Southwest Corridor
Rail Transit Study

4. RAIL TRANSIT TECHNOLOGIES

Introduction

This chapter presents a comparison of the two rail transit technologies being considered for the Southwest rail transit line: light rail transit (LRT) and diesel multiple unit (DMU). Light rail transit (LRT) is included in this analysis because previous studies determined that LRT is a feasible alternative for service between Hopkins and downtown Minneapolis. LRT was also included because it is the chosen technology for the Hiawatha and proposed Central Corridors. The Colorado Rail Car Company's Aero Diesel Multiple Unit (DMU) technology is also included to determine if it is a lower-cost alternative to LRT because it can operate on existing freight rail tracks at the same time as freight trains. In June 2003, the Colorado Rail Car Company received Federal Railroad Administration (FRA) approval to operate the Aero DMU vehicle on freight rail tracks at the same time as freight trains.

Other transit technologies, particularly Bus Rapid Transit (BRT) have been studied for a Southwest Transitway. BRT is not included in this analysis because in 2001 the Minnesota State Legislature enacted legislation that banned the Metropolitan Council from studying, planning, designing, constructing, or operating an exclusive busway in the cities of Minnetonka, Eden Prairie, Chanhassen, and Chaska as well as the Kenilworth and Midtown Corridors in Minneapolis.

Rail Transit Technologies

Light Rail Transit (LRT)

Light rail vehicles (LRV) are electrically powered receiving a current from an overhead wire. They can operate in exclusive rights-of-way or in existing roadways and up to four LRVs can be coupled into trains. Several North American cities currently operate LRT lines including Baltimore, Boston, Calgary, Cleveland, Dallas Denver, Los Angeles, Ottawa, Portland, Sacramento, St. Louis, Salt Lake City and San Diego. The Twin Cities is in the process of constructing it's first LRT line, the Hiawatha Line, which will operate from downtown Minneapolis to the Mall of America and is scheduled to begin operation early in 2004.

Diesel Multiple Units (DMU)

Diesel Multiple Units are self-propelled diesel-powered rail cars designed for regional passenger service. DMUs can operate on active freight railroad tracks at the same time as freight trains. A variety of DMUs currently operate in Canada and Europe; however, these vehicles do not meet FRA standards for U.S. operation. DMU is not a new technology, the Dallas Area Rapid Transit (DART) operates refurbished 1950s era DMUS on its commuter rail line to Fort Worth. The Colorado Rail Car Company's Aero DMU is the first recently constructed DMU that is approved by the FRA for use in the United States.

Source: Scott Walker

Technology Characteristics

For purposes of this analysis, the Bombardier light rail vehicle, the vehicle that will be used for the Hiawatha LRT line, and the Colorado Rail Car Company's Aero diesel multiple unit vehicle will be used. The primary similarities between light rail transit (LRT) and diesel multiple unit (DMU) systems include the passenger carrying capacity of the vehicles, the tracks, and the maintenance facility requirement. The primary differences between LRT and DMU systems include the vehicles, their power systems, travel time, track ownership, system connectivity, and their usage in the United States.

Rail Transit Technology Similarities

The primary similarities between light rail transit (LRT) and diesel multiple unit (DMU) systems include the passenger carrying capacity of the vehicles, the tracks, and the maintenance facility requirement.

Vehicle Capacity

The Bombardier LRT vehicle and Aero DMU vehicle can be configured to provide similar passenger carrying capacity of approximately 246 passengers per train set (two cars per train set).

Tracks

For purposes of this study, both LRT and DMU service are assumed to require two tracks to support the service frequency (i.e., 7.5 minutes during peak hours) in both directions. For LRT, two new tracks are assumed to be constructed. For DMU, the existing freight rail track is assumed to reconstructed and a second, parallel track constructed.

Maintenance Facility

For purposes of this study, both LRT and DMU service are assumed to require a new maintenance facility. While the maintenance facility constructed for the Hiawatha LRT line does have some excess capacity, that capacity is assumed to be used by the proposed Central LRT line. It is assumed that DMU vehicles would require a separate maintenance facility with unique equipment.

Rail Transit Technology Differences

The primary differences between LRT and DMU systems include the vehicles, their power systems, travel time, track ownership, system connectivity, and their usage in the United States.

Vehicle Size & Weight

The Aero DMU vehicle is substantially larger (3 feet taller, 1.2 feet wider) and 60% heavier than the Bombardier LRT vehicle. The larger size of the Aero DMU means that it cannot share station platforms with the Hiawatha LRT line currently under construction. The greater weight means that the Aero DMU takes longer to accelerate/decelerate than the Bombardier LRT vehicle thus increasing the travel time for the Aero DMU.

Power Systems

The Bombardier LRT vehicle is electrically powered from an overhead catenary system whereas the Aero DMU vehicle is powered by two on-board diesel engines. Because the Bombardier LRT vehicle is electrically powered it is likely to be quieter and emit less pollutants than the Aero DMU vehicle

Travel Time
The travel time for the Aero DMU vehicle is longer than for the Bombardier LRT vehicle for two primary reasons. First, the Aero DMU has slower acceleration/deceleration rates than the Bombardier LRV, and second, the Aero DMU has fewer boarding doors which means it takes longer to board passengers than does the Bombardier LRV.

Track Ownership
Typically, LRT systems operate on publicly owned right-of-way while DMU or Commuter Rail systems operate on private railroad rights-of-way under lease agreements negotiated with the private railroad companies. In the case of a Southwest DMU line, this lease agreement would be negotiated with three private freight rail companies - the Canadian Pacific, the Burlington Northern & Santa Fe, and the Twin Cities & Western Rail Companies. It is believed that the annual lease payment for a Southwest DMU line would be considerably higher than for those of typical Commuter Rail service because the Southwest DMU operation would utilize the freight rail tracks for approximately 20 hours per day (4:30 AM to 12:30 AM) at frequencies of 7.5 minutes during the peak periods, 10-15 minutes during the mid-day and early evening, and 30 minutes in the late-evening. Most commuter rail systems operate peak only service on weekdays at frequencies of 20 to 60 minutes. Due to the frequency of DMU service it is unlikely that the private freight rail companies would operate freight service at the same time, thus limiting freight rail service to 12:30 AM to 4:30 AM.

System Connectivity
LRT vehicles can be through-routed with the Hiawatha and proposed Central LRT lines. This means that Southwest LRT passengers could have a one-seat ride (i.e., no transfer) to the core of downtown Minneapolis, the University of Minnesota (UMN), the Minneapolis-St. Paul Airport (MSP), the Mall of America (MOA), and downtown St. Paul. Because the Aero DMU vehicle is wider it cannot use the Hiawatha LRT stations and as such cannot be through-routed with the Hiawatha and proposed Central LRT lines. DMU passengers destined for downtown Minneapolis, the UMN, the MSP, the MOA, or downtown St. Paul would be required to transfer at the proposed downtown Multi-Modal Station (North 5th Street and North 3rd Avenue) to either a bus or the Hiawatha/Central LRT lines.

Existing Systems
LRT is in use in many cities throughout North America, Europe, Asia, and South America. Since the Aero DMU only recently received FRA approval for operation in the U.S., it is not currently in operation. However, older forms of DMUs are in existence in Europe, Canada, and in Dallas, Texas. The European and Canadian DMUs could not operate in the U.S. due to different safety standards. In the case of the Dallas Trinity Railway Express system, the DMU vehicles are refurbished vehicles from the 1940s, which are compliant with FRA safety standards. Currently, the Dallas Trinity Railway system owns the freight rail tracks and allows the Union Pacific and Burlington Northern Santa Fe railroads access.

Table 4.1
Summary of Technology Characteristics – Light Rail Transit and Diesel Multiple Unit[1, 2]

	LRT	DMU
Track Alignment		
Track gauge	4'-8½"	4'-8½"
Horizontal Alignment		
Minimum radius	100 feet	250 feet
Vertical Alignment		
Grades		
Maximum sustained grade, unlimited length	4.0%	4.2%
Maximum sustained grade with up to 2,500 ft between PVI's of vertical curves	6.0%	TBD[3, 4]
Maximum short sustained grade with no more than 500 ft between PVI's of vertical curves	7.0%	TBD[3, 4]
Curves		
Minimum radius – Crest curve	820 ft	2,000 ft
Minimum radius – Sag curve	1,150 ft	2,000 ft
Vehicle		
Length over body ends	92 ft	83'-6½"
Width, maximum	8.8 ft	10 ft
Height above top of rail	11.4 ft, excluding pantograph[5]	14.4 ft
Weight, empty	105,000 lbs	164,000 lbs
Step height above top of rail	14 in	18 in
Floor height above top of rail Number of stairs	14 in 3	18 in 4
ADA access	Level boarding	Lifts, add low-floor trailer car or high platform with bridge plates
Number of seats	66	90 to 98
Maximum passengers with standees (AW3 load)	246	228 to 246
Operations		
Acceleration		
Maximum operating speed	55 mph	90 mph
Time to accelerate to 55 mph	40 sec, variable rate	48 sec, variable rate
Deceleration		
Service braking	2.0 to 3.0 mphps[6]	1.5 mphps[6]
Emergency braking	5.0 mphps[6, 7]	1.8 mphps[6]
Noise (Sound Exposure Level, in dBa)[8]	82 dBa	85 dBa
Propulsion power	Via 750V DC overhead contact electrical system	2 on-board diesel engines
Potential for Joint Track Use[9]		
Rail Mode	*LRT*	*DMU*
Freight Rail	No	Yes
Passenger/Commuter Rail	No	Yes
High-Speed Rail	No	No
LRT	Yes	No
Other Considerations		
Vehicle cost[10]	$2.5 million	$2.9 million[11]
Annual vehicle maintenance cost per vehicle[7]	$655,000[12]	To be determined
Annual lease payment for joint track use	Not required because tracks are in publicly owned.	An annual lease payment is required and would be negotiated with the private freight rail company. Preliminary estimates are $1 to 7.5 million/year.

Notes

1 Vehicle characteristics based on Bombardier LRV to be used in Hiawatha LRT and Colorado Rail Car's prototype of their Aero DMU.
2 Source: *Hiawatha LRT Light Rail Transit Project, Phase 2 RFP, Part 5 – Design Criteria/Performance Specifications*, 7 April 2000.
3 Source: *Colorado Rail Car, New DMU, 2002 Edition*. Data provided are for single-level powered car.
4 At this time, only theoretical values are available from Colorado Rail Car
5 Height of pantograph ranges from 1.6 feet (low) to 10.5 feet (working range).
6 Miles per hour per second.
7 Without track brake.
8 Typical bus noise is 84 to 88 dBa. Typical automobile noise is 73 dBa.
9 Source: *Joint Operation of Light Rail Transit or Diesel Multiple Unit Vehicles with Railroads*, TCRP Report #52, 1999..
10 In Year 2002 dollars.
11 Does not include cab modifications, wheelchair lifts, additional doors, signal and communication system, on-board diagnostics or provisions for other vendors to furnish and install the above.
12 Source: Metro Transit 2003 Light Rail Operations and Maintenance Cost Model (Hiawatha LRT). Includes labor and non-labor costs.