Rail Technologies and Design Guidelines Update Report

Final Draft

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Planning and Engineering Services for Phase II
of the Metro Regional Transit Project

Prepared by
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Regional
Transit
Project

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RAIL TECHNOLOGY AND DESIGN GUIDELINES REPORT UPDATE

TECHNICAL MEMORANDUM

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1.0 Introduction

The Municipality of Metropolitan Seattle (Metro) is considering, as part of the region's long-range Regional Transit Project (RTP), the use of a high capacity rail transit system. In addition to a high capacity rail transit system, no-build, Transportation System Management (TSM) and Bus Transitway alternatives are also being evaluated. This on-going study, in conjunction with earlier studies, will determine the preferred high capacity transit technology for use in the region. A high capacity rail transit system, if selected for deployment, would be planned to accommodate the projected ridership in the year 2020, with initial operation on a core segment(s) by the year 2000.

The original Rail Technology and Design Guidelines Report was prepared by the Gannett-DeLeuw team as part of the Metro Rail Planning Study and was issued in August 1990. As part of the Regional Transit Project the Rail Technology and Design Guidelines Report has been reviewed and updated, as appropriate, as a result of the recent work on the RTP. This technical memorandum represents the summary of that review and update.

1.1 Purpose

The overall purpose of the Rail Technology and Design Guidelines Report is to identify the appropriate rail technologies for use in the Seattle region, and once the technologies have been identified to provide design guidelines for use during the planning and initial design and estimating work. This Update of the Rail Technology and Design Guidelines Report reassesses, revises and refines the technology selection as a result of the work that has been performed since the original report was prepared.

1.2 Background

The Rail Technology and Design Guidelines Report was prepared by Gannett-DeLeuw in August 1990. This report reviewed earlier work, such as the North Corridor Alternatives Analysis, the Multi-Corridor Project, the North-Corridor Extension Project, and the Tacoma-Seattle Connections Transit Project. These projects generally recommended or focused on Light Rail Transit (LRT) technology.

The Gannett-DeLeuw study examined several different transit technologies for use in the Seattle region. The technologies that were considered were:

- PRT-LS - Personal Rapid Transit, Low Speed
- PRT-HS - Personal Rapid Transit, High Speed
- INT-LS - Intermediate Transit, Low Speed
- INT-HS - Intermediate Transit, High Speed
- Large -HS - Large or Heavy Rail Transit, High Speed

After an initial screening, only those systems corresponding to the INT-HS classification were carried forward for further evaluation. The INT-HS category included the largest peoplemover systems, monorail systems, automated guideway systems and LRT. Table A lists some of these representative systems and where examples of these technologies are in use.

TABLE A

SUMMARY OF EVALUATED RAIL TECHNOLOGIES

Technology	Examples of Application
Peoplemover	Detroit, Miami, Tampa
Monorail	Orlando (Disneyworld), Kitakyushu (Japan), Seattle
Automated Guideway	Vancouver, Lille (France), London (England), Berlin (Germany)
LRT	Portland, San Diego, Pittsburgh

These technologies were then evaluated for line haul capacity, trip speed, physical constraints and incompatibilities with existing and envisioned facilities. The result of this evaluation was the recommendation to use Light Rail Transit technologies.

1.3 Methodology

1.3.1 Technology Selection Update

The methodology used to update the earlier report has been to review the basis for the determinations that were made in the context of the evolved RTP rail alternative definition. Where the presence of updated or more fully developed information results in a change in the earlier technology selection, those changes are detailed. Where no change from the earlier work would result, this update does not address that area or determination. The result of the technology selection, as revised by this update, is then fully stated as part of the Summary, Conclusions and Recommendations.

1.3.2 Design Guidelines Update

The design guidelines that were developed as a part of the earlier work are not being updated by this report. A technical memorandum entitled, Rail Technology Perspective, provided revised design guidelines and was issued as final draft on September 27, 1991. The memorandum placed the projected needs of the region for rail transit in context by relating conceptual demand and physical characteristics of the region to other cities currently operating bus/rail systems. The memorandum also provided a set of functional design criteria for the rail component of the RTP system. Revised and expanded design guidelines and design criteria will be assembled for use for the RTP. These RTP Design Guidelines and Design Criteria will be refined incrementally as the project proceeds through the alternatives analysis and preliminary engineering phases. The design guidelines for Civil Design, and Stations contained in the original work have been reviewed and no major revisions are expected to these, except for possible future recommendations to use high level station platforms and to eliminate at-grade crossings of streets. The use of high level platforms will be addressed subsequent to the finalization of the patronage estimates and tunnel operations assessment. The Operating Assumptions are being re-assessed as part of the Operating and Maintenance Cost Estimate task.

2.0 Technology Definitions and Descriptions

The originally selected definitions encompass all of the applicable rail technologies that need to be considered. No adjustments to these definitions are needed, other than to observe that the capacity ranges are to a degree arbitrary and that a specific application of one of these technology can overlap into the range defined for another of the technologies.

3.0 RTP Requirements

3.1 Capacity

3.1.1 System Capacity

The original report considered a peak hour, peak direction capacity requirement of 8,000 to 12,000 riders per hour per direction in the year 2000. The recently issued Rail Perspective Technical Memorandum examined the systems capacity requirements based on a conceptual projected year 2020 peak ridership of 12,000 riders per hour per direction, with a recommended design value that is 50% greater to allow for growth beyond 2020 and/or under estimation of the demand. Thus the RTP design capacity for the year 2020 was projected to be 18,000 riders per hour per direction.

It should be noted that patronage forecasts are in progress and that the above capacity may be revised once the patronage studies are completed. The increase in peak demand from 12,000 to 18,000 riders per hour per direction would push the technology selection toward the higher capacity options.

3.1.2 Vehicle Loading Density

A passenger loading density of 2.69 sq. ft. per passenger was used to estimate the capacity of the different technologies in the Gannett-DeLeuw report. This value was stated as being the industry standard for design loading. The US DOT/UMTA report Urban Rail in America, November 1980, states that a value of around 3.75 sq. ft. (of gross floor area) per person is used by several agencies to calculate the "normal design load". The Rail Technology Perspective Technical Memorandum recommends the use of 3.75 sq. ft. per person for determining the normal design load.

How the 2.69 sq. ft. per passenger value was applied to the different technologies in order to standardize their capacities is not clear. For LRT the design capacity according to the Rail Technology and Design Guidelines report, is listed variously as 107 passengers and 166 passengers. Using a value of 3.75 with a 90 ft. long by 8-3/4 ft. wide car (and making allowances for non usable spaces) a capacity of 160 passengers results. Using 2.69 for the same calculation results in a capacity of 220 passengers.

Somewhat similar variations in car and train capacities also occur for the AGT and Heavy rail technologies. Loading densities for AGT, LRT and Heavy Rail Transit are in similar ranges and the vehicle sizes/lengths are flexible enough that the total passenger capacity for a fixed length train should be essentially equal. Figure #7 in the Gannett-DeLeuw report lists significantly different capacities for these three technologies. The Heavy rail transit was specifically dropped from further evaluation because of this listed higher capacity. The train capacity for all three of these technologies, when they are equalized, will be in the range of 600 to 700 passengers for the 360 ft. train length that is consistent with the DSTP stations. Table B compares the capacities of these technologies after adjusting for their application to the RTP.

The Large or heavy rail transit should not be eliminated on the basis that it has too large a capacity for use in the Seattle region. Its inherent capacity is very little different than that for LRT vehicles, when they are compared under equal design and operating assumptions. The following table provides comparative capacity for AGT, LRT and Heavy Rail Transit systems, normalized to a common application for the RTP.

TABLE B

SUMMARY OF RAIL TECHNOLOGIES CAPACITY

TECHNOLOGY	PASSENGERS PER VEHICLE[1]	CARS PER TRAIN[2]	PASSENGERS PER TRAIN	HOURLY CAPACITY[3]
AGT	111	6	666	26,640
LRT	160	4	640	25,600
HEAVY RAIL	113	6	678	27,120

Notes:

1 - Based on 3.75 sq. ft./person.
2 - Train length of 360 ft.
3 - Passengers per hour per direction at 1-1/2 minute headway (40 trains/hr.).

3.2 Travel Time, Speed and Train Performance

The travel time from the end of a line into the CBD, or vise versa, are a primary measure of the utility of the transit system to the user. This time needs to be competitive with the time required by other modes of travel. Gannett-DeLeuw estimated the time required to travel from Alderwood Mall into the DSTP, assuming varying numbers of stations along the line and various top speed capabilities for the vehicle. From the results of these calculations the recommendation was to provide an average speed of 35 mph, with a top speed of 60 to 70 mph. These recommendations result in a calculated travel time from Alderwood Mall to the DSTP, assuming 10 intermediate stations, of 22 to 24 minutes.

The average speeds assumed are somewhat optimistic because the slowing effects of grades, curves and signaling systems were not considered. However, the effect of these will be nearly the same for all of the technologies and does not appear to bias the selection of the technology.

3.3 Use of DSTP for Rail System

The original report concluded that operation in the DSTP would preclude several technologies, primarily because of the need to maintain compatibility with continuing bus operations. However, review of the analysis and conclusions reached has suggested that more flexibility exists in accommodating rail technologies into the DSTP with joint bus/rail operations than originally indicated.

The use of electric linear induction motors for AGT's was eliminated because the necessary motor reaction surface was considered to be incompatible with buses. This reaction surface, however can be set between the running rails and flush with the top of the running rails, with adequate support to allow a bus to travel on top of it. In the tunnel sections, this placement would be in an area that buses would straddle rather than run on. In the stations, this area would only be run on when a bus was changing lanes to pass a delayed bus.

AGT's and Heavy Rail Transit were also eliminated because they were considered to work only with 3rd rail type power collection. These technologies can be powered from an overhead wire or set of wires, similar to LRV's and trolley buses.

The possible future conversion of the DSTP platforms from the current low level to high level revolves around the need to have the faster loading times associated with high platforms (including loading of wheelchairs) and the practicality of joint bus/rail operation at high levels of demand, rather than the specific choice of a rail technology. The possible need for added platform capacity will be determined after the completion of patronage forecast and the tunnel capacity analysis. If added capacity is required based on the analysis, the phased conversion of existing facilities or additional capacity through center platforms will be addressed as part of the systems plan. The center platform would be used by the rail system. Buses would continue to use the present low level platforms. A center platform would eliminate the possibility of buses passing in the station areas, however the utility of such passing, once rail is introduced into the tunnel, is unclear.

Some AGT technologies use a raised curb or curbs or a subsurface guidebeam to guide the AGT. Joint bus/rail operation with this type of AGT technology does not appear practical.

Another problem with AGT technologies was not discussed is the compatibility of joint use of the DSTP with buses and automated vehicles. None of the current control technologies are capable of detecting and controlling bus movements with the degree of safety necessary to allow joint use. An AGT option would therefore require manual operation through the DSTP to permit joint bus/AGT use.

3.4 Use of I-90 Floating Bridge

The conclusions reached by the Gannett-DeLeuw study are consistent with the recent review of the I-90 Floating Bridge's capability. All steel rail technologies are practical; monorail does not appear to be practical, AGT's that use a below grade guidebeam are not practical.

3.5 Environment - Community Fit

Although the RTP alignments will pass through or near a number of environmentally sensitive areas, none of the evaluated technologies is inherently better or worse at solving the total range of problems that will be encountered.

3.6 At-Grade Crossings

While it has been determined to utilize exclusive right-of-way for the rail system, the determination to have or exclude at-grade street crossings has not been conclusively made. Therefore, the technology selection should not preclude the use of at-grade crossings.

As stated in the Gannett-DeLeuw report, any technology that requires a special guideway construction, that can not be paved level for cross traffic is not compatible with at-grade crossings. This restriction rules out monorail systems and certain AGT technologies that require raised or major subsurface guidance structures. The configuration of the power pick-up, i.e. third rail, also has certain limitations for at-grade crossings.

At-grade crossings are also not consistent with fully automated operation. Although a high level of automated operation is practical, as long as there is a train attendant that can control (stop) the train should there be an obstruction at the grade crossing.

4.0 Appropriate Technology Classes

4.1 Rail Technology Selection

Summarized below are the updated conclusions and recommendations regarding each of the high capacity technologies that were considered as candidates for this update of the rail technology assessment.

- **Light Rail**

  Concur with the previous recommendation that Light Rail is the easiest rail technology to implement for the RTP over the range of probable variations and conditions that will need to be accommodated.

- **Automated Guideway (AGT)/Peoplemover**

  This technology has significant constraints that must be addressed inorder to utilize it for the RTP. Fully automated operation is not compatible with joint use of the DSTP and at-grade crossings. Some of the AGT technologies require guidance structures that are not compatible with the DSTP, I-90 floating bridge and at-grade crossings. However, the Vancouver Skytrain system could be used for the RTP, if a high level platform were provided in the DSTP, joint bus/AGT use of the DSTP was eliminated as a requirement and at-grade crossings were eliminated. Given these constraints, this technology should not be considered unless the above constraints are eliminated as a result of the on-going studies.

- **Monorail**

  Concur that monorail technology is not appropriate for the RTP. Monorail's require the use of large beams that are not compatible with operation in the DSTP and at-grade crossings and switching of monorails is at best clumbersome.

- **Heavy Rail Transit**

  Heavy Rail Transit is typified by systems such as San Francisco's BART, Atlanta's MARTA and Washington, DC's WMATA. This technology was originally eliminated from full consideration as it was asserted to have too large a capacity for use on the RTP. However, when evaluated as it would be applied to the RTP, its capacity is only slightly different than that of LRT. The major constraints that must be addressed in applying Heavy Rail Transit to the RTP are the use of high level platforms and third rail power pick-up.

Heavy rail can be powered from an overhead system. This technology is recommended for continued consideration for the RTP.

4.2 Summary and Recommendations

The updated recommendation of technologies to be considered for the RTP includes both the LRT and the Heavy Rail Transit technologies.

The application of these two rail technologies differs in only one significant area. The Heavy Rail Transit requires the use of high level platforms, whereas LRT technology can use either high level or low level platforms (or even both through the use of hi-low steps).

Aside from the platform level, the application of these two technologies differs only in details that are of less significance than the variations possible within one of these technologies. Indeed many of the elements of the two technologies are the same. Although Heavy Rail Transit is not usually associated with overhead wire power collection and at-grade crossings, both of these exist on Heavy Rail Transit systems (specifically CTA's Skoie Swift line has at-grade crossings and both over head and 3rd rail power collection; MBTA's Blue line has both overhead and 3rd rail power collection).