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April 1986

AMTRAK

Review of AMTRAK's Study of Rail Service Through Oklahoma

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UNITED STATES GENERAL ACCOUNTING OFFICE
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RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION

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To Congressional Requesters

On July 23, 1985, we briefed Representative Bob Whittaker and staff from offices of interested Oklahoma, Kansas, and Missouri members of Congress on the results of our review of Amtrak's analysis of seven proposed passenger rail routes through Oklahoma. This briefing was in response to a May 30, 1984, request from interested members of Congress that we evaluate the methodologies Amtrak used to analyze the market potential for reinstating passenger rail service through Oklahoma. As we agreed at the time of the briefing, this report provides a written summary of our results.

Our work assessed whether the revenue and cost projection models and supporting data bases that Amtrak used for the Oklahoma route analyses reasonably represented actual market conditions and costs for the proposed Amtrak routes. On the basis of our review of the models and data bases, we also evaluated the supportability of Amtrak's conclusions regarding the financial and ridership performance of the seven Oklahoma route options.

This report is based largely on information obtained from Amtrak and on interviews with Amtrak officials directly responsible for the development and operation of the revenue and cost projection systems and data bases we evaluated. Although there were some problems with the documentation of the revenue model and its data bases that precluded us from fully applying appropriate model evaluation methods, the information did allow us to provide significant observations regarding Amtrak's current methodologies for estimating revenues on proposed passenger service routes.

We concur with Amtrak that it is likely that passenger service initiated on any of the seven proposed Oklahoma route options would produce substantial financial losses. The proposed Oklahoma route options required an increased revenue contribution of between 74 and 174 percent to break even financially. Given the magnitude of these projected losses, we conclude that the seven Oklahoma route options are not likely to meet Amtrak's criterion for initiating new rail service. Moreover, we believe

that the level of losses on long-distance western routes currently operating adjacent to the service areas of the proposed Oklahoma route options reinforce Amtrak's conclusions as to the likely losses on any of those options, given existing cost, fare, and ridership conditions in that region of the nation.

While we found no significant problems with the Amtrak cost projection models used in the Oklahoma route analyses, we found that Amtrak's revenue projection model has some structural design, data, documentation, and statistical reliability limitations. However, we conclude that the extent of these revenue model limitations is not significant enough for us to reject Amtrak's conclusion that each of the proposed Oklahoma route options would operate at a substantial loss. We conclude this because of the magnitude of losses projected on the seven Oklahoma routes, the model's tendency to predict higher passenger revenues than actually occur, and the history of financial losses on Amtrak service through Oklahoma.

One design deficiency in the revenue model is that it is not designed to estimate the effect of airline, bus, and auto competition on rail service demand projections. This finding is not solely relevant to the issues associated with potential rail service to Oklahoma. The revenue model is one that Amtrak uses in analyzing the financial and ridership performance of new and restructured routes operating outside the northeast rail corridor. We believe that Amtrak's use of a rail revenue projection model that cannot represent the effects of price and service competition from other transportation modes may reduce the reliability of Amtrak's projections of passenger revenues in markets where competition from those modes is significant.

Amtrak commented officially on a draft of this report, and their comments have been incorporated or otherwise addressed in the report.

As agreed, we are sending copies of this report to other interested congressional offices and committees, to the President of Amtrak, and to the Secretary of Transportation. Copies will also be made available to other interested parties. If you have any further questions regarding this briefing report, I can be reached at (202) 275-4905.

Herbert R. McLure

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Associate Director

LIST OF CONGRESSIONAL REQUESTERS FOR GAO'S REVIEW OF AMTRAK'S STUDY OF RAIL SERVICE THROUGH OKLAHOMA

The Honorable Don Nickles
United States Senate

The Honorable Mickey Edwards
House of Representatives

The Honorable Bill Emerson
House of Representatives

The Honorable Glenn English
House of Representatives

The Honorable James R. Jones
House of Representatives

The Honorable Dave McCurdy
House of Representatives

The Honorable Jan Meyers
House of Representatives

The Honorable Jim Slattery
House of Representatives

The Honorable Mike Synar
House of Representatives

The Honorable Wes Watkins
House of Representatives

The Honorable Bob Whittaker
House of Representatives

GAO BRIEFING ON REVIEW OF AMTRAK'S STUDY OF RAIL SERVICE THROUGH OKLAHOMA

PREPARED AT THE REQUEST OF MEMBERS
OF THE OKLAHOMA, KANSAS, AND MISSOURI
CONGRESSIONAL DELEGATIONS

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ABBREVIATIONS

DOT	Department of Transportation
FY	Fiscal Year

GLOSSARY

Long-term avoidable cost	All those costs attributable to the operation of a given train over a period beyond 1 year.
Passenger-mile	Railroad operating statistic representing a single passenger carried on a train for 1 mile.
Short-term avoidable cost	All those costs attributable to the operation of a given train over a period of less than 1 year.
Train-mile	Railroad operating statistic representing a train traveling the distance of 1 mile.

SUMMARY OF REVIEW FINDINGS

Our evaluation of Amtrak's revenue and cost projection methods and marketing conclusions for seven proposed Oklahoma route options lead to the following observations:

1. It is likely that service initiated on any of the seven proposed Oklahoma route options would generate substantial financial losses. The proposed Oklahoma options required an increased revenue contribution of between 74 to 174 percent in order for any of the proposed routes to meet Amtrak's financial criteria for initiating new rail service. (See p. 17.)

2. The level of losses on long-distance, western routes currently operating adjacent to the service areas of the seven proposed Oklahoma service options reinforces Amtrak's conclusions that losses would likely occur on all of the seven proposed Oklahoma options, given existing cost, fare, and ridership conditions in that region of the nation. All of these existing long-distance routes meet Amtrak's financial and ridership criteria for continuation of service, but none would meet the financial criteria for new service. (See p. 18.)

3. Amtrak's revenue projection model has some structural design, data, documentation, and statistical reliability limitations. However, given the model's tendency to predict higher revenues than actually occur, we conclude that the revenue model's limitations are not serious enough for us to reject Amtrak's conclusion that each of the proposed Oklahoma route options would generate substantial losses. (See p. 20.)

4. The revenue model was not designed to estimate the effects of airline, auto, and bus competition on projected rail travel demand. This may reduce the reliability of Amtrak's revenue projections in markets where competition from these modes is significant. (See p. 20.)

5. We found that the cost projection models Amtrak used in analyzing the seven Oklahoma routes had no significant cost allocation, structural design, data, documentation, or statistical reliability limitations. (See p. 32.)

SECTION I: BACKGROUND

On May 30, 1984, members of Congress from Oklahoma, Kansas, and Missouri requested that we evaluate the methodologies Amtrak used to analyze the market potential for reinstating passenger rail service through Oklahoma. The request specifically asked us to examine the revenue and cost models Amtrak used to analyze the potential financial and ridership performance of seven route options for rail service through Oklahoma. These models are the same ones Amtrak uses to assess the potential performance of new routes and restructured existing routes outside the northeast rail corridor between Washington, D.C., and Boston. In the course of our evaluation, we

--assessed whether Amtrak revenue and cost projection models and their supporting data bases used in the Oklahoma route analyses reasonably represented the actual market conditions and costs that could exist on proposed Amtrak routes, and

--evaluated the supportability of Amtrak's conclusions regarding the financial and ridership performance of the seven Oklahoma route options.

In assessing Amtrak's revenue model, we applied computer model evaluation criteria contained in our 1979 Guidelines for Model Evaluation: Exposure Draft.[1] Our evaluation focused on three modeling issues that we believe were relevant in Amtrak's Oklahoma route analyses:

Validity--What theoretical assumptions were made in developing the model? How reasonable were those assumptions? How complete and appropriate were the data used in the model? What effect did the use of these assumptions and data have on the model's results? Was the model adequately tested to ensure that it behaved as the developers intended?

Verification--Did the model include the assumptions, variables, and mathematical structure intended by Amtrak? Did the model's computer program appropriately incorporate those assumptions, variables, and mathematical structure?

Documentation--Was the computer model's documentation written so that the model could be understood, used, maintained, and evaluated?

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[1]More detail about the methodology we used in this evaluation is contained in our report Guidelines for Model Evaluation: Exposure Draft (PAD-79-17, Jan. 1979).

We focused our assesssment of Amtrak's cost projection methods in the Oklahoma route analyses in the following areas:

--The appropriateness of Amtrak's use of actual costs, adjusted systemwide average costs, and allocated overhead costs in each operating cost category.

--The appropriateness of Amtrak's use of long-term avoidable costs.

--Amtrak's documentation of its Oklahoma cost projections.

--The statistical analyses Amtrak performed on its cost projections to estimate their reliability.

--The potential for reducing labor and certain overhead costs in the Oklahoma route analyses through changes in Amtrak's costing assumptions.

This report is based largely on information obtained from Amtrak that we analyzed and on interviews with Amtrak officials directly responsible for developing and operating the revenue and cost projection systems we evaluated. We also reviewed documents describing the structure and operation of the revenue and cost projection models as they were used in the seven Oklahoma route analyses, and we reviewed the data used in those models to see whether it was consistent with the market and cost conditions of the proposed Oklahoma routes. Our review was performed in accordance with generally accepted government auditing standards.

SECTION II: AMTRAK'S OKLAHOMA RAIL SERVICE ROUTE ANALYSES WERE PERFORMED IN RESPONSE TO CONGRESSIONAL CONCERNS ABOUT THE TERMINATION OF RAIL SERVICE THROUGH OKLAHOMA AND KANSAS IN 1979

Amtrak provided daily passenger rail service through Oklahoma and Kansas on the Lone Star route between Chicago and Fort Worth, Texas until October 1, 1979, when the service was eliminated. Amtrak's termination of the Lone Star was consistent with the recommendations in the Department of Transportation's (DOT's) Final Report to Congress on the Amtrak Route System. DOT was directed by Section 4(b)(1) of the Amtrak Improvement Act of 1978 to recommend a restructured route system. To meet this objective, DOT recommended that Amtrak discontinue 16 routes that were operating outside the northeast rail corridor. Amtrak selected seven of these for termination including the Lone Star. DOT provided the following reasons for recommending termination of Lone Star service:

> "Subsequent analysis of this route indicated that its level of usage, which was already one of the lowest among Amtrak's long-distance routes, declined 17 percent in fiscal year 1978, to 94 passenger-miles per train-mile, which is well below the level generated by any long-distance service in the recommended system. Moreover, the Southwestern cities located along this route produce less ridership per capita than the national average, indicating a particularly strong affinity for other modes of transportation. The area has a highly developed highway system and an extensive system of trunk and intrastate airline service that is highly competitive."[1]

In response to congressional concerns about the lost Oklahoma service, Amtrak in 1984 projected costs and revenues for seven alternative routes for rail service through Oklahoma--a modification of the old Lone Star route was one of these options. The map on page 14 indicates the seven route options, and the tables on page 17 summarize the financial and ridership estimates Amtrak projected for the seven options.

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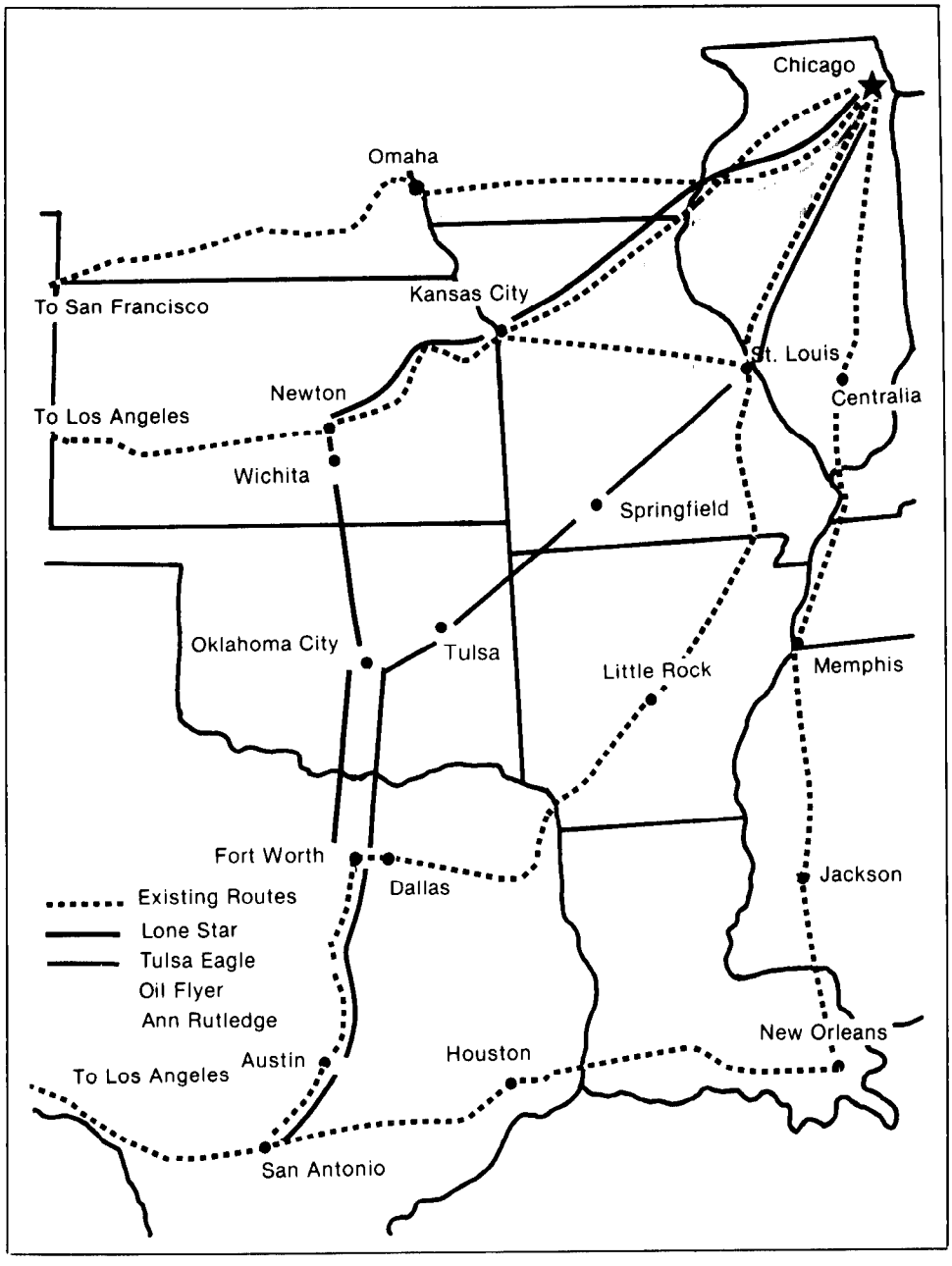
[1]U.S. Department of Transportation, Final Report to Congress on the Amtrak Route System (Jan. 1979).

Figure II.1: Oklahoma Service Options with Selected Existing Routes



EXPLANATORY NOTES FOR THE MAP OF THE SEVEN OKLAHOMA RAIL SERVICE OPTIONS

The map illustrates the seven Oklahoma route options Amtrak analyzed. The two Lone Star route options (daily and tri-weekly) ran over a major portion of the same route that the original Lone Star did when its service was terminated in 1979. A significant portion of each of the other five route options would have operated over routes that had no prior Amtrak rail service.

The seven route options considered by Amtrak are as follows:

1. The daily Lone Star option would provide daily service between Chicago and Fort Worth via Wichita and Oklahoma City. Connecting bus service to Dallas and a tri-weekly cross-platform transfer to the existing Eagle at Fort Worth would be available. The Eagle currently operates between Chicago and San Antonio.

2. The tri-weekly Lone Star option would provide the same service as the daily Lone Star except that the train would operate tri-weekly on the same days as existing Eagle service.

3. The tri-weekly Tulsa Eagle option would provide service between Chicago and San Antonio via Springfield, Missouri; Tulsa, and Oklahoma City, with connecting bus service available from Fort Worth to Dallas. The train would run on the days that the existing Eagle would not operate from St. Louis to San Antonio and would have no connections to westbound trains.

4. The daily Oil Flyer option would provide service between Chicago and Fort Worth via Kansas City, Tulsa, and Oklahoma City with connecting bus service to Dallas and a tri-weekly cross-platform transfer to the existing Eagle at Fort Worth.

5. The tri-weekly Oil Flyer option would provide the same service as the Daily Oil Flyer except that it would operate tri-weekly on the same days as existing Eagle service.

6. The daily Ann Rutledge option would provide service between Chicago and Fort Worth via St. Louis, Kansas City, Tulsa, and Oklahoma City, with connecting bus service to Dallas and a tri-weekly cross-platform transfer to the existing Eagle at Fort Worth. The service would be an extension of the Ann Rutledge, which presently operates between Chicago and Kansas City.

7. The tri-weekly Ann Rutledge option would provide the same service as the daily Ann Rutledge except that it would operate tri-weekly on the same days as existing Eagle service.

SECTION III: AMTRAK'S CRITERIA FOR EVALUATING THE FINANCIAL AND RIDERSHIP PERFORMANCE OF THE SEVEN PROPOSED OKLAHOMA RAIL SERVICE OPTIONS

Amtrak used the following criteria in evaluating the financial and ridership performance of the seven proposed Oklahoma rail service options:

1. Legislatively mandated Amtrak service criteria for existing long-distance routes:

   A. Ridership criterion--at least 150 passenger-miles per train-mile.

   B. Loss criterion--no more than 11 cents per passenger-mile (based on short-term avoidable costs, in FY 1985 dollars).

2. Amtrak's criterion for new routes--no new train service will be started unless 100 percent of a route's long-term avoidable costs are covered by its revenues.

The Amtrak Reorganization Act of 1979 established a ridership criterion for long-distance routes of 150 passenger-miles per train-mile. This criterion ensured that at least 150 passengers, on average, were aboard an operating train between its origin and destination. That same act established a loss criterion of 7 cents per passenger-mile (11 cents, in FY 1985 dollars) in order to place a maximum limit on the losses that any train could incur in carrying 1 passenger for 1 mile. This loss criterion is based on short-term avoidable costs, which include all those costs attributable to the operation of a given train over a period of less than 1 year. Existing trains must meet both the ridership and short-term loss criteria.

In 1982 Amtrak started a policy that no new rail service would be initiated unless the proposed route's revenues covered 100 percent of its long-term avoidable costs.[1] Thus, only new rail routes that would not reduce Amtrak's systemwide financial performance could be considered viable candidates for new service. Amtrak assessed the performance of the proposed Oklahoma service options using the ridership and short-term loss criteria that it applies to existing trains and the long-term loss criteria that it applies to proposed new routes.

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[1]Long-term avoidable costs include short-term avoidable costs plus heavy equipment overhauls, insurance claims, and general support overhead costs attributable to a given train over a period beyond 1 year. Long-term avoidable costs are approximately 18 percent above short-term avoidable costs.

SECTION IV: AMTRAK PROJECTED LOSSES FOR ALL OF THE SEVEN PROPOSED OKLAHOMA ROUTE OPTIONS

On the basis of projections from its revenue and cost models, Amtrak concluded that none of the seven Oklahoma service options would meet the financial criterion for new rail service. Table IV.1 shows that all of the options generated financial losses. No routes were able to fully cover their long-term avoidable costs with revenues and thereby meet Amtrak's criterion for new rail service.

Moreover, only the Lone Star routes would have been able to meet the criteria for existing service. As can be seen in table IV.2, only the two Lone Star routes exceeded the minimum ridership criterion of 150 passenger-miles per train-mile. The two Lone Star routes and the two Ann Rutledge routes met the short-term avoidable loss per passenger-mile criterion of no more than 11 cents per passenger-mile.

Table IV.1

Oklahoma Service Options
Projected First-Year Route Operating Losses

Option	Projected revenue	Projected long-term avoidable cost	Projected long-term avoidable loss
	----------(FY 1985 000's)----------		
Daily Lone Star	$5,360	$10,435	($5,075)
Tri-weekly Lone Star	2,986	5,189	(2,203)
Tri-weekly Tulsa Eagle	3,066	7,953	(4,887)
Daily Oil Flyer	4,209	11,541	(7,332)
Tri-weekly Oil Flyer	2,513	6,196	(3,683)
Daily Ann Rutledge	4,458	10,171	(5,713)
Tri-weekly Ann Rutledge	2,368	5,399	(3,031)

Source: Amtrak.

Table IV.2

Oklahoma Service Options
Projected First-Year Route Performance

Option	Required percentage revenue increase	Short-term avoidable loss/ pass-mile	Passenger-mile/Train-mile
		(FY 1985)	
Daily Lone Star	95	($0.070)	166
Tri-weekly Lone Star	74	(0.050)	216
Tri-weekly Tulsa Eagle	159	(0.136)	87
Daily Oil Flyer	174	(0.148)	89
Tri-weekly Oil Flyer	147	(0.122)	125
Daily Ann Rutledge	128	(0.108)	91
Tri-weekly Ann Rutledge	128	(0.108)	114

Source: Amtrak.

Table IV.2 also presents the increases in revenues needed for the Oklahoma routes to fully cover their long-term avoidable costs. By this measure, the two Lone Star routes were the best performing of all the Oklahoma options. They required a 74- to 95-percent increase in annual revenues, or an additional $2.20 to $5.08 million (FY 1985 dollars) per year to break even compared with the 128- to 174-percent revenue increases needed for the other Oklahoma options to break even and meet AMTRAK's new service criteria.

All the routes currently running in western states adjacent to the service area of the terminated Lone Star route sustain financial losses each year. Table IV.3 shows the actual 1983 and 1984 and estimated 1985 passenger-miles per train-mile, short-term avoidable losses per passenger-mile, and ratios of route revenues to long-term avoidable costs for the four western routes running nearest to Oklahoma.

Table IV.3

Amtrak Route Statistics for 1983, 1984, and Estimated 1985

		1983			1984			Estimated 1985		
Train	Route	Short-term avoid. loss/PM[a]	Pass.-mile/ train-mile	Revenue/ cost ratio	Short-term avoid. loss/PM[a]	Pass.-mile/ train-mile	Revenue/ cost ratio	Short-term avoid. loss/PM[a]	Pass.-mile/ train-mile	Revenue/ cost ratio
Empire Builder	Chicago-Seattle-Portland	($0.073)	146	0.50	($0.050)	165	0.56	($0.050)	166	0.58
California Zephyr/ Desert Wind/ Pioneer	Chicago-Oakland-Los Angeles-Seattle	(0.063)	151	0.54	(0.044)	176	0.59	(0.041)	183	0.62
Southwest Limited	Chicago-Los Angeles	(0.057)	151	0.54	(0.047)	151	0.56	(0.054)	154	0.54
Sunset Limited/ Eagle	Chicago-New Orleans-Los Angeles	(0.074)	170	0.48	(0.056)	194	0.52	(0.063)	207	0.50

[a]In FY 1985 dollars.
PM=passenger-mile

Source: Amtrak.

Except for the Empire Builder's low passenger-mile per train-mile performance in 1983, the adjacent routes met Amtrak's criteria for continuing service in the national system between 1983 and 1985. However, none of the routes met the more stringent financial criterion for initiating new rail service as measured by their performance on the revenue-to-long-term avoidable cost ratio. All of the routes have ratios of less than 1 for the period from 1983 to 1985; their revenues do not cover their long-term avoidable costs.

The level of losses on these currently operating routes reinforces Amtrak's conclusions as to the likely losses on any of the seven Oklahoma options, given existing cost, fare, and ridership conditions in that region of the nation.

SECTION V: DESCRIPTION OF AMTRAK'S REVENUE MODEL

As part of its feasibility analysis of restoring intercity rail passenger service through Oklahoma, Amtrak employed a rail travel demand forecasting model to project passenger revenues for seven route options and to assess whether any of those options could meet the ridership and financial performance criteria for adding new trains to the system.

Amtrak uses this model to aid in making route initiation and restructuring decisions for routes outside the northeast rail corridor. Amtrak designed the revenue model to reflect the influence of a number of factors on the demand for rail travel including the following:

1. Population of cities served along the route.
2. Cities or stations on the route.
3. Rail route distance.
4. Rail travel time between cities served.
5. Arrival and departure times.
6. Station wait.
7. Frequency of train service.
8. Amtrak fare.
9. Any special attractiveness of rail travel between the city-pairs to be served by the rail route.

SECTION VI: STRUCTURAL DESIGN LIMITATIONS WITH THE REVENUE MODEL AMTRAK USED IN THE SEVEN OKLAHOMA ROUTE ANALYSES

The following is a list of structural design limitations in the revenue model Amtrak used in analyzing the seven Oklahoma route options:

1. Marketing variables representing the influence of competing modes on rail service demand were not included in the model.

2. The mathematical structure of the model may result in underestimated ridership.

3. The model assumed a constant relationship between population of a city and the potential demand for rail service from that city.

4. The model assumed the same mix of passenger classes for each of the Oklahoma routes.

5. The model did not include unique features of markets for rail passenger service.

We conclude that the extent of these model limitations is not significant enough to prompt us to reject Amtrak's conclusion that each of the Oklahoma options would operate at a substantial loss, given the magnitude of the losses projected for the seven Oklahoma options and the model's tendency to over-predict passenger revenues on actual routes.

MARKETING VARIABLES REPRESENTING THE EFFECT OF COMPETING TRANSPORTATION MODES ON RAIL SERVICE DEMAND WERE NOT INCLUDED IN THE MODEL

The revenue model Amtrak used to analyze the Oklahoma route options did not include information on the availability and price of service from competing transportation modes such as airlines, buses, and automobiles. Although the model was initially designed to represent the effect of auto travel costs on rail ridership, Amtrak did not include the auto cost variable in the Oklahoma route analyses. The inclusion of competing modal information could have yielded ridership revenue estimates that better represented competitive market conditions presently faced by Amtrak trains.

Since service was terminated on the Lone Star in 1979, significant changes have taken place in the competitive positions of the airline and bus industries and in the costs of auto travel. A significant change in the air travel market took place with airline deregulation in 1978. This resulted in

substantial airfare reductions and improvements in service competition in many major cities while airfares rose and service declined in some small communities. These airline industry changes could affect the price and availability of air service competition with Amtrak in both large and small communities--for instance, airline service may be less competitive into and out of small cities and more competitive for larger cities.

The second significant transportation market change since 1978 was federal reform of intercity bus regulation. The Bus Deregulation Act of 1982 has had significant effects on prices and services. Fares have risen generally and service has been withdrawn in many small communities.

The third significant change in the transportation market since 1979 is the reduction in auto travel costs. The average price of gasoline, in real terms, dropped 3 percent between 1979 and 1984. This, in combination with a nationwide increase in automobile fuel efficiency, yielded a 25-percent drop, in real terms, in the average fuel costs per mile of auto travel between 1979 and 1984.

Amtrak provided us with documentation of its revenue model that represented auto travel as the only mode competing with rail. However, in our examination of the revenue model's structure as it was used in the seven Oklahoma route analyses, we did not find any evidence that Amtrak used the auto cost variable in its analyses of those routes. Amtrak officials told us that they did not include the cost of auto travel in the Oklahoma route analyses because they felt it would not vary greatly between the seven route options.

All of the above changes in the prices and service availability in competing modes that have occurred since the Lone Star service was terminated in 1979 are likely to have altered the demand for passenger rail service since that time in all of the communities included in Amtrak's Oklahoma analyses. Yet, Amtrak's revenue projections cannot reflect such changes in the transportation marketplace because Amtrak's revenue model does not incorporate the competitive offerings of other modes.

It is noteworthy that, while Amtrak did not estimate the effects of competition from other transportation modes in its Oklahoma route analyses, DOT explained its reasons for recommending termination of Oklahoma rail service in 1979 by referring not only to the ridership performance of the Lone Star but also to the effects of competing modes on rail ridership. DOT expressed its belief that the population along the old Lone Star route had a particularly strong affinity for modes of transportation other than rail, stating that the area has a highly developed highway system and extensive inter- and intrastate airline service.

Without a detailed study of the relative competitive positions of all transportation modes along the seven Oklahoma routes, it is not possible to estimate the effect that including the above competition factors would have had on the Oklahoma ridership and revenue forecasts. However, the price reductions and service improvements of airlines for larger cities could tend to increase the proportion of such cities' travellers preferring these modes over passenger rail. Conversely, for those smaller cities where airline and bus deregulation may result in higher fares and service withdrawals for those modes, we would expect Amtrak's competitive position to improve relative to these modes. The reduction in auto travel costs could tend to increase the proportion of total travellers preferring auto travel over passenger rail.

Amtrak recognizes the value of competing modes in rail revenue projection modeling. The revenue model used to estimate rail ridership for new and restructured routes in the heavily travelled northeast rail corridor includes variables for price and service competition from airline, bus, and auto traffic. Amtrak officials stated that the cost of developing the data bases to support a similar, multi-modal revenue-modeling system for routes outside the northeast corridor would be high. They also noted that such data may quickly become obsolete where competitive conditions change often in transportation markets.

THE MATHEMATICAL STRUCTURE OF THE REVENUE MODEL MAY RESULT IN UNDERESTIMATED RIDERSHIP

The structural form of Amtrak's revenue projection model results in underestimated ridership projections. Amtrak acknowledged this in its documentation of the revenue model. This underprediction of ridership would lead to underprediction of revenues. Amtrak did not estimate the effect of this underestimation on the revenue projections for the Oklahoma routes, but it did attempt to correct for it by using a single correction factor--an adjustment of the constant term in the model. As discussed on page 27, we believe that this approach is inappropriate.

THE REVENUE MODEL ASSUMED A CONSTANT RELATIONSHIP BETWEEN THE POPULATION OF A CITY AND THE POTENTIAL DEMAND FOR RAIL SERVICE FROM THAT CITY

The revenue model assumes that a given change in the population size of cities on a rail route will yield the same percentage change in rail ridership projected for those cities, regardless of the size of the cities involved. However, it is not likely that this relationship is constant across cities of

differing sizes. Small cities without direct airline service, adequate bus service, or proximity to interstate highways may have higher rail ridership on a per-capita basis than larger cities with well-developed access to competing passenger modes. On the other hand, some larger cities may make greater use of intercity trains since the percentage of people who own autos may decline as city size increases above a certain point. Highly developed transit systems in larger cities may lessen public dependency on autos.

We did not have sufficient information to say whether either of these city-size effects is true for the Oklahoma routes. Amtrak has tested alternative forms of the revenue model that assumed that cities of different population sizes would have different per-capita ridership and has found that this adjustment to the model is worth further study.

THE REVENUE MODEL ASSUMED THE SAME MIX OF PASSENGER CLASSES FOR EACH OF THE OKLAHOMA ROUTES

The revenue model projects passenger revenues using a single yield factor that represents the ticket prices paid by passengers.[1] The single yield factor used in the model does not differentiate between classes of passengers (discount, coach, and first-class sleeper) who each pay significantly different ticket prices over a given route. Amtrak's Oklahoma service projections used the same yield factor for five of the seven Oklahoma service options. Amtrak stated that the fiscal year 1985 average yield projected for all western long-haul routes was applied to the two Lone Star options, the single Oil Flyer option, and the two Ann Rutledge options. The fiscal year 1985 average yield for the Eagle route currently operating from Chicago to San Antonio was applied to the two Tulsa Eagle options. Thus, Amtrak assumed that five of the seven Oklahoma service options had the same mix of passenger classes. This assumption was made despite the fact that each of the Oklahoma routes had different schedules, covered different distances, and served populations of different compositions and sizes. Such variation in rail markets could result in different mixes of passenger class for each route, and this variation in passenger-class mix could result in different revenue estimates than those projected with the single revenue yield factor used in the Oklahoma route analyses.

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[1]Revenues derived from sources such as food and beverages were estimated as a percentage of total passenger revenues in the Oklahoma analyses. Revenues from mail and freight delivery were not included in the Oklahoma estimates.

To assess the degree of variation in passenger-class revenue mix on actual routes, we calculated the composition of revenues from different passenger classes for three western routes operating adjacent to the Oklahoma service area in 1984 and for all nonnortheast corridor, long-distance routes operating over the same period. Table VI.1 presents the actual September 1984 year-to-date revenues, by source. The table also presents the percentage of total route revenues coming from first-class passengers and coach passengers. It can be seen that there are no significant differences between the two routes and the long-distance totals in terms of the percentage of revenues derived from first-class and coach passengers. On the basis of this analysis, we conclude that it was appropriate for Amtrak to use the same yield factor for five of the proposed Oklahoma routes.

Table VI.1

Composition of Passenger-Class Revenues for Two Western Routes and for All Nonnortheast Corridor Long-Distance Routes

Route	First-class revenues[a]	Percent of total passenger revenues	Coach revenues[ab]	Percent of total passenger revenues	Total passenger revenues
Chicago-Los Angeles	$5,785	30	$13,798	70	$19,583
Chicago-San Antonio	2,329	27	6,255	73	8,584
Total nonnortheast corridor, long-distance routes	63,052	24	204,366	76	267,418

[a] Thousands of FY 1984 dollars.

[b] The Train Information System that these data were derived from does not separately report figures for discount passengers. They are included in the coach-class data.

Source: Amtrak.

THE REVENUE MODEL DID NOT INCLUDE UNIQUE RAIL MARKET FEATURES FOR THE OKLAHOMA ROUTES

The revenue model does not represent the effect on ridership of special conditions in origin or destination cities and cities along each route. Cities with special market conditions such as the presence of universities, the state's capital, tourist attractions, or military facilities may have substantially different ridership demands than cities without such features. A city having many college students or military personnel whose financial limitations and time valuations may make them more likely to use low-cost transportation might have more rail ridership.

Amtrak's model used a correction factor that was designed to represent the effect on projected ridership revenues of variables not included in the model. Documents describing the revenue model used in the Oklahoma route analyses note that the correction factor was designed, in part, to compensate for the exclusion of unique rail market features from the variables used in the model. As we discuss on page 27, we believe that there are significant problems with the correction factor Amtrak used to correct for this and other limitations of the revenue model.

LIMITATIONS WITH AMTRAK'S REVENUE MODEL ARE NOT SUBSTANTIAL ENOUGH TO INVALIDATE AMTRAK'S LOSS PROJECTIONS FOR THE OKLAHOMA ROUTES

The above limitations with the structure of Amtrak's revenue model raise questions regarding the model's predictive capability. To assess the predictive performance of the model, we reviewed test results that compared the projected and actual ridership and passenger-miles for fiscal year 1977 Amtrak routes operating between Chicago and Houston and between New York and Chicago via Pittsburgh. These were the only available Amtrak data comparing actual route ridership figures to projections made by an Amtrak revenue model similar to that used in the Oklahoma route analyses.

Table VI.2

Comparison Between Actual and Projected Passenger Levels and Passenger-Miles for Two Fiscal Year 1977 Amtrak Routes

Factors	New York-Chicago	Chicago-Houston
Actual passengers (thousands)	1,040.5	288.6
Estimated passengers (thousands)	1,402.8	356.8
Percent over predicted	34.8	23.6
Actual passenger-miles (millions)	136.3	111.8
Estimated passenger-miles (millions)	164.6	118.5
Percent over predicted	20.8	6.0

Source: Amtrak.

Table VI.2 presents a comparison between actual and projected revenues for the two routes. The model overpredicted passenger levels by 24 to 35 percent and over predicted passenger-miles by 6

to 21 percent. Since passenger-mile levels are more closely related to revenue estimates than are passenger levels, we believe that the over prediction ranges for passenger-miles may more closely represent the potential over prediction ranges for the model's projections of revenues. From these limited data, we believe that the revenue model tends to over predict higher revenues than would actually occur on rail routes.

The proposed Oklahoma route options required an increased revenue contribution of between 74 and 174 percent to meet Amtrak's criterion that revenues on new routes must cover their long-term avoidable costs. Given the apparent tendency of the model to over predict revenues on actual routes, we conclude that the structural limitations we have found with the model are not substantial enough for us to reject Amtrak's conclusion that each of the proposed Oklahoma route options would operate at a significant loss.

Given changing transportation market conditions, we believe that the revenue model's inability to represent the effects of competing modes is its most significant limitation. Deregulation of the airline industry and the reduction of auto travel costs have generally improved the competitive positions of these modes relative to rail travel on a national basis. However, we cannot predict how such trends might affect the potential for rail ridership in Oklahoma without a study of the relative competitive positions of all the modes along the seven proposed Oklahoma routes. We believe that the magnitude of the losses on long-distance routes currently operating adjacent to Oklahoma reinforces Amtrak's projections of substantial losses for all of the seven Oklahoma route options. Amtrak's financial and ridership performance along these adjacent routes is a good indicator of its competitive position relative to other modes in that region of the nation.

SECTION VII: DATA PROBLEMS WITH THE REVENUE MODEL

THE REVENUE MODEL DID NOT USE DATA ON CONNECTING PASSENGERS

Amtrak estimated the connecting passenger revenues for western and eastern connections for each of the seven Oklahoma route options. However, these estimates were not included in the route revenue projections for the Oklahoma route options because Amtrak felt they were not reliable statistically. Connecting passengers are those who use more than one route or train to get from one point to another.

Amtrak stated that it cannot obtain detailed connecting revenue data on a route-, route segment-, and/or train-specific basis because it tickets passengers for an individual route segment and does not have ticket information on connections that passengers may make to or from that route segment. Amtrak can only determine the origins and destinations of passengers connecting to or from either end of a route by sampling reservations or by examining actual tickets. Conversely, airlines use multi-segment, tear-sheet tickets that show all the connections to or from the various flight segments.

We could not estimate the effect that inclusion of eastern and western connecting ridership would have on the Oklahoma route estimates. We believe that connecting ridership would have increased the overall ridership estimates for the Oklahoma options. However, given Amtrak's caveats regarding the statistical reliability of its connecting revenue estimates, we do not know what effect this would have on the projected Oklahoma option revenues.

CORRECTION FACTORS USED IN THE REVENUE MODEL HAVE SIGNIFICANT PROBLEMS AND WERE DEVELOPED FOR SOME OKLAHOMA ROUTES USING DATA FROM A ROUTE OUTSIDE THE OKLAHOMA SERVICE AREA

The revenue model projects passenger revenues by estimating the effects of the variables in the model--population, route distance, travel time, arrival and departure times, station wait periods, frequency of service, and Amtrak fare--on rail travel demand on the route. However, these variables can explain only a portion of that demand for rail travel between city pairs on a given rail route. Tests of an earlier version of the revenue model found that the model's variables accounted for approximately 67 percent of the variation observed between actual and predicted ridership.

In order to improve the accuracy of the revenue model's projections of ridership revenues, Amtrak uses a correction factor called an "attractiveness factor." It is called an attractiveness factor because it adjusts the model's projections to reflect that cities are attractive to rail travellers for reasons other than those related to the variables in the model.

The attractiveness factor is developed by comparing the actual patronage on an operating route's prior service and the projected patronage estimated for that route by the model.[1] The attractiveness factor acts, in part, as a correction factor for the variation between actual and expected ridership which could be caused by a number of significant variables that were not included in the model. These omitted variables include

--measures of competition from other modes (airlines, bus, and automobiles) that may differ substantially between various cities,

--special market conditions in origin or destination cities such as: universities, state capitals, tourist attractions, and military facilities, and

--any other omitted explanatory variable which might explain the difference between actual and estimated rail ridership for a given route.

The attractiveness factor is also used to correct for the effects of the underestimation of ridership caused by the structure of the model as described on page 22. However, we believe it is inappropriate to use a single correction factor to compensate for these two problems. If the only predictive error in the model came from the omission of variables in the model, the model's coefficients would be biased, but their bias would be of indeterminate direction. Some of the coefficients would be biased to overestimate ridership and some would underestimate ridership. Conversely, if the only predictive error in the model came from the structural form of the model, it would yield underestimates of ridership, as Amtrak acknowledges.

Amtrak uses the attractiveness factor in an attempt to adjust for the effects of both of these problems by adjusting the constant term in the model. However, the model's coefficients are not adjusted. They remain biased coefficients, and their bias is of indeterminate direction because of the omitted-variables bias.

There is an additional problem with the attractiveness factor. For those route options which had no prior rail service, Amtrak had to use an attractiveness factor from an adjacent route

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[1]The attractiveness factor takes the log of the ratio between the actual and projected patronage for a route.

for which it had records of prior passenger service. The attractiveness factors Amtrak developed for the two proposed Lone Star routes were based on actual 1979 Lone Star service data. However, the other five options had no prior rail service over the majority of their route distance. For these routes, ridership data for the current Eagle route which operated between Chicago and San Antonio was used as the basis for the attractiveness factors developed for the two Oil Flyer routes, the two Ann Rutledge routes, and the Tulsa Eagle route. We conclude that there was no feasible alternative way for Amtrak to develop correction factors for those routes having no prior rail service. However, for these five route options, there is an additional bias of unknown direction and magnitude caused by the use of an adjacent, operating route's attractiveness factor.

We do not know to what extent the attractiveness factor improves the accuracy of the revenue model's projections of rail ridership because of the unknown direction of the bias caused by the omission of variables from the model. For those proposed Oklahoma routes that had no prior rail service, we believe that this problem is complicated by the use of an adjacent, operating route's attractiveness factor.

SECTION VIII: THE REVENUE MODEL HAD SIGNIFICANT DOCUMENTATION AND STATISTICAL ANALYSIS PROBLEMS

1. Documentation and statistical analysis problems with the revenue model prevented us from fully evaluating the Oklahoma route revenue projections.

2. Records for the seven Oklahoma route analyses were so poorly maintained as to make them unusable in reconstructing and evaluating the Oklahoma route analyses.

3. There was no written documentation of statistical reliability and sensitivity analysis tests performed on the revenue model.

4. Amtrak performed no sensitivity analyses to estimate the effect of changes in the model's variables on the revenue model's Oklahoma projections.

5. The documentation and statistical analysis problems with the revenue model would not invalidate Amtrak's loss projections for the Oklahoma routes.

Clear, complete, and concise documentation is a basic criterion for designing, understanding, using, and maintaining complex computer models. It is important that model documentation include written descriptions of

--the model's assumptions, mathematical structure, computer code listings, data requirements, and estimates or other outputs from the model;

--the model's operating and statistical and sensitivity analysis procedures; and

--the results of statistical and sensitivity analyses of the model itself and its output.

Amtrak maintained acceptable documentary records of the revenue model's structure and assumptions. The flowcharts and model computer code that depicted the model's mathematical equation forms and data inputs were up to date and understandable. Amtrak maintained written records of procedures defining how the revenue model was to be operated but had no documents defining the model's statistical and sensitivity analysis procedures.

Amtrak's revenue projection records for the Oklahoma route analyses were disorganized, and it was impossible to reconstruct the revenue analyses so that we could evaluate them fully. The physical condition of the records for the Oklahoma route analyses

made it impossible to determine what the inputs to the model were for each route analysis, how the route analyses were performed, what the results of the analyses were, and how those results were interpreted by Amtrak so that it could develop estimates of the revenues for each of the seven Oklahoma route options. The condition of records documenting both the revenue model's procedures and the individual Oklahoma route analyses prevented us from replicating and independently confirming the accuracy of Amtrak's computer-modeled projections of the Oklahoma route revenues.

Amtrak did not perform statistical and sensitivity analyses on the revenue model as it was used in the Oklahoma analyses. Statistical analyses would have specified the statistical reliability of the overall model and each of its variables. Sensitivity analyses would have allowed Amtrak to determine which variables in its model induced the most dramatic shifts in Oklahoma ridership revenues.

Since Amtrak did not perform any statistical or sensitivity analyses on its revenue model, we had no data with which to assess the statistical reliability of either the model or its projections in the Oklahoma route analyses. The absence of sensitivity analyses for the Oklahoma projections meant that we could not assess the relative importance of the variables used to project Oklahoma ridership revenues. The absence of such statistical and sensitivity analyses also means that Amtrak has limited baseline information that would allow it to improve the structural design or the statistical reliability of the model.

SECTION IX: AMTRAK'S COST ESTIMATION MODEL USED IN THE OKLAHOMA ROUTE ANALYSES HAD FEW PROBLEMS

1. Amtrak's cost modeling systems had no major structural problems.

2. Amtrak's cost model documentation was well done.

3. The cost model used appropriate and timely data.

4. Cost model estimates had minor statistical reliability problems.

5. Our alteration of some cost allocation and labor cost assumptions used in the Oklahoma route analyses did not significantly reduce the losses projected for the Oklahoma route options.

We found that Amtrak included all relevant cost categories in its cost estimates for the seven Oklahoma route options. Actual costs, adjusted systemwide average costs, and allocated systemwide general support costs were appropriately used in the cost model, and the long-term avoidable cost methodology used in the model appropriately represented the costs of additional train service in the Oklahoma route options. The cost estimation methods were applied consistently in all of the Oklahoma route option analyses.

Amtrak's cost model was well documented. All costs for the Oklahoma route analyses were clearly traceable to their source documentation.

There were no problems with the timeliness of cost data used in the Oklahoma analyses. Data for all cost categories were assembled for the fiscal year 1984 accounting quarter in which the Oklahoma route analyses occurred. Amtrak inflated these figures to yield cost estimates for fiscal year 1985.

Amtrak cost model estimates had minor statistical reliability problems. Between 1980 and 1984, Amtrak's cost-modeling system could not readily compare actual costs with projected costs on a route-by-route basis. This may have somewhat reduced the reliability of the cost estimates used in the Oklahoma route analyses performed in 1983. Amtrak developed a cost variance analysis system in 1984 to improve its capability to compare actual and projected costs on a route-by-route basis.

We assessed two of Amtrak's cost estimation assumptions. First, Amtrak's methods for allocating general support costs may have overstated the marginal general support costs associated with new train service on the seven Oklahoma route options. On the

basis of data provided by Amtrak, we reduced general support costs to eliminate those long-term costs that may not be attributable to adding Oklahoma route service.

Second, Amtrak assumed that then-current labor contract work rules for switching crews and on-board service crews would apply in the Oklahoma options. This assumption may have increased these labor costs in the Oklahoma route analyses beyond levels achievable with more efficient labor agreements. Amtrak can negotiate new labor contracts and revise work rules before new rail service begins. On-board switching crew and service crew costs were the two labor cost areas where savings may have been possible for the Oklahoma routes. On the basis of data provided by Amtrak, we reduced these labor costs to estimate the financial effect of more efficient labor agreements.

For demonstration purposes, we analyzed the effect of reducing the long-term general support overhead costs and the switching and on-board crew costs for the daily and tri-weekly Lone Star options--the best performing financially of the seven Oklahoma route options. As can be seen in table IX.1, these cost reductions only marginally reduced the losses estimated for these two options. Additional increases in revenues of 78 to 57 percent, respectively, would still have been required for these two route options to meet Amtrak's financial criteria for new routes.

Table IX.1

Oklahoma Service Options: Estimated Effect on Projected First-Year Route Operating Losses and Breakeven Revenue Requirements of Modifications to Amtrak's Overhead and Labor Cost Assumptions

Option	Projected revenue	Projected long-term avoidable cost	Projected long-term avoidable loss	Potential overhead and labor cost savings	Revised long-term avoidable loss	Revised required revenue increase
	(FY 1985 000's)					(percent)
Daily Lone Star	$5,360	$10,435	($5,075)	$895	($4,180)	78
Tri-weekly Lone Star	2,986	5,189	(2,203)	513	(1,690)	57

Source: Amtrak.

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