million, or just over \$13 million a month.
- Operating costs at SIA and DIA are based on recently completed budgets for the airport system, which estimated monthly operating costs of \$12.1 million at both airports for the last half of 1994.
- The debt service requirement on the 1994A bond issue has increased by about \$2 million a month.

Section 4
Cost of DIA's Delayed Opening

GAO Funds Available to Finance
Future Delay Costs



Funds Available to
Finance Future Delay
Costs

The airport system has \$467.2 million available to cover further delay costs to DIA.

Section 4
Cost of DIA's Delayed Opening

Table 4.3: Reserve Funds in the Denver Airport System and Amounts Available to Cover Future Delay Costs

Dollars in millions		
Source	Total amount	Available
Bond reserve fund	\$308.6	\$209.5
New 1994A bond issue	192.6 ^a	119.6
Capital fund	167.7	128.2
United's delay cost payments	9.9	9.9
Total	\$678.8	\$467.2

^aThe total amount shown for the new bond issue excludes \$64.4 million transferred to the capital fund.

Bond Reserve Fund

The bond reserve requirement for DIA is now \$308.6 million. Under the terms of the bond ordinance, funds can be withdrawn from this account only if they are needed to meet debt service requirements. Funds withdrawn must be paid back at the rate of 1/60th of the amounts owed each month. Given this requirement, \$209.5 million of the \$308.6 million could be used before outside sources would have to be tapped. However, according to bond analysts to whom we spoke, drawing on these resources before DIA opens could affect the airport's credit standing.

Capital Fund

All of the airport system's surpluses are paid into a capital fund after O&M costs, debt service requirements, and O&M reserve account requirements are made. The capital fund can be used to pay capital costs, extraordinary costs, or bond requirements. The projected balance in the capital fund as of December 31, 1994, was \$167.7 million, of which \$128.2 million is available.

Monthly Payments on Delay Costs by United Airlines

In accordance with an earlier agreement with the airport system, United will make monthly payments of \$1.7 million during the last half of 1994, which cumulatively totals \$9.9 million. This amount will cover United's share of the airport system's delay costs for the period March 9 through May 15, 1994.

Section 4
Cost of DIA's Delayed Opening

Table 4.4: Application of Proceeds of the Series 1994A Bonds

Dollars in millions	
Application	Proceeds
Available for funding delay costs	\$119.6
Fund costs of alternative baggage system	50.6
Transfer to capital and project funds	64.4
Transfer to aviation fuel tax fund	10.8
Transfer to bond reserve fund	3.3
Underwriters' discount and cost of issuance	4.4
Original issue discount	3.9
Total proceeds	\$257.0

Application of Proceeds of the Series 1994A Bonds

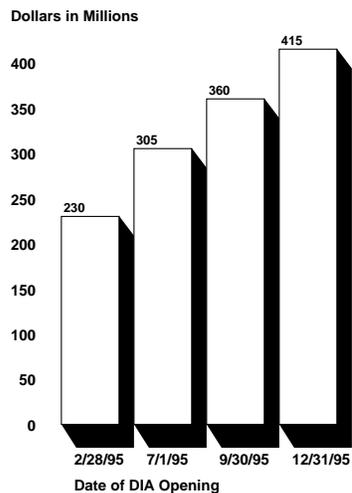
The airport system sold \$257 million in airport system revenue bonds—Series 1994A—with an effective date of August 30, 1994. The airport system plans to apply these proceeds as follows:

- \$50.6 million to install an alternative baggage handling system.
- \$64.4 million for other capital projects, including funds to cover the costs for modifications to the automated baggage system.
- \$10.8 million to partially replenish funds used to cover earlier deficits. Airport officials told us that the \$10.8 million will bring the total in this fund to the amount needed to retire SIA's 1984 and 1985 revenue bonds.
- \$3.3 million to increase the bond reserve fund to its new minimum requirement.
- \$4.4 million for costs associated with selling the bonds.
- \$3.9 million for the original issue discount on the bonds.

After satisfying these requirements, \$119.6 million of the \$257 million in bond revenues will remain for future delay costs. The airport system classifies this money as capitalized interest, which is money set aside to pay debt service requirements before DIA opens.

Section 4
Cost of DIA's Delayed Opening

GAO Forecast of Cumulative Operating Deficits



2/28/95 is the latest announced DIA opening date.

**Forecast of
Cumulative Operating
Deficits**

The deficit likely will continue to accumulate by \$18 million to \$19 million each month if the opening of DIA is delayed beyond February 1995. If DIA does not open in 1995, the total deficit will grow to \$415 million by December 31, 1995. However, if the airport is not open by October 1995, the City will need to tap the bond reserve fund to pay for the operating deficit.

GAO Summary of Total Delay Costs
(in Millions)

Net Deficit	\$230
Opportunity Costs	37
Changes to Baggage Systems	86
Fees From Bond Issue	8
Total	<hr/> \$361

Summary of Total Delay Costs

If DIA had opened by January 1, 1994, and operated in accordance with its final 1994 budget, the airport system would have incurred a \$37 million surplus instead of a \$230 million deficit through February 1995. (See table 4.5.) This means that the real costs from the delayed opening of DIA will total about \$267 million by February 1995. In addition, the airport system would not have had to incur \$8.3 million for underwriting costs and issue discounts from the 1994A bond issue. Furthermore, about \$86 million for modifications to the baggage handling systems would have been avoided. Therefore, the true delay costs are about \$361 million.

Table 4.5: Comparison of Budgets for the January 1, 1994, to February 28, 1995, Period for Two DIA Opening Dates

Dollars in millions		
Revenues and costs to Denver Airport System	Jan. 1, 1994, opening date	Feb. 28, 1995, opening date
Revenue from airlines ^a (landing fees and terminal rent)	\$ 313.2	\$ 106.0
Other operating revenues (mostly concessions)	92.8	62.9
Nonoperating revenues (PFCs, interest, aviation fuel tax)	91.9	104.5
Total revenues	497.9	273.4
O&M cost ^b	(171.3)	(158.9)
Debt service cost	(289.8)	(344.5)
Net surplus (deficit) ^c	\$ 36.8	\$(230.0)

^aRevenue from airlines, mainly through landing fees and rents, would increase substantially at DIA compared with revenue from airlines at SIA.

^bO&M costs in DIA's budget included about \$6 million for the 14 months for residual operations at SIA. Until disposal of SIA occurs, it will remain part of the airport system. The airport system's funds will be used to pay any costs at SIA, but those costs will not be included in airlines' rates and charges. Instead, SIA costs will be paid from DIA's net revenues. After SIA closes, airport system officials expect to spend about \$25 million on capital projects through 1998 for environmental cleanup, demolition of structures, and structural repairs. Airport system officials are currently developing a master plan for the disposition of SIA and have begun a 5-year leasing program for SIA facilities. Ultimately, airport system officials expect that the disposition of SIA will produce \$75 million in net proceeds.

^cAirlines receive 75 percent of net revenues produced from operations at DIA.

Impact of Delayed Opening on DIA's Ability to Meet Operating and Debt Service Costs

GAO Impact of Delayed Opening on DIA's
Operating and Debt Costs

- Traffic and Revenue Forecasts
 - Key Assumptions
 - Sensitivity Analysis
- Airline Situation
- Results From Risk Analysis

In September 1991, we reported on the likelihood that DIA would earn sufficient revenues to cover its operating costs and meet obligations to bondholders. We estimated the probabilities of various factors, such as alternative traffic levels, and then calculated whether revenues would be adequate to cover all costs.¹ The 1991 risk analysis found that the probability that the airport would experience a shortfall in revenues was low. We updated our analysis to take into account a number of recent events that could affect the airport's ability to meet its operating and debt service costs.

The new analysis is based on the models developed for the 1991 report. Modeling risk assessment is highly sensitive to the assumptions made governing key variables. We paid particular attention to traffic estimates, as they are critical to predicting airport revenues. The details of the approach are discussed in appendix I.

Passenger Traffic Volume

Passenger traffic is a direct source of revenue to DIA via the \$3.00 PFC per enplanement. More importantly, in accordance with the agreements between the City of Denver and the airlines, all costs not covered through other means such as PFCs and rents from airport concessionaires must be paid by airlines' user fees. The agreements between Denver and the airlines specify that these charges are not to exceed \$20 per passenger enplaned at DIA in 1990 dollars. The cap is allowed to rise with inflation, so that today, the maximum charge to the airlines per enplaned passenger is \$22.50 in current dollars. If airline payments combined with revenues from other sources are not sufficient to cover an airport's operating costs and repay debt, the airport has a shortfall.

Airlines' passenger traffic in Denver rose steadily after 1970, peaking in 1986 at slightly over 16 million enplaned passengers. Traffic declined to below 14 million enplanements in 1989 and 1990 and our September 1991 study used this lower base in developing traffic forecasts and revenue projections. However, traffic grew by 2.8 percent in 1991 and recovered strongly in 1992 and 1993, when enplanements grew by 8.9 percent and 5.7 percent, respectively. In 1993, there were 16.32 million enplanements at SIA.

¹We contracted with Hickling Corporation, a consulting firm that specializes in risk assessment for airport investment projects, to assist us in this evaluation.

Section 5
Impact of Delayed Opening on DIA's Ability
to Meet Operating and Debt Service Costs

**Table 5.1: Annual Enplanements at DIA
 Between 1994 and 2000 Under Low,
 Median, and High Traffic Forecasts**

Enplaned passengers in millions			
Year	Lower bound estimate	Median estimate	Upper bound estimate
1994	14.573	16.192	17.002
1995	14.719	15.962	17.451
1996	14.866	16.422	17.900
1997	15.014	16.882	18.349
1998	15.165	17.343	18.798
1999	15.316	17.803	19.247
2000	15.469	18.263	19.697

Note: Actual enplanements in 1993 were 16.32 million.

Annual Enplanements at DIA Between 1994 and 2000 Under Low, Median, and High Traffic Forecasts

To forecast traffic for 1994 and beyond, the current analysis took, as a starting point, recent projections made by the consultant to the airport system prior to the latest bond prospectus. Those projections indicated no growth in 1994 and a decline to 16 million enplanements in 1995. Traffic is then expected to increase and reach 18.3 million annual enplanements in 2000. FAA also projected traffic at Denver, but while it also assumed no growth in 1994, FAA estimates that enplanements will increase to 17 million in 1995 and to 21.9 million in 2000. The present analysis is based on the more conservative estimates developed for the bond prospectus as a median forecast.

Upper and lower bound estimates of enplanements were then developed. The lower bound projection assumed that traffic in 1994 would be 10 percent lower than the current forecast, or about 14.6 million enplanements annually. Traffic, thereafter, is assumed to grow by only 1 percent per year, yielding 15.5 million enplanements in 2000, nearly 1 million fewer than in 1993. It is assumed that there is a 90-percent probability that this lower bound forecast will be exceeded. The upper bound forecast assumes that traffic in 1994 is 5 percent higher than projected in the prospectus and grows linearly, so that it reaches 90 percent of FAA's forecast for 2000. It is assumed that there is only a 10-percent chance that traffic growth will exceed this forecast.

Section 5
Impact of Delayed Opening on DIA's Ability
to Meet Operating and Debt Service Costs

Table 5.2: Mean Cost per Enplaned Passenger If DIA Opens by March 1, 1995

Year	Current dollars	1990 dollars
1995	\$17.35	\$14.46
1996	19.50	15.57
1997	18.08	13.83
1998	18.47	13.54
1999	17.64	12.41
2000	19.32	13.01

Table 5.3: Mean Cost per Enplaned Passenger If DIA Opens by July 1, 1996

Year	Current dollars	1990 dollars
1996	\$20.62	\$16.47
1997	19.43	14.89
1998	19.60	14.37
1999	18.96	13.30
2000	20.68	13.89

Note: The calculations for these tables are based on assumed enplaned levels of 14.6 million to 17 million enplaned passengers in 1994 and subsequent years as shown earlier in this section. These levels are associated with the median of the forecast. The airport recently announced its intention to accelerate principal repayment on the 1994A bonds, and this could increase the cost per enplaned passenger by about \$1 between 1995 and 2000.

Mean Cost per Enplaned Passenger for Two Opening Dates

The Mayor of Denver has announced a new opening date of February 28, 1995, but there is no guarantee that DIA will, in fact, open then. Therefore, we examined the impact on operating revenues and debt service costs if the airport is not open until July 1, 1996. On the basis of information provided by the airport system, we assumed that any further delays in opening DIA will cost at least \$18 million per month and would be debt financed.²

If current traffic forecasts materialize and if the current projections of the airport's operating costs are accurate, then regardless of whether DIA opens by March 1, 1995, or by July 1, 1996, expected revenues appear to be sufficient to allow the airport to meet scheduled debt payments. Despite the fact that airlines' user fees will be almost 10 percent higher than they would have been had the airport opened on time, the cost per enplaned passenger will be several dollars below the \$20 cap in 1990 dollars. With a 1995 opening, the cost per enplaned passenger will peak at about \$15.57 in 1996 (in 1990 dollars) and then decline. With a 1996 opening, the peak again occurs in 1996 at \$16.47 in 1990 dollars.

Our analysis depends on cost and revenue forecasts that were developed for the recent bond prospectus. Those projections, in turn, depend on several key assumptions made by the Denver Airport System. First, the airport assumes that it will be able to refinance the 1984 and 1985 bonds in 1995 and to restructure debt service. Doing so will reduce the airport's debt service by \$121 million over the 1995-99 period. If the airport does not refinance and restructure this debt, debt service costs will be higher and the airport will need to find alternative revenue sources or to raise the fees paid by the airlines.

²The debt service figures used in our analysis were provided by the Denver Airport System in August 1994.

Second, the revenue projections to the year 2000 are based on Continental Airlines' agreement to lease 20 gates over that period at a cost of \$273 million. However, Continental is reducing its presence at Denver. The airport's projections account for a reduced presence by Continental after the year 2000, when it will have a commitment for only four gates, but assume that Continental will either pay for the space or will sublet the space to another airline. Third, the airport's projections assume that \$95 million committed by FAA in its letter of intent from the discretionary account of the AIP will be funded as planned. Finally, airport financial forecasts were based on an assumption that a baggage system with sufficient operational reliability would permit the airport to open.

Another key element of the airport's cost is its debt service, and there are differences in various reports on debt service requirements. An analysis of 1996 debt service requirements can illustrate the problem. The audited financial statements for the Denver Airport System prepared by Deloitte & Touche as of December 31, 1993, reported a 1996 debt service requirement of \$302.5 million. The latest Denver Airport System plan of finance shows a 1996 debt service requirement of \$289.6 million. The bond prospectus financial analysis prepared by Leigh Fisher Associates, the airport's consultant, reported a 1996 debt service requirement of \$243.7 million. Denver Airport System officials and their consultants provided the following rationale to reconcile these differences.

- The audited financial statements did not include debt service on the 1994A bonds, amounting to \$24.4 million in 1996, because these bonds were issued after the last audit which was done as of December 31, 1993.
- Denver's plan of finance assumes a \$30.5 million debt service reduction in 1996 based on the refinancing in 1995 of the 1984 and 1985 airport system revenue bonds.
- The bond prospectus debt service requirement was inconsistent with those in the other two reports largely because it excluded \$40.5 million of passenger facility charges (PFC) in 1996. It assumed that PFCs would be a revenue source that should be offset against total debt service.

Section 5
Impact of Delayed Opening on DIA's Ability
to Meet Operating and Debt Service Costs

-
- DIA, in its plan of finance and in its bond prospectus, reduced debt service requirements from the audited amount by \$10.7 million in 1996 to account for estimated market rates of interest on variable rate bonds. The audited financial statements were prepared assuming maximum rates of interest on variable rate bonds.
 - Several other variables that involve smaller dollar amounts were included in the reconciliation.

Section 5
Impact of Delayed Opening on DIA's Ability
to Meet Operating and Debt Service Costs

Table 5.4: Reduced DIA Enplanement Estimates to Levels Where There Would Be a Significant Risk of Costs Exceeding Revenues

Enplanements in millions			
Year	Lower bound estimate	Median estimate	Upper bound estimate
1994	11.075	12.306	12.921
1995	11.186	12.131	13.263
1996	11.298	12.481	13.604
1997	11.411	12.831	13.945
1998	11.525	13.180	14.287
1999	11.640	13.530	14.628
2000	11.757	13.880	14.969

Note: Actual enplanements in 1993 were 16.32 million.

Reduced DIA Enplanement Estimates to Levels Where There Would Be a Significant Risk of Costs Exceeding Revenues

The financial risk model was run by using different assumptions of depressed levels of traffic in order to determine the sensitivity of DIA's financial situation to the traffic forecast. We undertook this analysis partly because Continental, one of the principal airlines expected to operate a hub at DIA, is scaling back its scheduled operations substantially. Today, Continental handles about 24.2 percent of the traffic at SIA and United handles about 57.4 percent. No other airline handles as much as 5 percent, although Delta and American handle 4.1 percent and 3.7 percent, respectively. Continental plans to reduce the number of daily flights out of Denver from 94 to 23 by the end of October 1994.³ United plans to increase its daily departures from 277 to 300 by the end of 1994.

Projected traffic levels would need to be nearly 20-25 percent lower before the model found that there would be significant risk that DIA's estimated costs might exceed revenues. We are not making an independent analysis of traffic at DIA; however, several points are relevant to Denver's air traffic. First, United will be handling almost 60 percent of the enplanements, and that airline is committed to DIA. Second, approximately 46 percent of the traffic is originating or ending in Denver, and that traffic is dependent on factors such as Denver's economy, rather than on airlines' user fees. Third, in Continental's 100 largest markets connecting through Denver, United offers competing service in 77. In Continental's top 1,000 markets that connect through Denver (which account for more than three-fourths of all Continental's traffic over Denver), United offers competing service in 547.⁴ Finally, while airlines' user fees at Denver will be high, the costs of using alternative hub airports can lead to higher airline operating costs, which in many cases offset the higher fees at DIA.

³Although Continental is scaling back its operations, other airlines may increase their operations at DIA to compensate for Continental's reduction in flights. DIA's revenue flow assumes revenues from the reduced level of Continental's operations; however, any additional change would affect the airport's revenues.

⁴These data are for the first quarter of 1994, the most recent for which data are available. We define United as "competing" if it has at least a 10-percent share of the market.

Objectives, Scope, and Methodology

To determine the problems with the baggage handling system, we interviewed officials of the DIA management team, including contractors, the airlines, an airline baggage consultant, and the consultant hired by the City of Denver to evaluate the system. We reviewed the system's completion schedules including lists of tasks remaining to be completed, specifications for the system, and other contract documents such as agreements between the City, United, and BAE; and we observed tests of the automated system.

To determine the cost of the delayed opening of DIA, we reviewed cost estimates and the resources available to pay these costs. In addition, we performed an analysis of projected revenues and operating costs to determine the reasonableness of those projections and to identify the financial effects of continued delays. For our analysis, we (1) interviewed appropriate officials of the Denver Airport System and the City Treasurer's Office, consultants responsible for projecting airport revenues and debt service, and airline representatives; (2) reviewed and analyzed DIA's accounting records, documents, and procedures, including the audited 1993 financial statement; and (3) reviewed relevant financial information contained in official statements for issued bonds. We did not audit, and do not express an opinion on, the data provided by DIA that are used in our analysis. We identified the underlying assumptions included in DIA's revenue and cost projections. We note the key assumptions used in the analysis where appropriate.

Certain information such as the airport system's 1993 financial statement was independently audited by Deloitte & Touche. The auditor issued an unqualified opinion on the airport system's financial position as of December 31, 1993.

To address the financial outlook of the DIA project, we discussed the costs, including delay costs and available funding sources to finance those costs, with DIA officials, officials from the City's Revenue Department, the airport's financial adviser at First Albany Corp., bond analysts, and officials from credit-rating agencies. We also contacted United and Continental—the two principal airlines serving the airport—for their views on the proposed fees and charges. As part of these discussions, we collected relevant information on the airport's costs, revenues, debt, user fees, and traffic levels.

To determine whether expected revenues would be sufficient to cover operating costs and service the debt, we contracted with Hickling

Corporation, an airport consulting firm, to perform a risk analysis. Hickling developed a risk assessment model to assist us in our 1991 study. That model included six submodels: traffic, O&M costs, project costs, nonairline revenues, project finance, and airline revenues. We updated the analysis using the most recent information on traffic projections, the project's cost, the financing plan, and the airport's financial statements. The model uses this information to simulate possible outcomes and develops an estimate of the probability that net revenues will be sufficient to service the debt.

Modeling risk assessment is highly sensitive to the assumptions made governing key variables. The approach that was taken was to construct a range of possible values for the key factors such that there is only a 10-percent chance that the actual value will be higher than the top of the range and a 10-percent chance that the actual value will be lower than the bottom of the range.

In addition to the assumptions surrounding traffic levels and traffic growth discussed in section 5, several other assumptions were key to the analysis. According to the information we developed from the airport system's provided data, the cost of further delays is assumed to be about \$18 million per month. If DIA does not open by February 28, 1995, it is assumed at a 90-percent certainty level that subsequent delay costs will be at least \$17 million per month and it is assumed that there is a 10-percent chance that they will exceed \$20 million per month. It is further assumed that all costs associated with delays after February 28, 1995, will require additional debt financing. The analysis assumes that the terms of the new debt would be 30-year bonds with equal annual payments. The interest rate on the new debt issue is assumed to have a median value of 7.8 percent. The 80-percent confidence interval for interest rates has an upper bound of 9.5 percent and a lower bound of 7.2 percent.

Originally, the goal was to estimate the probabilities that DIA would open on certain dates given as the best estimates of technical specialists involved in correcting the problems with the baggage system. A questionnaire was developed to elicit responses on the likelihood of failure of key subsystems of the baggage handling system. We received some response to our questionnaire, but several key organizations did not wish to speculate on when the problems with several subsystems would be corrected, even though their speculations represented the best informed judgments. When Denver's Mayor announced that the airport would open on February 28, 1995, with an alternative baggage handling

system, we refocused our analysis to look at the impact on the airport's revenues and costs at different opening dates.

Hickling Corporation used its proprietary Risk Analysis Process (RAP) software and modified it to represent DIA. The RAP model is a Monte Carlo simulation that uses the uncertainty ranges for key variables to make repeated estimates of forecast outcomes in the form of probability distributions.

We did not review the documentation of the RAP model's internal logic or attempt to verify the RAP model. Therefore, we cannot attest to its validity. As with the output of other policy-assisting tools, its outputs cannot be relied upon as exact predictors of the future.

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