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T R F

TRANSPORTATION RESEARCH FORUM

THE RAIL PASSENGER LINK under consideration is located in the Edmonton-Calgary Corridor Region which in turn is situated in the Province of Alberta in Western Canada as shown in Figure 1.

The populations of the communities in the study area vary widely with Edmonton and Calgary each approaching one half-million, while the next largest community, Red Deer, has approximately 28,000. The combined Edmonton-Calgary population accounts for 76% of Corridor Region population. This distribution of population is rapidly changing as Edmonton and Calgary account for almost all new growth, even more investment in intercity transportation facilities and services.

Table I provides a comparison between the Edmonton-Calgary Corridor and other corridors in terms of length, population and modal split.

This paper describes the current rail system, some of the technical aspects in improving service, and then costs and evaluates several alternative service improvements for the Edmonton-Calgary Corridor.

RAIL PASSENGER SERVICE IN THE EDMONTON-CALGARY CORRIDOR

With a 174 mile air distance separating the cities of Edmonton and Calgary, it is quite reasonable to consider in some detail the possibility of quality rail passenger service between these cities. The current rail passenger service has the

INTERCITY RAIL PASSENGER ROUTE IN WESTERN CANADA

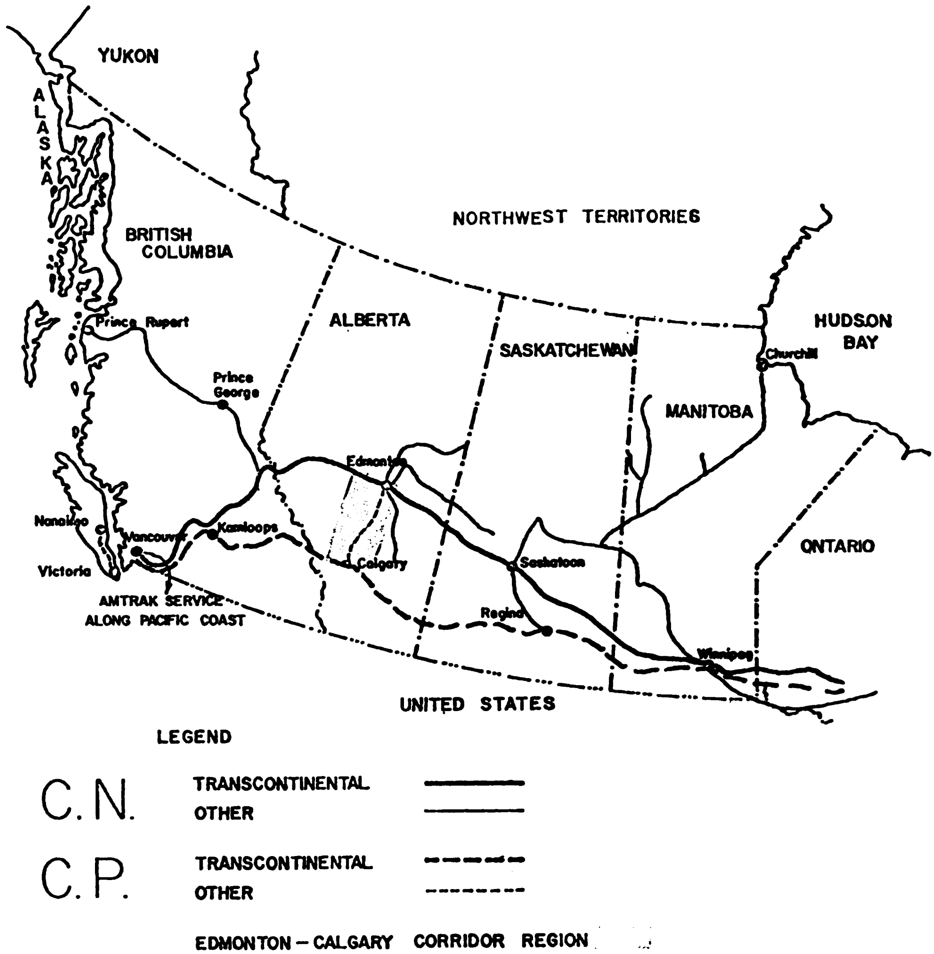

FIGURE 1

Rail Passenger Service in the Edmonton-Calgary Corridor

*by Stein Jahnsen**, *John Mayne***, *John Morrall****, and *Fred Sturm*****

COMPARISON OF CORRIDOR LENGTH, POPULATION, AND INTERCITY MODAL SPLIT FOR SELECTED CORRIDORS

Intercity Corridor	Corridor Length (miles)	Corridor Population (millions)	Modal Split (%) Auto	Rail	Bus	Air
Calgary-Edmonton (1974)	175	1	67	1	12	21
Ottawa-Montreal (1974)	125	2	74	8	14	4
Montreal-Toronto (1971)	335	6	50	17	2	31
Canadian Intercity Average (1971)	—	—	85	3	5	7
Sacramento-Stockton-San Francisco Bay Area (1973)	—	6	90	—	8	2
Washington-New York City (1971)	225	30	68	13	8	11
London-Manchester (1968)	194	20	37	55	3	5

TABLE I

largest trip time, the highest price—excluding air—and the lowest frequency of service of all the modes available for intercity trips, and correspondingly receives the smallest patronage—less than 1% of the intercity market. Yet it would appear quite possible to upgrade the level of service offered through the use of new higher speed trains, more frequent departures and a more reliable service, since the corridor involved seems physically well-suited for improved rail service.

THE PRESENT RAIL SERVICE

The CP rail and roadbed are considered in good condition as is evident from the 90 mph speed limit for passenger trains. The existing signalling on this line is as follows: 59% automatic block signalling, 39% unsignalized, and 2% centralized traffic control. There are a total of 155 public level crossings, 30-35 of which are urban crossings. In addition, there are numerous private crossings on the line.

CP Rail provides a passenger service which is one of four modes used in the Corridor Region, namely, rail, bus, air and automobile. Four trains run every weekday, two departures per city, (two on weekends) between Edmonton and Calgary making four intermediate stops, and cover the 195 miles between Edmonton and Calgary in 3 hours and 25 minutes. Between 1964 and 1974 total annual traffic on the service dropped from just over 200,000 to 27,000 resulting in a present average load factor of 32%. The present service is uneconomic and unattractive for a number of reasons. Travel times are long, fares relatively high and only two departures a day provided. The equipment used is about 20 years old and the service offered is a regional service and does not take advantage of the express service capabilities that rail is usually assumed to have. The net result is low demand in turn resulting in high per passenger system costs and high per passenger

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This paper is an extract of the rail alternatives discussed in the Edmonton-Calgary Corridor Transportation Study, a multi-modal study that considers and evaluates alternative systems opportunities and policies in the immediate, medium and long term for the study area.

CP RAIL RDC SERVICE CHARACTERISTICS

Vehicle Type	Rail Diesel Car II (RDC II)
Train Consist[1]	normally one RDC II (56 seats)
Maximum Cruise Speed	70-80 mph
Intercity Line Haul Travel Time[2]	3 hrs. 25 mins.
Number of Runs per Day	4 on weekdays, 2 on weekends
Available Daily Seats	224 on weekdays, 112 on weekends
Annual Service Capacity	69,000 seats
Annual Effective Seat-Miles (ESM)[3]	11.9 million
Annual Effective Passenger-Miles (EPM)[4]	3.8 million
Average Load Factor	32%
Subsidy payment	$550,000
Avoidable net operator cost	$300,000
Annual avoidable[5] system cost	$850,000

1 This refers to the type of rail equipment that makes up a train. Some weekend runs use 2 RDC's per train.
2 The scheduled time includes 4 intermediate stops. It is estimated that the service could meet a 3 hour, 17 minute schedule if it were non-stop Edmonton-Calgary.
3 ESM equals annual seat times the air-mile distance between terminals of 172 miles.
4 Estimated.
5 Avoidable costs are defined as those expenses that would no longer be incurred if CP Rail ceased to operate the passenger service, after allowing a reasonable period of time for adjustment to the new condition.

TABLE II

INTERCITY RAIL PASSENGER ROUTE IN WESTERN CANADA

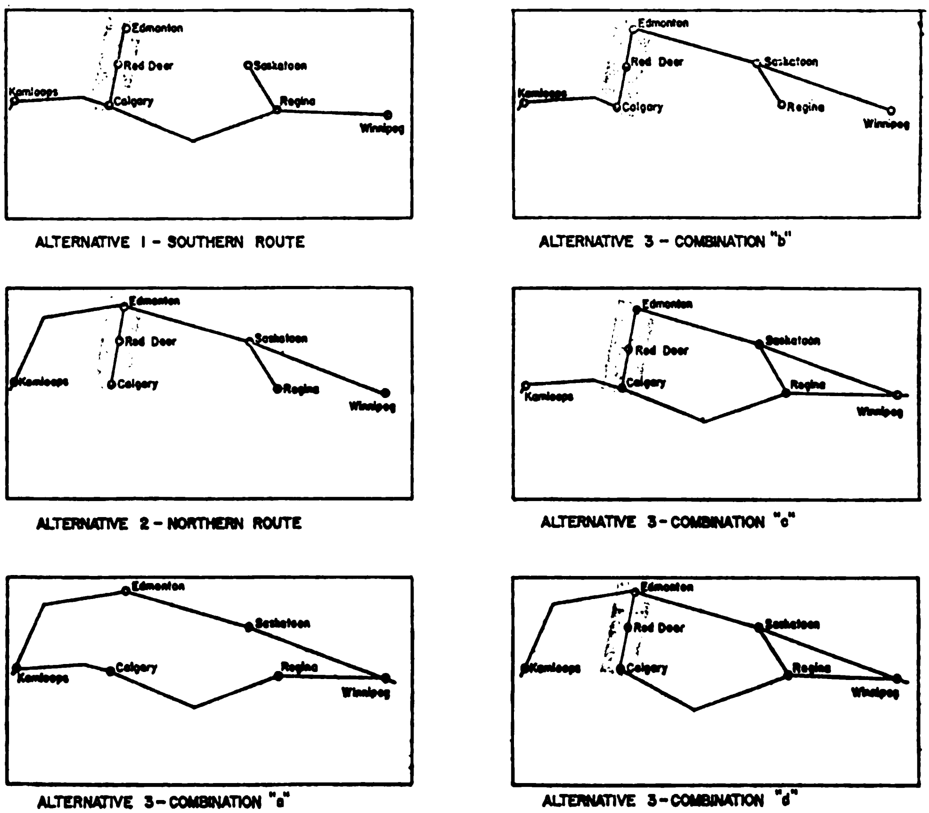

FIGURE 2

IMPROVED RDC SERVICE (R-1) SYSTEM CHARACTERISTICS

	Improved RDC Service (R-1)	1974 RDC Service	IMPROVEMENT Increase (Decrease)	% Increase (% Decrease)
SERVICE CHARACTERISTICS				
Runs per day	10	4	6	150%
Available daily seats	560	224	336	150%
Annual effective seat-miles (ESM)	34.8 million	11.9 million	22.9 million	190%
Annual effective passenger miles (EPM)[1]	13.9 million	3.8 million	10.1 million	265%
USER IMPACTS				
CBD-CBD Intercity Travel Time:				
Line Haul	3 hrs. 5 mins.	3 hrs. 25 mins.		
Access/Egress	40 mins.	40 mins.		
Total	3 hrs. 45 mins.	4 hrs. 5 mins.	(20 mins.)	(9%)

1 These values for R-1 assume a 40% load factor.

TABLE III

energy consumption. Table II provides a summary of the present CP Rail service characteristics.

RAIL ALTERNATIVES IN THE IMMEDIATE TERM[1]

One option is clearly to continue the present service, alternatively, the present rail passenger service could be discontinued. One rail alternative (R-1) which represents an improvement in the service could also be considered. More use could be made of the present equipment. In addition, marginal improvement in travel time could be achieved by eliminating all intermediate stops except perhaps for a stop at Red Deer, and by some marginal improvements in grade crossing protection. These modifications would allow for a twenty-minute saving in intercity travel time. In Table III the characteristics of the improved service (R-1) are compared with the present service. The total system investment cost for R-1 was estimated at $3 million for improvements in grade crossings and right-of-way protection. The annual avoidable operating cost would be $1.6 million, almost double that of the existing service.

Termination of rail service would not significantly reduce the level of service that now exists. There are so very few passengers on the rail service and the bus mode is providing an identical, if not better service. The impact of transferring rail passengers to other modes is summarized in Table IV.

IMPROVING RAIL PASSENGER SERVICE IN THE MEDIUM TERM[2]

The question of improving passenger rail service in the Corridor Region is a complex one, far more so than is usually realized. At this moment it is unclear who would finance the substantial capital requirements needed for improved service. Community reaction against the service can be expected. Problems here relate to the question of appropriate

IMPACT OF TRANSFERRING ALL RAIL PASSENGERS TO OTHER MODES

Mode	Maximum[1] % Increase in Passengers	Maximum Impact on Vehicles and Frequency	Ease of Absorbing Transfer of Rail Passengers
Auto	1%	26 auto/day	No measurable impact on highway system.
Bus	6	2 buses/day	Means 1 extra bus each way or an 8% increase in frequency indicated by trends.
Air	3	—	Easily absorbed.
Bus and Air	2	—	Easily absorbed.

1 If all passengers were transferred to that particular mode.

TABLE IV

PASSENGER RAIL ALTERNATIVES SERVICE CHARACTERISTICS

		Alternative		
	Current	R-2	R-3	R-4
Vehicle Type	Rail Diesel CAR II (RDC II)	Self-powered diesel (SPD), conventional curve speeds	Locomotive-hauled tilting coach train	Locomotive-hauled tilting coach train
Train Consist	One RDC (56 seats)	Two SPDs (60 seats)	1 locomotive; 1 club car (60 seats) and 2 coach cars (84 seats each)	1 locomotive; 1 club car (60 seats) and 2 coach cars (84 seats each)
Maximum Cruise Speed	75 mph	90 mph	90 mph	125 mph
Non-Stop Intercity Line-Haul Time	3 hrs. 15 mins.[1]	2 hrs. 55 mins.	2 hrs. 25 mins.	2 hrs. 10 mins.
Number of Runs per Day	4[2]	10	10	10
Available Daily Seats	224[2]	1,200	2,280	2,280
Annual Service Capacity	69,000 seats	438,000 seats	832,000 seats[3]	832,000 seats[3]
Annual ESM	11.9 million	74.5 million	141.5 million	141.5 million

1 Estimated. The scheduled time is 3 hours, 25 minutes, including 4 intermediate stops.

2 On weekdays. On weekends, 2 runs are provided, with 112 seats.

3 Consisting of 219,000 club car seats and 613,000 coach seats.

TABLE V

levels of grade crossing protection, to insure safety of the community, noise, pollution and road congestion within and around communities, and the fact that most smaller communities through which it would pass would not have the high speed service available to them. There are also several technical problems including general uncertainty as to equipment and infrastructure reliability and performance when high speed service is operating. In addition, the kind of equipment which would provide the appropriate level of capacity for such a rail service in the Corridor is not generally available. Most locomotive hauled trains would provide too much capacity while self-powered equipment cannot provide fast enough service. Even the higher speed trains considered would still result in trip travel time between Edmonton and Calgary at least one hour slower than that by air, the rail line between the two cities has few straight portions where the train can achieve the high speeds it is capable of.

The final problem relating to possible improved rail service is the fact that any kind of a successful service would require significant changes in travel patterns. With the present rail service having less than one percent of the travel market, the question is not one of merely shifting a few people from another mode to the rail but of drastically changing travel patterns of intercity travellers.

RAIL PASSENGER ALTERNATIVES IN THE MEDIUM TERM

Three levels of improved rail passenger service are presented, each representing a higher level of service for increased costs. The 90 mile-per-hour conventional service uses self-powered diesel equipment. The second level alternative uses new first generation 90 mph high-speed passenger rail equipment with tilting coaches which allow significantly higher speeds than those possible with conventional equipment. This would result in a 30 minute saving over the 90 mile-per-hour conventional service. The highest level of service considered utilizes the same equipment as for the 90 mile-per-hour improved service but at a top speed of 125 miles per hour. This produces an additional 15 minutes saving on the intercity trip time. In all cases considerable investment in improved grade crossing protection, track upgrading, signal investment, and rolling stock are incurred. These alternatives, shown in Table V, are representative of the kinds of improved rail service that could be implemented.

The costs of the three intermediate term alternatives are summarized in Table VI. The $38 million investment required for the 125 mph improved service is incurred mainly through improvements in track, signalling, and grade crossings. The investment given for grade separation (where trains would exceed 110 mph at major crossings) include the cost of fourteen grade separations at almost $800,000 each. If grade separations were required at major crossings where speeds exceed 100 mph, costs would rise dramatically, for as many as twenty-three crossings would be affected. By restricting the train to a top speed of 110 mph and requiring no grade separations, the investment cost can be reduced by almost $11 million, with a time loss of only 4 minutes. Because of very limited experience with high speed rail operation, it is highly uncertain what level of grade crossing protection would be required. At worst, grade separation might be required for all crossings, which would mean that the costs given here severely underestimate the total systems cost.

Higher speed and better quality service incur increased operating costs for fuel, crew wages, on-board services, and general traffic for overhead. The direct operating costs of fuel and crew wages, in particular, increase more than two times between the R-2 and the R-3 and R-4 options. Fuel costs for R-4 are estimated to be 20% greater than for R-3, reflecting higher fuel consumption rates at higher speeds.

DEMAND FOR RAIL PASSENGER SERVICES

Most data available on other corridors suggests that the major determining factor in modal choice for intercity travel are: convenience of travel, door-to-door travel time, safety and trip cost. A flaw that often exists in models for modal choice is their failure to adequately identify the groups who have a choice between modes of travel and the basis on which their choices are made. Figure 3 emphasizes the breakdown of the intercity market into travellers who are modal captives and those who actually have a choice. Although in the figure all trip purposes are combined, it is useful to consider business and non-business travellers separately. Many business travellers feel they must use the fastest service available and hence are air captives. For many non-business travellers, cost is more important; thus, they are captive to automobile or bus transportation. Another large group of automobile users consists of business and non-business travellers who need

ECONOMIC COST SUMMARY, PASSENGER RAIL ALTERNATIVES

AVOIDABLE SYSTEM COST	90 mph CONVENTIONAL (R-2) Cost Estimate (thousands)	90 mph IMPROVED (R-3) Cost Estimate (thousands)	125 mph IMPROVED (R-4) Cost Estimate (thousands)
Vehicle Investment	$ 3,000	$ 6,800	$ 6,800
System Investment	7,100	11,100	31,100
Total Investment	$10,100	$17,900	$37,900
Annualized Investment Cost	$ 1,120	$ 2,050	$ 4,120
Annual Avoidable System Operating Cost	2,470	5,310	5,440
Annual Avoidable System Cost	$ 3,590	$ 7,360	$ 9,560

TABLE VI

private transportation at the end of the trip. In order to improve the potential viability of the rail alternatives, a stop in Red Deer has been assumed for all the options. This would add 2-3 minutes at the most to the CBD-CBD travel time.

Total CBD-CBD travel time for all of the services currently in existence, and for the proposed rail service alternatives are shown in Table VII. As can be seen, R-1 would be able to compete time wise with the bus, while R-3 would have to be implemented to successfully compete with automobile in terms of travel time.

For the intercity market the most likely shift would occur from the bus mode and from the non-business automobile market. To a lesser extent there is some possibility of shifting from air and from the business automobile market to an improved rail passenger service. For the Red Deer-Calgary/Edmonton market, again the bus mode seems to be the most likely service from which demand could be captured, and perhaps some of the business automobile travel.

IMPACT OF SUCCESSFUL RAIL PASSENGER SERVICE

Successful rail service is defined as that service with a 60% load factor.[8] In order to achieve a 60% load factor significant demand would have to be shifted from the express bus service. While this may be an undesirable effect of its own, it would have the additional effect of reducing or eliminating the regional bus service. This is because, currently, the express bus service is cross-subsidizing the regional bus service, most routes of which are losing money. Finally, this capture of the bus market would result in possible increases in energy consumption for transportation during the planning period since the bus is a much more energy efficient mode than the rail. On the more positive side, successful passenger rail service would be a less costly transportation mode than the air.

Improved service would continue to require subsidization and certainly would involve substantial capital outlay to reduce travel time.

COMPARISON OF CBD-CBD INTERCITY TRAVEL TIMES

Mode	CBD-CBD Travel Time
Auto	3 hrs. 20 minutes
Bus	3 hrs. 55 minutes
Air	1 hr. 40 minutes
Current Rail	4 hrs. 05 minutes
R-1	3 hrs. 45 minutes
R-2	3 hrs. 35 minutes
R-3	3 hrs. 05 minutes
R-4	2 hrs. 50 minutes

TABLE VII

PURPOSE OF RAIL PASSENGER SERVICE

The possible detrimental effects of improved rail service leads one to consider what exactly would be the purposes of a Corridor passenger rail service. One purpose of passenger rail service could be to increase the choice of mode for low income travellers. This naturally requires low fares and results in very high subsidies. In addition, low fares would insure, since the improved rail services do offer significant time savings over the bus mode, that the bus mode's demand would be significantly decreased.

Another possible purpose might be to reduce energy consumption and congestion in the transportation system during the medium term. This requires, clearly, that the patronage for the rail service would come from either or both the automobile market and the air market, since the rail service is more energy intensive than the bus service. However, it is not easy to distinguish bus passengers from automobile passengers, and the likely result would be that, due to capture from bus, there would be no reduction in total energy consumption. Indeed, there might even be increases in energy consumption if most of the demand did come from the bus mode. The rail service could, on the other hand, be designed to attract from the air market. In this case energy savings would be achieved although they would be quite small until near the end of the medium term. However, the important point is that this purpose would then be at odds with the purpose just mentioned, namely, to attract low income travellers. It would be extremely difficult to attract both the air market and the bus market, although coach and club fares would to some extent make possible the combining of these two purposes.

Another possible purpose for improving rail service could be to serve as an initial commitment to a long-term ground transportation system. This would require a long-term commitment and the acceptance of large losses during the medium term. In addition, appropriate right-of-way would have to be reserved as soon as possible and substantial capital investments made now although the pay-off would not come until many years in the future. Viewed in this light, an improved rail service would lead to long-term energy savings if significant shifts from the air and automobile market occurred. However, the success of an improved rail service is very dependent on the policies that relate to automobile and air travel. Continued encouragement of these other two modes through continued high highway expenditures and indirect subsidy payments to the air mode would greatly increase the difficulty of rail service becoming viable even in the long term. With or without the kinds of policies that will encourage rail passenger use, improved rail service is definitely a long-term proposition in the Corridor Region.

A final purpose would be to provide an efficient mode of transportation; that is, a cheap mode of transportation from society's point of view. This would depend on getting good load factors on the rail service and, since the rail service would be compared to the air services in terms of cost, getting a better accounting of the true cost of air passenger travel. Rail travel is cheaper than air travel, in the sense that it uses less resources than does travel by air. An improved rail service would offer an intermediate level of service to the express traveller in terms of travel time, cost, and frequency, service between that offered by a highway and that offered through the air.

This section clearly points out that improved rail services can serve many purposes. Since many of these purposes directly counteract each other one of the prerequisites for improving the rail service is a clearer understanding of the purposes and the ensuing trade-offs of the improved service, along with appropriate multi-modal policies to support and encourage the service.

CONCLUSIONS

The general conclusions reached on the possibilities of future passenger rail service are outlined in Table VIII. Improved service will continue to require subsidization and certainly will involve substantial capital outlay if reductions in travel time are desired. A new level of service would be offered. On the other hand, termination of passenger rail service in Corridor Region would not significantly reduce the level of transportation service. It should be pointed out also, that termination of passenger service for now would not rule out the possibility of introducing higher speed passenger service in the future when equipment and infrastructure uncertainties are better known.

Because of the probable shift from bus to rail, introduction of improved rail service during the medium term will not reduce energy consumption for travel in total. However, in the longer term, if a permanent switch to ground transportation is desired, energy will be saved by shifting traffic to rail from the automobile and air modes. Because of this and the fact that large capital expenditures are required for infrastructure improvements, passenger rail service should be regarded as a long-term proposition, rather than as being an alternative with large pay-offs in the medium term.

One of the main problems for introducing higher speed service between Edmonton and Calgary is the fact that it would quite likely adversely affect the existing bus service. Should improvements in the rail service be undertaken, this possible impact should be carefully studied.

Finally, while the analysis suggested that low load factors should be expected on any improved passenger rail service, the underlying assumption is that current fare levels and subsidies will persist. The government could, if desired, ensure higher load factors by implementing any of several policies. For example, a larger shift from air to rail could be achieved if restrictions on the number of landings at the Edmonton Industrial Airport were introduced or if user fares on air services were drastically increased through elimination of

IMPROVED PASSENGER RAIL SERVICE CONCLUSIONS

1. The purposes of improved rail service are not well defined. In particular, it is not clear at which travel market group or groups an improved rail service should be aimed.
2. Passenger rail service will continue to require subsidization and will involve substantial capital outlay.
3. Termination of the passenger rail service will not significantly reduce the level of transportation service available in the Corridor.
4. Immediate termination of the passenger rail services does not preclude its resumption at some future time.
5. Introduction of improved rail service during the medium term will not reduce energy consumption in total. In fact, with load factors of less than 60% and large shifts from the bus mode, energy consumption will increase. Thus, arguments for improved rail service should not be based solely on energy considerations.
6. In the longer term, if a permanent switch to ground transportation is desired, energy will be saved by shifting traffic to rail from the automobile and air modes.
7. For these and other reasons, passenger rail service should be regarded as a long-term (post-1983) proposition.
8. If low-income travellers are to be attracted to rail, the bus mode will lose a portion of its current market.
9. Achievement of a 60% load factor on the rail service is highly unlikely under present conditions, especially if patronage of the bus service is not to be reduced significantly. Rather, 30%-40% load factors might be expected. Even a 30% load factor represents a major shift in travel patterns; for R-3 and R-4, it amounts to a twelve-fold increase over rail demand in 1974.
10. Improved rail service would offer the express traveller a new intermediate level of service in terms of travel time, cost and frequency.

TABLE VIII

the indirect air subsidy. Similarly, large shifts in gasoline prices coupled with the establishment of competitive rail fares, could encourage a significant shift from automobile to rail. Lower speed limits on the highways, in particular, would increase the appeal of improved rail services. In view of these potential effects, it is critical that all governments involved reconsider their respective transportation policies in a multi-modal context, to ensure that these policies are complementary rather than counter-productive. Improved rail passenger service should only be part of an overall transportation plan.

FOOTNOTES

1 1976-1977.
2 1978-1983.
3 The average load factor for all CN and CP services in 1974 was 38% and 46% respectively.

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REFERENCES

Alberta Transportation Department (1976), *Edmonton-Calgary Corridor Transportation Study Final Report*, Edmonton, Alberta.

Canadian Transport Commission (1975), *Intercity Passenger Transport in Canada, a Review of the Existing Intercity Passenger Transport Systems*, Research Branch Report No. 252, Ottawa.

Canadian Transport Commission (1976), *Notice of Public Hearings Concerning Transcontinental Passenger Train Services* (*Montreal-Toronto-Vancouver*), File No. 49893-2, Ottawa.