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Hiawatha Light Rail Transit System

Transportation & Maintenance Operations Plan

June 2004

HIAWATHA CORRIDOR LIGHT RAIL TRANSIT PROJECT TRANSPORTATION AND MAINTENANCE OPERATIONS PLAN (TMOP)

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GLOSSARY

"A" CAR - The end of the LRV without the pantograph. Both A and B cars have a full width operator cab. In both cases, cabs are separated from the passenger areas by partition walls and an access (lockable) door.

ACCIDENT - An unforeseen event or occurrence which results in injury or property damage.

"B" CAR - The end of the LRV with the pantograph.

BALLAST - The crushed rock base for rail ties and track.

BELL SIGNAL – A signal indication given with a bell.

BERTH, TRAIN - The space designated for a train of given length to occupy when it is stopped at a station plafform, in a terminal, or at some other designated place.

BLOCK - A section of track of defined limits the use of which is governed by fixed signals, signals or the Controller's orders.

ABSOLUTE - A block that may be occupied by only one train at a time.

CLEAR – A block which contains no trains.

OCCUPIED – A block which contains one or more trains.

BLUE FLAG - A portable blue flag/light marker placed at both ends of a rail vehicle as an indication that personnel are working on, under or about the vehicle(s). Any rail vehicle(s) so protected must not be coupled to or moved. Other rail vehicles must not be placed where they will obstruct the "blue" signal in any way without first warning the work person.

BRAKE - Electric and /or mechanical device to slow trains or cars and bring them to a stop, including:

DYNAMIC - A primary braking system in which current derived from the train motors acting as generators provides braking action.

FRICTION - A power operated system which applies stopping forces to brake discs on the truck axles. The brakes are applied by spring action and released by air pressure.

TRACK - An electromagnetic brake located between the wheels of each truck, which operates through direct contact with the running rail.

BULLETIN BOARDS - The specific location where employees reporting for duty will examine any new bulletins or notices posted affecting the operation of the system.

BUMPING POST - Structure at the end of tracks to prevent car(s) from rolling off the track.

"C" CAR – The C car serves to articulate the vehicle (A-C-B) at the vehicle center and is attached into A & B cars at both ends.

CAB - The operating compartment of a rail vehicle from which control of the vehicle is achieved.

CAR - A single, articulated light rail vehicle (LRV).

CHOCK, WHEEL - A device placed under a rail vehicle between the top of the rail and the rail vehicle wheel to prevent vehicle movement when brakes are not applied or are defective.

CLEARANCE CARD – A written receipt of verbal permission from the RCC, which permits, when completed, the Train Operator to pass an interlocking signal displaying a STOP indication or enter a Work Permit area occupied by another train or OTE (On Track Equipment).

COAST - A position on the master controller in which neither power nor braking is commanded.

CONSIST - The number and specific identity of the cars within the make up of a train.

COUPLE - To connect rail vehicles together in order to permit the resulting consist to be operated from one cab.

COUPLER - A device for joining mechanical, electrical and pneumatic systems of rail vehicles together thus allowing train line control functions to reach each car in the consist.

CROSSOVER - Two track switches connected so as to form a continuous passage between two parallel tracks.

CURRENT OF TRAFFIC - The movement of trains on a main track, in a designated direction.

DEADMAN CONTROL - A device used on rail vehicles that must be held in the operating position to permit vehicle movement.

DE-ENERGIZE - To remove electrical power.

DERAIL DEVICE - Equipment designed to cause moving rail equipment to leave the rails.

DERAILMENT - The condition when the vehicle wheel tread leaves the ball of the rail.

DIVERGING ROUTE - A change in a train's directional movement over a reverse track switch to allow for crossover movement, train storage, reversing direction or other purposes.

DOUBLE TRACK – Two main tracks upon which the current of one tack is in a specified direction and the other track is operated in the opposite direction.

DWELL TIME - The total elapsed time from the instant that a train stops in a station until the instant it resumes moving.

EMERGENCY - A condition that can result in death or injury to persons. Employees or damage to equipment and property.

ENERGIZE - To turn on electrical power.

ENERGIZED EQUIPMENT - Electrical apparatus, wires, cables, switches and motors that are connected to an electrical power source and are considered energized.

FIELD TRANSIT SUPERVISOR – A Rail transportation department supervisor in the field having authority over Train Operators, other transit employees and contractors working in an assigned area.

FLAG - A device used for relaying signals indicating conditions in the right-of-way. A flag may be made of cloth, metal or other suitable material, or may be a light during hours or conditions of darkness.

FLAG PERSON - Person designated to provide protection at work locations.

FLAGGING PROTECTION - Flags and lights/lanterns used by work crews for protection while working on or about the track.

FOULING POINT - The closest point to which a car may approach a switch from the trailing direction without being in danger of collision with a train passing through the switch on another track. In ABS territory, the closest point to which a car may approach the insulated rail joint or vehicle detector governing occupation of the block in which the switch is situated.

FOULING POINT MARKER - The location on a track, marked in yellow, beyond which vehicle movement or storage of a rail vehicle will interfere with vehicle movement on another track.

FROG - A track structure used at the intersection of two running rails to provide support for wheels and passageways for their flanges, thus permitting wheels on either rail to cross the other.

GRADE CROSSING - A crossing over the track at track level by a road or footpath.

HAZARD - Any real or potential condition that can cause injury, death, damage or loss of equipment or property.

HEADWAY - The timetable separation between two trains traveling in the same direction on the same track.

HI-RAIL EQUIPMENT - Tire mounted vehicles, normally used for construction; with flanged steel wheels that can be moved on and off the tracks.

INCIDENT - An unforeseen event or occurrence which does not result in injury or property damage.

INTERLOCKING - An arrangement of signals and signal appliances so interconnected that their functions must succeed each other in proper sequence and for which interlocking rules are in effect. It may be operated manually or automatically.

INTERLOCKING CONTROLS - Systems or devices capable of controlling the functions of intedookings remotely.

INTERLOCKING LIMITS - The tracks between the extreme outer, opposing, interlocking signals of an interlocking.

LOCAL CONTROL PANEL - Wayside train control equipment having interlocking control capability, located in signal and communication rooms.

LRV - Light Rail Vehicle.

MAINLINE - The territory controlled by the Controller, consisting of main tracks, interlocking, pocket tracks, controlled sidings, tail tracks, and spur tracks.

MAIN TRACK - The designated track on the Mainline upon which trains are operated by signals or when authorized by the Controller, in a manner prescribed by the rules.

MANUAL BLOCK SYSTEM – A procedure that may be used by the RCC to authorize trains to proceed on sight from one specific point to another through train orders to the Train Operator. This procedure may be used when the Automatic Block Signal system cannot be used and for special purposes including moving work equipment on rail system right-of-way. Manual blocking is not used for unsignaled single-track movements.

MANUAL CROSSOVERS – Crossovers consisting of hand-operated non-remotely controlled switches.

MILEPOST - A sign along the track right-of-way indicating the distance in miles from the yard or terminal.

SPEEDS

NORMAL – The maximum speed at which a train may be operated and is the lowest of the speed allowed by a wayside signal, the speed posted on a wayside sign, a hand signal given by an authorized person, a written or verbal speed instruction given by an authorized person, the speed allowed by sight distance, or the speed allowed by track or street conditions.

CONTROLLED – A speed that will permit stopping within one-half range of vision. It will permit stopping short of a train, a car, an obstruction, OTE, or a stop sign.

RESTRICTED SPEED – A speed that will permit stopping within one-half range of vision. It will also permit stopping short of a train, a car, an obstruction, a stop signal, a derail or an improperly lined switch. The Train Operator must keep a lookout for broken rail. It will not exceed 15 mph.

SLOW ZONE - An area within defined limits where train or rail equipment speed is reduced for track work or other purpose.

LIMIT - The maximum allowable speed at which a rail vehicle may operate.

PANTOGRAPH - A device for collecting electricity from an overhead contact wire.

OVERHEAD CONTACT SYSTEM (OCS) - That part of the overhead line equipment comprised of the catenary, catenary supports, overhead wire, foundations, counter -weights and other equipment and assemblies, that distributes electric power from a substation to the car or trains.

CATENARY - A system of overhead wires, in which the contact wire is supported from one or more longitudinal messengers, either directly by hangers in combination with auxiliary conductors and clamps.

CONTACT WIRE - A contact wire that provides power to the rail vehicle through direct contact with the pantograph.

ISOLATOR - A space in the overhead contact wire at a specific location(s) to isolate the flow of traction power within a defined track section.

HANGER - A fitting by means of which the contact wire is suspended from the OCS.

MESSENGER - The longitudinal wire or cable of an OCS from which the contact wire is suspended.

RAIL - Track and special trackwork, consisting of two rails so arranged as to provide.

BASE - The bottom part of the rail which rest on the tie plates.

CLIP - The clip, which holds the base of the rail to the tie plate.

GUARD - A rail installed parallel to and inside of the running rails of a track to hold wheels in coned alignment to prevent their flanges from striking the points of turnout or crossing frogs or the points of switches.

HEAD - The top part of the rail which the train wheels run on.

RESTRAINING - A guard rail installed adjacent to and parallel with the inside running rail of curved track. It bears against the backside of the wheels and steers the inside wheels of each truck around the curve, thereby discouraging the leading outside wheel flange from climbing the outside rail.

RUNNING - The rail which the train runs on.

STOCK - The running rail against which a switch rail operates in a turnout.

RAIL BULLETIN – An Order issued in writing by the Assistant General Manager, Rail Operations or his/her designee notifying rail system personnel of changes of procedures, special checks, fare changes, etc.

RAIL SYSTEMS EMPLOYEE - The term *Rail System Employee* as used in Metro Transit's Light Rail Operating Rules is every person who works in the Metro Transit Light Rail Operations division; every other Metro Transit employee either in connection with their work or as a rail passenger; and each contractor, consultant, or vendor who enters or operates on or about the Metro Transit Light Rail System.

RAIL VEHICLE - A self-propelled vehicle operating on tracks, which could be a passenger vehicle (LRV), hi-rail vehicle or other truck and track equipment.

RCC – RAIL CONTROL CENTER – The designated location from which all Metro Transit Light Rail operations are authorized and directed by Transit Supervisors. The RCC is located on the third floor of Light Rail O & M facility.

RED TAG - A two-part, red identification tag issued by a Controller to designated construction, testing, or maintenance personnel to work in an area where the Overhead Contact System will not be energized, and train operations will not be conducted, while the Red Tags are in their possession.

RED TAG AREA - An area where the Overhead Contact System will not be energized and train operations will not be conducted while a Red Tag is issued for that area.

REVERSE RUNNING - The movement of a train or trains against the normal current of traffic.

RULES for LIGHT RAIL OPERATION BOOK – Transit system rules issued by order of the Assistant General Manager, Rail Operations, which must be obeyed by all rail system employees. The Rules for Light Rail Operation System Rule Book may be supplemented by General Orders, Train Orders and Rail Bulletins.

SCADA (SUPERVISORY CONTROL AND DATA ACQUISITION) – This system is a complex monitoring and control system that incorporates computers, SCADA screens, and communication lines. The computers and SCADA screens are located in the RCC on the third floor of the Light Rail O&M Building. Transit Supervisors are responsible for the monitoring of the system. The SCADA terminal can be used to request information, issue commands and respond to alarms.

SCHEDULE – The part of a timetable designating the movement of regular scheduled trains.

SECTIONALIZING - The ability to de-energize a specific Overhead Contact System section for work or other purposes.

SIGNALS - A method or device conveying information affecting movement of a train or car.

ASPECT - The appearance of a fixed signal conveying an indication as viewed from the direction of an approaching train.

AUDIBLE - A signal in which the indication is given by long and short sounds of the horn or bell.

BAG - A cover placed over a wayside signal that eliminates the ability of the wayside signal from displaying a visual aspect to the Train Operator. When a wayside signal is to be covered or "bagged" the wayside signal is considered out of service.

BLOCK - A fixed signal at the entrance to a block, governing the movement of trains through that intersection.

CONTROLLED – A wayside signal that can be controlled from the RCC or a Local Control Panel.

DWARF – A controlled low wayside signal.

GOVERNING – The wayside signal or hand signal, whichever is more restrictive.

HAND - A signal, the indication of which is given by the motion or position of a person's hand, arm, or by flag, light, or object held by a person.

HORN – A signal indication given by a horn.

FIXED - A permanently located signal indicating a condition affecting the movement of a train.

INDICATION - The information conveyed by the signal aspect.

INDICATOR - Signals which indicate the position of the switch points.

INTERLOCKING - A fixed wayside signal governing movement through interlocking.

LUNAR – White aspect signals located at grade crossings. Lunar signals allow the operator to know if the crossing signals are activated.

SIGNS - A permanently or temporary sign indicating maximum allowable speed.

SINGLE TRACK OPERATION - The bi-directional movement of rail vehicles over a single track while operating within defined limits on the mainline.

SWITCH POINT INDICATOR - Signal which indicates the position of switch points.

STANDARD OPERATING PROCEDURES (SOPs) - The SOPs contain instructions explaining operation, performance, and procedural responsibility for Light Rail Employees.

STATION - A location designated for the purpose of loading and unloading passengers.

STATION, TERMINAL - The station located at each end of the rail system where tumback operations are normally made.

SUB-STATIONS - Facility used to transform High AC voltage to 750 volts, DC for distribution to the Overhead Contact Systems.

SWITCH - A special track work with movable points to divert a train from one track to another.

SPRING - A switch equipped with a spring arranged to restore its points to their original position after having been trailed through by a train.

DUAL CONTROL - A power operated switch that can also be operated by hand.

ELECTRIC LOCKED – A track switch that is electrically locked and unlocked by the RCC then operated by hand in the field.

FACING – A switch placed so when a car approaches the switch the car may diverge to another track.

HAND-OPERATED – A track switch that is operated manually. Speed over these switches cannot exceed 5 mph. These switches are not to be trailed.

NON-TRAILABLE – A track switch which must be lined for both facing and trailing moves.

POINT - A movable tapered running rail, the point of which is designed to fit against the stock rail.

POSITION, NORMAL - The track switch positioning allowing a rail vehicle to proceed on a straight route.

POSITION, REVERSE - The track switch position allowing a rail vehicle to proceed on a diverging or merging route.

FACING MOVEMENT - Switch points that face toward the approaching train.

TRAILING MOVEMENT - Switch points, which face away from the approaching train movement.

TEST TRACK LIMITS - The territory defined by a Test Track Limit Sign, separating the main track from the test track.

TIMETABLE – A publication containing instructions relating to the movement of trains or equipment and other essential information.

TRACK - The two adjacent running rails upon which the train or other rail vehicles operate.

AUXILIARY - Any track other than a main, yard, or shop track.

DOUBLE - Two main tracks upon one of which the current of traffic is in a specified direction and upon the other in the opposite direction.

MAIN – All tracks outside the Yard used for scheduled train operations.

POCKET - A track located between the two primary tracks on which an out-of-service train may lay over or reverse its direction.

SINGLE - A single main track on which trains can be operated in both directions.

TRAIN - One or more rail vehicles combined into an operating unit, with headlights displayed to the front and taillights to the rear.

EXTRA TRAIN - A train not authorized by a timetable schedule.

REGULAR TRAIN - A train authorized by a timetable or schedule.

SWEEP TRAIN - The first train to operate over any section of the Mainline right-of-way each day or after an interruption of service exceeding one hour must be operated at restricted speed. Train Operators must be especially alert and stop short of obstructions on the track, any damage to track, contact rail, wayside signals, improperly aligned switches, or any conditions which could be hazardous to the operation of the train. Should any hazardous condition exist the train must be stopped and the condition reported to the RCC.

TRAIN OPERATOR - The employee having direct control and responsibility for the safe movement of the rail vehicle.

TRAIN ORDER - An Order issued in writing by the Assistant General Manager, Rail Operations or his/her designee to operating employees (daily) notifying them of an activity or condition affecting system operation.

TRANSIT SUPERVISOR – The designated employee on duty in the RCC having authority over train movements and other activities affecting train movements and system operations.

TVM (TICKET VENDING MACHINE) – A machine or a group of machines whose purpose is to receive a monetary transaction and dispense tickets to our customers. These machines will be placed on the station platforms.

WORK ZONE – A section of track marked with work signs and traffic warning cones (also protected by flaggers as needed) through which trains operate at a restricted speed, because of a work crew, maintenance equipment, or some condition on or near the track.

WORK VEHICLE/ON-TRACK EQUIPMENT (OTE) – Any vehicle specifically designed for rail maintenance, including but not limited to hi-rail, tamper, etc.

YARD – A system of tracks within defined limits used for making up and storing of rail vehicles, upon which movements must be made at Yard speed, subject to applicable rules and special instructions.

LIMIT SIGN – A posted sign identifying yard entry and exit locations for rail traffic approaching from or exiting the mainline.

SPEED – The maximum speed permitted in the yard is 10 mph, except over switches, which is 5 mph. The rear trucks of the LRV must clear the switch before resuming the 10 mph speed limit.

TRACK – Any track located within the limits of the yard used for car storage, servicing, repair, or other purposes.

HIAWATHA CORRIDOR LIGHT RAIL TRANSIT PROJECT TRANSPORTATION AND MAINTENANCE OPERATIONS PLAN (TMOP)

1.00.00 HIAWATHA CORRIDOR LIGHT RAIL TRANSIT PROJECT

The Metropolitan Council in cooperation with the Minnesota Department of Transportation (MNDOT), Hennepin County and the Metropolitan Airport Commission (MAC) initiated the design and construction of the development of the Hiawatha Corridor Light Rail Transit line. The Hiawatha Corridor LRT line is a 12.01 mile corridor between downtown Minneapolis and the Mall of America, with intermediate service to the Minneapolis-St. Paul Airport. This LRT line is the first line in a planned LRT and commuter rail network for the Minneapolis-St. Paul region.

1.01.00 PURPOSE OF THE PLAN

The Transportation and Maintenance Operations Plan (TMOP) serves as the principal source document which sets forth the operations and maintenance practices necessary to deliver the projected transit services in a safe, dependable and efficient manner, and to provide a quality service to the riders. The TMOP is intended to:

- Guide systems design to assure conformance to the operating intent
- Define the project's service and operating characteristics
- Define the project's operating and maintenance policies and objectives
- Define the staff responsibilities, levels and organizational relationships required to operate and maintain the project
- Define the system and operating requirements for assuring service dependability and system availability

The TMOP is intended to serve as a detailed definition of operations and maintenance methods, practices and costs. As the Hiawatha Corridor LRT project progresses through final design, this document is continually reviewed and updated as necessary.

1.02.00 RELATIONSHIP TO OVERALL TRANSPORTATION NETWORK

The Hiawatha Corridor LRT project is a direct outgrowth of prior transportation planning activities in the Minneapolis region and is the highest priority corridor for transit improvement. Transportation planning efforts for the Hiawatha Corridor date back nearly two decades. In 1985, Light Rail Transit (LRT) was selected as the preferred alternative in the Hiawatha Avenue Environmental Impact Statement. Today the Hiawatha Corridor is designated as a transitway by the Metropolitan Council, and offers the opportunity to provide a high quality transit system to the Twin Cities.

The Metropolitan Council's 2020 Transit System Plan recommended that transitway development along the Hiawatha Corridor be pursued immediately. Connecting downtown Minneapolis, the University of Minnesota, numerous Minneapolis residential neighborhoods, the Minneapolis-St. Paul International Airport complex, and the Mall of America, the Hiawatha Corridor has long been recognized as having all the attributes for a successful transit corridor.

Hennepin County, with support from the Metropolitan Council and Mn/DOT, applied for federal transportation funding for the Hiawatha LRT corridor in February 1997, making it imperative that updated cost estimates be developed for use in advancing financing and construction plans. With major portions of the TH 55 (Hiawatha Avenue) roadway reconstruction project scheduled for completion over the next few years, an important window of opportunity is available to coordinate roadway and transit improvements in the corridor.

Combined with such transit supportive programs as the Metropolitan Council's Livable Communities Act, the State of Minnesota's property tax reduction for development near transit routes, the Hennepin Works Program, and Hennepin County's and Minneapolis Community Development Agency's redevelopment goals, transit improvements are poised to work in concert to support, reinforce and stimulate the revitalization activities of the area.

1.03.00 ORGANIZATION OF THE OPERATIONS PLAN

Remaining sections of the TMOP are organized as follows:

- Chapter 2 – System Description provides an overview of the project, describes the LRT alignment and its interface with other transportation modes, and outlines the projections, analyses and assumptions used in developing the service plans and determining operating requirements. Service plans have been defined for the projects planned Opening Year (2004) and Design Year (2020).

- Chapter 3 – Facilities and Systems describes the facilities and systems required to operate and maintain the project, including vehicles, stations and yard and shop.

- Chapter 4 - Transportation Operations describes the activities required to provide revenue service, including descriptions of normal operations, special event operations and abnormal operations.

- Chapter 5 – LRV and System Maintenance identifies requirements for maintenance of vehicles, facilities and equipment.

- Chapter 6 - Operating and Maintenance Costs and Staffing Requirements presents the operating and maintenance (O&M) cost methodology, staffing requirements and annual O&M cost estimates for the design year operations.

2.00.00 SYSTEM DESCRIPTION

This chapter of the TMOP presents a description of the Hiawatha Corridor Light Rail Transit (LRT) project; outlines the projections, analyses and assumptions used in developing service plans; and presents operating requirements for the projects planned opening year (2004) and for the years 2005-2007 and beyond.

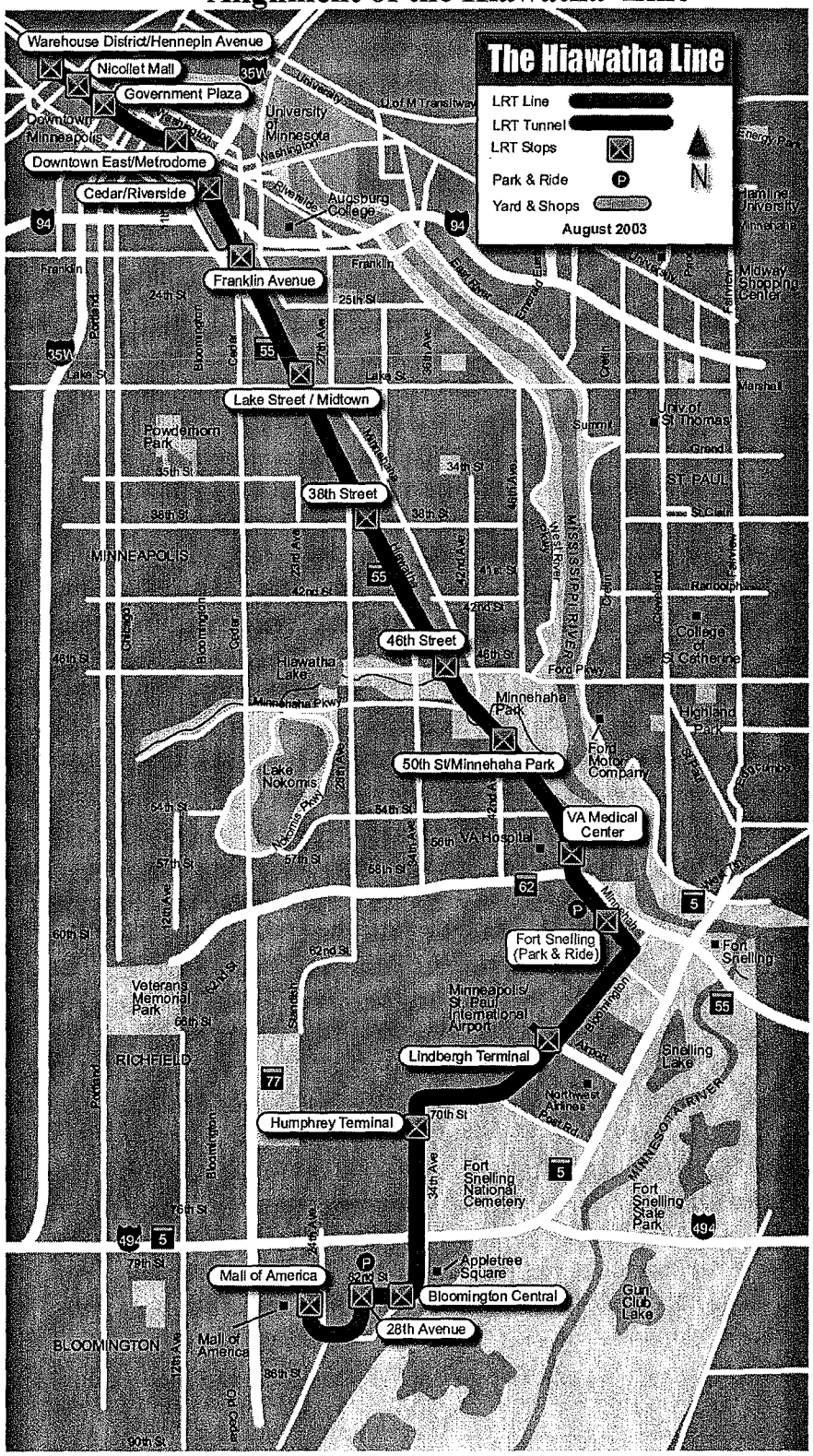
2.01.00 ALIGNMENT

The Hiawatha Corridor LRT line, which will be constructed in two phases, is a 12.01-mile corridor between downtown Minneapolis and the Mall of America, with intermediate service to the Minneapolis-St. Paul Airport. The alignment is primarily at-grade except for aerial structures over major roadways, a tunnel underneath the two main airport runways and a mined station underneath a new airport transportation center. The Hiawatha Corridor alignment begins at the Warehouse District in Downtown Minneapolis, with the first southbound station located between 1st Avenue North and Hennepin Avenue. The alignment continues southeast along 5th Street South, cutting diagonally northeast across the block bound by 5th Street South, 4th Street South, Park Avenue South and Chicago Avenue South. The alignment continues along the northeast side of the Metrodome following the north side of South 4th Street and then proceeds southeast at-grade along the SOO Line Railroad crossing over South 3rd Street, TH 122 and I-35W on bridge structures. The alignment passes under I-94 at-grade.

South of I-94, the Hiawatha LRT line passes over East Franklin Avenue and Cedar Avenue on bridge structures and continues at-grade to East 26th Street. South of East 26th Street the alignment changes from the east side to the west side of Hiawatha Avenue via aerial structure. The alignment resumes at-grade operation at approximately East 32nd Street following the southwest side of Hiawatha Avenue to Minnehaha Avenue. South of Minnehaha Avenue the rail alignment transitions from the west side of Hiawatha Avenue to the southwest side of Minnehaha Avenue. South of the V.A. Medical Center Station the LRT line operates along an aerial structure over TH 55 and TH 62 leading into the Fort Snelling Station. Phase A of the Hiawatha Line, which is due to open in April of 2004, ends at the Fort Snelling station.

The alignment continues at-grade passing through the Fort Snelling station, and then descends into a tunnel under the Minneapolis-St. Paul International Airport, ascending south of the airport at East 70th Street near 34th Avenue South. The alignment ascends near East 70th Street and 34th Avenue South, then continues along 34th Avenue at-grade passing under the I-494 overpass to Ceridian Drive. The LRT line proceeds west along the north side of Ceridian Drive transitioning south onto 28th Avenue then west along Old Shakopee Road across 24th Ave, then North terminating at the Mall of America. The Mall of America station concludes Phase B of this line and is due to open in December of 2004. Figure 2-1 illustrates the Hiawatha Corridor LRT alignment.

Figure 2-1
Alignment of the Hiawatha Line



2.01.01 Stations

There are 17 stations along the Hiawatha Corridor alignment:

- Warehouse
- Nicollet Mall
- Government Plaza
- Downtown East/Metrodome
- Cedar/Riverside
- Franklin Avenue
- Lake Street
- 38th Street
- 46th Street
- 50th Street/Minnehaha Park
- VA Medical Center
- Fort Snelling
- Lindbergh Terminal
- Humphrey Terminal
- Bloomington Corporte
- 28 Avenue Station
- Mall of America

2.01.02 Yard and Shop

The Hiawatha Corridor project included construction of a new rail vehicle maintenance facility and storage yard. The site of this yard is located just north of the East Franklin Avenue station and is bounded by Cedar Avenue on the east, Hiawatha Avenue to the west, East Franklin Avenue on the south and I-94 along the north side. This facility was turned over to the Metropolitan Council in October 2002.

2.01.03 Special Trackwork

Following is a general description of crossovers and pocket tracks included in the Hiawatha Corridor Light Rail project's alignment. Locations of crossovers and pocket tracks are also reflected in the project's Plan and Profile drawings.

Crossovers are located at each terminal station to facilitate train movements into and out of the station. Each terminal crossover will be automatically operated. Terminal crossovers are located at the following locations:

- Interlocking (south) of the Warehouse Station.
- Interlocking located south of the Mall of America Station.

Additional crossovers have been specifically located to support any unusual operations strategies (i.e., single-track operations, rerouting trains, short-turning trains) and facilitate access to/from the yard described in Chapter 4. These crossovers will be operated by the Rail Control Center Supervisor or by LRT Field Supervisors in the field. These crossovers are at the following locations (refer to Section 4.05.03):

- Single crossover located east of the 28th Avenue Station.
- Interlocking located south of East 72nd Street (south of Humphrey Terminal Station).
- Interlocking with a center pocket track (minimum length for 3-car trains) located south of the Fort Snelling Station.
- Single (electric lock) crossover located south of the East 46th Street/Minnehaha Creek Station (between 46th Street and Minnehaha Parkway).
- Single (electric lock) crossover located south of 32nd Street
- Single crossover located near the rail yard south of the Cedar-Riverside Station (to accommodate pull outs and pull in).
- Single (electric lock) crossover located south of the Downtown East Station (just south of Norm McGrew Place).
- Single (manual) crossover located north of the Downtown East Station (just north of Park Avenue South).

The center pocket track located south of the Fort Snelling Station will allow Metro Transit to run a supplemental rail shuttle between the Fort Snelling Station and the Humphrey Terminal Station, replacing the current bus operated shuttle operations between the airport and the Humphrey Terminal area. The rail shuttle operation would only occur during early morning/evening and late evening rail operating hours.

2.02.00 INTERFACE WITH OTHER TRANSPORTATION MODES

The Hiawatha Corridor will interface with other transportation modes. Metro Transit local and regional bus routes will be modified to coordinate transfer opportunities with the LRT line.

2.02.01 SECTOR 5 REORGANIZATION

In 1998, the Metropolitan Council and Metro Transit embarked on a program to evaluate transit service and needs, determine market opportunities and recommend service and facility improvements. The metro area was divided into nine geographic sectors for this purpose. To date, transit-restructuring studies have been completed and implemented with successful results in Sectors 1, 2 and 7. For example, after restructuring in 2001, ridership in Sector 2 grew by 6 percent in 2002.

Sector 5, known as Central-South, includes downtown Minneapolis and downtown St. Paul, as well as the cities of Edina, Richfiled and Bloomington. It includes several major transportation corridors: Hiawatha, I-35W South and I-494. The new Hiawatha Light Rail Transit line is scheduled to begin service between downtown Minneapolis and Fort Snelling in (month) 2004 and will extend to the airport and the Mall of America in December 2004. The Light Rail line is entirely within the study area.

The study focuses on Sector 5, Metro Transit's most productive sector in terms of ridership. As a percent of Metro Transit's total service area, this sector is as follows:

Riders:	36.4 million / 55%
Routes:	55 / 38%
Rush hour Buses:	288 / 37%
Mid-day Buses:	142 / 46%
Population:	½ million / 20%
Jobs:	½ million /34%

An existing Conditions Report was completed to document current bus operations and ridership. A key element of this report was ridership data that showed boardings at each bus stop location. This was an important resource used in making the planning decisions and ultimate route re-configurations.

Table 2-1
Proposed 2004 Bus Route Connections at Rail Stations

Rail Station	Rte #	Route Name	Headway Peak	Headway Base	Type of Stop	Bus Gates Required	Additional Notes
Dwtn E. Metrodome	13 16 50	U of M Camp. Conn. Mpls./St.Paul/Univ Ave	All 5 - 10	All 10 - 15	All Mid Rte.	All Streetside	Stop and go streetside stop. All routes run both directions
Cedar Riverside	N/A	N/A	N/A	N/A	N/A	N/A	No service
Franklin Ave. Station	2 8* 19 24	Franklin Ave-U of M Franklin Ave.-11th Cedar Ave.-28th Ave.-VA Med. Ctr. Franklin Ave.-Longfellow-Neigh.-46th St.	All 7 - 15	All 10 - 20	All Mid Rte.	All Streetside	Stop & go Streetside Transit Stop for both Cedar and Franklin – total of 4 gates
Lake St. Station	7 21 27 53	M'haha-27th Ave-Riverside St.P-Selby Ave.-Lake St. Lk. St.-Bloomtn Av-24th	All 7 - 15	All 15 - 20	All Mid Rte.	2 2 2 2	1 streetside bus gate on both N. and S. side of E. Lake Street Required –Total of 2
38th Street Station	14* 19 23	Bloom. Ave-38th St. 28th Ave.-Cedar Highlnd Pk.-38th St.-Uptwn	All 10 - 15	All 10 - 20	Mid Rte. EOL Mid Rte.	1 2 1	5-off-street bus gates are required
46th Street Station	24 27 46 64* 84*	Franklin Ave.-Longfellow Neigh.-46th St. Nokomis E.-M'haha Ave.-Phillips Neigh. Edina-50th St.-42nd St.-St. Paul Randolph-46th St. Snelling-Ford Pkwy-46th St.-St. Paul Ave	All 15 - 30	All 15 - 30	EOL - EOL EOL Mid Rte.	1 2 2 1 1	Bus Transfer Facility Information to be updated
50th Street Station/	27	M'haha-27th-Riverside	15	30	Mid Rte.	2	One streetside gate in each direction
VA Medical Center	19* 515*	28th Ave.-Cedar SoDale-66th St.- MOA-VA Merdical Ctr.	15	30	EOL EOL	1 1	To be updated
Fort Snelling	MVTA	Eagan	Unkwn	Unkwn	-	-	To be determined
Lindbergh Terminal	54	MOA-Airport-St. Paul-W. 7th	15	20	Mid Rte.	2	2 gates required
Humphrey Terminal	N/A	N/A	N/A	N/A	N/A	N/A	No service
24th Avenue		N/A	N/A	N/A	N/A	N/A	N/A
Bloom. Corp Center	N/A	N/A	N/A	N/A	N/A	N/A	No service
MOA	5* 54* 415* 440* 442* 444* 445* 449* 515* 538* 539* 540* 542*	Chicago Ave-MOA MOA- Airport-St. Paul MOA-Brn Inst.-Mndota Hts Apple Valley-Eagan Apple Valley-Burns. Burns.-Savage Eagan-Bl.Cross-Bl.Shield Eagan Employers MOA-Rich.-66th St. Bloom.-Edina Blomington Rich.-I 494 N. Service Rd. Bloom.-I 494 S. Service Rd.	All Rts 5	All Rts 5-10	EOL EOL EOL EOL EOL EOL EOL EOL EOL EOL EOL EOL EOL	1 1 1 1 1 1 1 1 1 1 1	Additional route(594) May be added after 2005

Note: EOL denotes the "end of the line" location for the identified route and indicates the possibility of scheduled layover time assigned to this location.

2.02.02 General Traffic

Control devices are used at all at-grade street crossings. Table 2-2 lists the proposed at-grade street crossings. The system has both gated and non-gated crossings. In general, crossings located in the dedicated right-of-way running along Hiawatha Avenue are designated as high-speed crossings and have gates. Crossings are protected with signals along segments which are mixed traffic (i.e. 5th Street). Crossings for pedestrians and bikes are signalized with audiable warning devices.

Table 2-2
Grade Crossing Locations

Station	Grade Crossing Location	Location (Milepost)	Crossing Protection / Signalization
Warehouse District /Hennepin Avenue		**.29**	
	Hennepin Avenue South	**.36**	Signalized w/ pre-emption
	Nicollet Mall	**.47**	Signalized w/ pre-emption
Nicollet Mall		**.48**	
	Marquette Avenue South	.54	Signalized w/ pre-emption
	2nd Avenue South	.61	Signalized w/ pre-emption
	3rd Avenue South	.70	Signalized w/ pre-emption
Government Plaza		**.72**	
	4th Avenue South	.78	Signalized w/ pre-emption
	5th Avenue South	.85	Signalized w/ pre-emption
	Portland Avenue South	.93	Signalized w/ pre-emption
	Park Avenue South	1.01	Signalized w/ pre-emption
Metrodome		**1.05**	
	4th Street South	1.12	Signalized w/ pre-emption
	Norm McGrew Pl.	1.21	Gated
	11th Avenue South	1.37	Gated
	15th Avenue South	1.74	Gated
Cedar-Riverside Avenue		**1.76**	
Franklin Avenue		**2.21**	
	Pedestrian Crossing Bridge	**2.48**	
	East 26th Street	2.76	Gated
Lake Street		**3.27**	
	East 32nd Street	3.58	Gated
	East 35th Street	3.98	Gated
38th Street		**4.35**	
	East 38th Street	4.39	Gated
	East 42nd Street	4.95	Gated
46th Street		**5.42**	
	East 46th Street	5.51	Gated
	East 50th Street	6.14	Gated
50th Street		**6.18**	
	Minnehaha Avenue S/B	6.50	
	East 54th Street	6.77	Gated
VA Medical Center		**6.94**	
	Veterans Drive	6.98	Gated
	Federal Drive	7.59	Gated
Fort Snelling		**7.70**	
Lindbergh Terminal		**8.73**	
Humphrey Terminal		**9.85**	
	34th Avenue South	9.91	Gated
	East 72nd Street	9.96	Signalized with pre-emption
	Northwest Airlines Entrance	10.20	Gated
	East 80th Street	10.92	Gated
	34th Avenue South	11.15	Gated
Bloomington Corporate		**11.28**	
28th Avenue Station		**11.55**	
	28th Avenue South	11.56	Gated
Mall of America		**12.29**	
	24th Avenue	**12.00**	

2.03.00 HOURS OF OPERATIONS

The Hiawatha Corridor Light Rail line will operate in revenue service seven days a week from approximately 4:00 a.m. to 1:00 a.m. A Sunday schedule will be in effect on New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving and Christmas. Operating schedules will be revised, if necessary, once actual operations begin and actual ridership demands are identified. Additional service may be added for special events.

2.04.00 VEHICLE LOADING STANDARDS

Service on the LRT line is provided by Light Rail Vehicles (LRVs) with a maximum design speed of 55 miles per hour and seating capacity of 66 passengers and a standing capacity of 54 passengers. The vehicle is low-floor, designed for level boarding from a low-level platform, approximately 14" above top of rail (TOR). The LRV is also articulated and capable of bi-directional operation as a single unit or as multiple units consisting of two to three vehicles. Each train consisting of one or more vehicles will be manually operated and powered by electricity drawn from an overhead catenary system.

LRV loading standards establish the level of crowding that a passenger can expect under normal conditions. Loading standards can be expressed as: (1) the average number of seated and standing passengers per vehicle for a specified period – usually a peak hour or peak 15 minutes within the peak hour ("peak of the peak"); or (2) the ratio of total passengers (seated and standing) to seats per vehicle for a specified period. Metro Transit has elected to use a lower loading standard (i.e., a lower level of passenger crowding), as have many new start LRT systems. The Hiawatha Corridor Light Rail operating plans reflect a load standard of 130 passengers per LRV. This load factor has been applied to peak hour peak direction (PHPD) maximum load points to determine the desired number and frequency of train cars to meet ridership demands. It should be noted that this load standard is an average applied to the peak hour of operation. Some trains will experience passenger loads in excess of the standard. For example, during special events a "crush load" is anticipated. This will be approximately 66-seated passengers and 124 standees or 190 passengers.

2.05.00 TRAVEL TIMES

Preliminary estimates of round-trip travel times are based on normal acceleration/ deceleration rates for typical LRVs and corridor drawings for the Hiawatha line (dated August 10, 1999). The following sections describe the vehicle performance characteristics, station-to-station run times and total cycle times.

2.05.01 Vehicle Performance Characteristics

The following section presents performance characteristics that have been assumed for the Hiawatha Corridor Light Rail vehicle. These characteristics have been verified through vehicle qualification testing conducted along the alignment in the summer of 2003.

- Acceleration

  According to the Hiawatha Corridor Light Rail Transit *Draft Design Criteria Report* (March 26, 1999) the LRV assumed for the Hiawatha Corridor has the capability to accelerate with an AW2 load (standees at 4 persons per square meter suitable standing space per passenger, plus AW1) at a rate of 3.0 mphps. Once the vehicle has reached approximately 25 mph, the acceleration rate begins to decrease.

- Normal Braking

  According to the Hiawatha Corridor Light Rail Transit *Draft Design Criteria Report* (March 26, 1999), normal service braking is defined as routine stopping to load/unload passengers and to comply with traffic control signals. The LRV assumed for the Hiawatha Corridor project has the capability to brake at a smooth and continuously controllable rate of approximately 3.0 mphps.

- Speed of Operation

  The LRV assumed for the Hiawatha Corridor project is assumed to have a maximum speed of 55 mph. However, the maximum speed is limited along sections of the alignment due to horizontal curve restrictions, at-grade crossings and speed limits for in-street operations imposed by affected jurisdictions

2.05.02 Travel Times

Station-to-station run times were calculated using the performance characteristics specified in Section 2.05.01. Twenty (20) second station dwells were assumed for all stations. The project is being designed for full pre-emption at all street crossings.

The estimated one-way travel time (Year 2003 Operating Plan) from the Warehouse District Station (Downtown Minneapolis) to the Ft. Snelling Station is 25 minutes. The estimated running time from Warehouse to the Mall of America (12.0 miles) is 37 minutes. This equates to a 21.0 mph scheduled speed. Total round trip travel times also include an allowance for an additional four minutes travel time each way to account for possible intersection delays. Travel time, station dwell time and average speed will be tested and confirmed during pre-revenue simulations, during June 2004.

2.06.00 RIDERSHIP PROJECTIONS

In order to determine peak period service demands in which to design adequate service supply, peak period peak direction boarding and alighting volumes must be determined by station. The ridership projections developed for Metropolitan Council (August 1998) reported peak hour LRT station boardings and alightings, as well as peak hour line loads in the peak and off-peak directions. Ridership at individual downtown stations was not reported due to the lack of model refinement at a station level. Consequently, downtown ridership is reflected in aggregate as total boardings, total alightings and maximum load.

Ridership forecasts have been developed for Metropolitan Council (August 10, 1999) based on the alignment described above (12.01 miles, 17 stations). These ridership forecasts estimate total daily LRT passengers by station for year 2020. Peak period, peak direction boarding and alighting projections are forthcoming. A review of the most recent year 2020 ridership projections reveals total overall LRT ridership to be within one percent of the August 1998 forecasts (24,600 vs. 24,800 boardings). For the purposes of operating plan development, the previous ridership projections generated for Metropolitan Council (August 1998) were as a base demand. Once peak period peak direction boarding and alighting volumes and maximum line loads are prepared for the most recent model run (August 1999), the operating plans will need to be re-examined.

2.06.01 Opening Year (2004) Ridership

The ridership projections developed for Metropolitan Council (August 1998) also provided forecasts for the year 2004, the system start-up year. These projections indicate 19,300 total daily LRT boardings. These forecasts (Table 2.3) reflect 2,391 (PHPD) boarding's with a **1,758 maximum line load** occurring between the Lake Street and 38th Street LRT stations.

Table 2-3
Hiawatha LRT Estimated Boardings/Alightings for the Year 2004 P.M. Peak Hour

	Southbound (Read Down)			Northbound (Read Up)		
Station	**Boarding**	**Alighting**	**Load**	**Boarding**	**Alighting**	**Load**
Downtown Minneapolis (1)	1,723	47		23	234	
			1,676			211
Cedar/Riverside Avenue	50	23		23	70	
			1,703			258
Franklin Avenue	50	47		23	70	
			1,706			305
Lake Street	75	23		47	94	
			1,758			352
38th Street	50	211		47	117	
			1,597			422
46th Street	50	141		23	141	
			1,506			540
50th Street	25	47		23	23	
			1,484			540
VA Medical Center	25	94		47	47	
			1,415			540
Fort Snelling	25	399		47	47	
			1,041			540
Lindbergh Terminal	124	47		47	70	
			1,118			563
Humphrey Terminal	124	70		47	47	
			1,172			563
80th Street - Deferred	0	0		0	0	
			1,172			563
Bloomington Corporate	23	23		70	23	
			1,172			516
28th Avenue	47	526		47	0	
			693			469
Mall of America	0	693		469	0	
TOTAL	2,391	2,158		983	983	

1. Hennepin Avenue/ First, Nicollet Mall, Government Center, and Metrodome Stations - individual numbers are not reported due to lack of model refinement at station level.
2. Source: "Transit Ridership Forecasts - Hiawatha Corridor" (memorandum from Stephen Wilson to Nacho Diaz, August 27, 1999).
3. Passenger forecasts revised downward for actual ridership loss from 7/1/01 fare increase and forecasted ridership loss expected from 7/1/03 fare increase.
4. Assumes 80th Street Station is deferred and base ridership is shifted to Bloomington Park and Ride Station.
5. Assumes 220 park and ride passengers from Mall of America Station shift to new Bloomington Park and Ride Station of which 37% (81 passengers) alight in the PM peak hour.
6. Assumes additional 385 park and ride passengers generated by additional capacity at new Bloomington Park and Ride Station of which 37% (142 passengers) alight in the PM peak hour.

2.06.02 Design Year 2020 Ridership

The ridership projections developed for Metropolitan Council (August 1998) forecasts a total of 24,800 daily LRT boardings for the year 2020. These forecasts (Table 2-4) reflect 3,096 peak hour peak direction (PHPD) boardings with a **2,399 maximum line load** occurring between the Lake Street and 38th Street LRT stations.

Table 2-4
Hiawatha LRT Estimated Boardings/Alightings for the Year 2020 P.M. Peak Hour

	Southbound (Read Down)			Northbound (Read Up)		
Station	**Boarding**	**Alighting**	**Load**	**Boarding**	**Alighting**	**Load**
Downtown Minneapolis (1)	2,364	70		23	305	
			2,294			282
Cedar/Riverside Avenue	49	23		23	94	
			2,320			353
Franklin Avenue	73	70		23	94	
			2,323			424
Lake Street	99	23		47	117	
			2,399			494
38th Street	49	258		47	141	
			2,190			588
46th Street	49	164		23	164	
			2,075			729
50th Street	24	47		23	23	
			2,052			729
VA Medical Center	24	117		47	47	
			1,959			729
Fort Snelling	24	493		70	70	
			1,490			729
Lindbergh Terminal	148	47		47	94	
			1,591			776
Humphrey Terminal	123	70		70	47	
			1,644			753
80th Street - Deferred	0	0		0	0	
			1,644			753
Bloomington Central	47	47		117	0	
			1,644			659
28th Avenue	23	650		94	23	
			1,017			565
Mall of America	0	1017		565	0	
			798			
TOTAL	3,096	3,096		1,219	1,219	

1. Hennepin Avenue/ First, Nicollet Mall, Government Center, and Metrodome Stations - individual numbers are not reported due to lack of model refinement at station level.
2. Source: "Transit Ridership Forecasts - Hiawatha Corridor" (memorandum from Stephan Wilson to Nacho Diaz, August 27, 1999).
3. Passenger forecasts revised downward for actual ridership loss from 7/1/01 fare increase and forecasted ridership loss expected from 7/1/03 fare increase.
4. Assumes 80th Street Station is deferred and base ridership is shifted to Bloomington Park and Park and Ride Station.
5. Assumes 220 park and ride passengers from Mall of America Station shift to new Bloomington Park and Ride Station of which 37% (81 passengers) alight in the PM peak hour.
6. Assumes additional 385 park and ride passengers generated by additional capacity at new Bloomington Park and Ride Station of which 37% (142 passengers) alight in the PM peak hour.

2.07.00 2004 OPERATING PLAN

Operations for the Hiawatha LRT system will commence in two phases. On June 26, 2004, operations will be started on the segment between Fort Snelling and downtown Minneapolis (Warehouse District Station). Full operations on the entire alignment from Mall of America to downtown Minneapolis will commence no later than December 31, 2004.

Table 2-5
Operating Hours and Fleet Consists

Weekdays	Hours	Headway Minutes	Phase 1A Trains	Phase 1B Trains	Train Consist
Early Morning Southbound	4:00 a.m. to 5:40 a.m.	30	2	3	2
Early Morning Southbound	5:40 a.m. to 6:40 a.m.	15	4	6	2
Early Morning Northbound	4:30 a.m. to 5:00 a.m.	30	2	3	2
Early Morning Northbound	5:00 a.m. to 5:30 a.m.	15	4	6	2
Early Morning Northbound	5:30 a.m. to 6:30 a.m.	10	6	9	2
AM Peak	6:40 a.m. to 9:30 a.m.	7.5	8	11	2
Midday	9:30 a.m. to 3:30 p.m.	10	6	9	2
PM Peak	3:30 p.m. to 6:30 p.m.	7.5	8	11	2
Evening	6:30 p.m. to 10:00p.m.	15	4	6	2
Late evening	10:00 p.m. to 1:00 a.m.	30	2	3	2
Weekends and Holidays	**Hours**	**Headway Minutes**	**Phase 1A Trains**	**Phase 1B Trains**	**Train Consist**
Early Morning	4:00 a.m. to 6:30 a.m.	30	2	3	1
Morning	6:30 a.m. to 8:30 a.m.	15	4	6	1
Midday*(Sunday midday begins at 9:30 a.m.)	8:30 a.m. to 6:00 p.m.	10	6	9	2
Evening	6:00 p.m. to 10:00 p.m.	15	4	6	2
Late evening	10:00 p.m. to 1:00 a.m.	30	2	3	1

Our analysis of equipment needs began with a determination of station-to-station running times. The following are tables depicting these times for Phase 1A and Phase 1B.

TABLE 2-6

Hiawatha Light Rail Transit Train Run Times

Minneapolis – Fort Snelling, service beginning June 2004

Metro Transit Service Development Division Estimates

Last Updated: May 2004

Note: Distances, times and speeds are assumed to be the same northbound and southbound

Northbound Stations	Seconds	Minutes	Feet	Miles	Scheduled MPH	Southbound Stations	Seconds	Minutes	Feet	Miles	Scheduled MPH
Mall of America	0.00	0.00	0.00	0.00	0.00						
28th Avenue	0.00	0.00	0.00	0.00	0.00	Warehouse	0.00	0.00	0.00	0.22	6.64
Bloomington Central	0.00	0.00	0.00	0.00	0.00	Nicollet	71	2	1,169	0.24	14.45
Humphrey Terminal	0.00	0.00	0.00	0.00	0.00	Government Center	60	1	1,272	0.33	9.89
Lindbergh Terminal	0.00	0.00	0.00	0.00	0.00	Downtown East/Metrodome	71	2	1,740	0.71	21.30
Fort Snelling	0.00	0.00	0	0.00	0.00	Cedar Riverside	115	2	3,749	0.45	13.59
VA Medical Center	109.00	2.00	3,971	0.75	22.56	Franklin Station	75	2	2,391	1.06	21.11
50th Street	120.00	3.00	4,054	0.77	15.36	Lake Street	127	3	5,574	1.07	32.04
46th Street	88.00	2.00	3,996	0.76	22.70	38th Street	105	2	5,639	1.07	32.03
38th Street	106.00	2.00	5,638	1.07	32.03	46th Street	106	2	5,638	0.76	22.70
Lake Street	105.00	2.00	5,639	1.07	32.04	50th Street	88	2	3,996	0.77	15.36
Franklin Avenue	127.00	3.00	5,574	1.06	21.11	VA Medical Center	120	3	4,054	0.75	22.56
Cedar Riverside	75.00	2.00	2,391	0.45	13.59	Fort Snelling	109	2	3,971	0.00	0.00
Downtown East/Metrodome	115.00	2.00	3,749	0.71	21.30	Lindbergh Terminal	0	0	0	0.00	0
Government Center	71.00	2.00	1,740	0.33	9.89	Humphrey Terminal	0	0	0.00	0.00	0
Nicollet	60.00	1.00	1,272	0.24	14.45	Bloomington Central	0	0	0.00	0.00	0
Warehouse	71.00	2.00	1,169	0.22	6.64	28th Avenue	0	0	0.00	0.00	0
						Mall of America	0	0	0.00	0.00	0
Total	1,047	23.00	39,193	7.42	19.24	Total	1,047	23	39,193	7.42	19.24

Seconds = estimated number from station to station, without dwell time

Minutes = agreed upon schedule minutes from station to station for current schedule development (rounded to account for station dwell times)

Feet = milepost to milepost distance from station to station
Miles = Feet / 5280

Scheduled MPH = Miles / (Minutes/60)

Note: Run times differ from Phase 1A to 1B due to speed restrictions at grade crossings. Phase 1B

TABLE 2-7

Hiawatha Light Rail Transit Train Run Times

Minneapolis - Mall of America, service beginning late year 2004

Metro Transit Service Development Division Estimates

Last Updated: May 2004

Note: Distances, times and speeds are assumed to be the same northbound and southbound

Northbound Stations	Seconds	Minutes	Feet	Miles	Scheduled MPH	Southbound Stations	Seconds	Minutes	Feet	Miles	Scheduled MPH
Mall of America	0.00	0	0	0.00							
28th Avenue	203.00	4	4,151	0.79	11.79	Warehouse	0.00	0	0.00	0.00	
Bloomington Central	80.00	2	1,436	0.27	8.16	Nicolet	71.00	2	1,169.00	0.22	6.64
Humphrey Terminal	194.00	4	7,299	1.38	20.74	Government Center	60.00	1	1,272.00	0.24	14.45
Lindbergh Terminal	114.00	2	5,911	1.12	33.59	Downtown East/Metrodome	71.00	2	1,740.00	0.33	9.89
Fort Snelling	110.00	2	5,370	1.02	30.51	Cedar Riverside	115.00	2	3,749.00	0.71	21.30
VA Medical Center	109.00	2	3,971	0.75	22.56	Franklin Station	75.00	2	2,391.00	0.45	13.59
50th Street	120.00	3	4,054	0.77	23.03	Lake Street	127.00	3	5,574.00	1.06	31.67
46th Street	88.00	2	3,996	0.76	22.70	38th Street	105.00	2	5,639.00	1.07	32.04
38th Street	106.00	2	5,638	1.07	32.03	46th Street	106.00	2	5,638.00	1.07	32.03
Lake Street	105.00	2	5,639	1.07	32.04	50th Street	88.00	2	3,996.00	0.76	22.70
Franklin Avenue	127.00	3	5,574	1.06	31.67	VA Medical Center	120.00	3	4,054.00	0.77	23.03
Cedar Riverside	75.00	2	2,391	0.45	13.59	Fort Snelling	109.00	2	3,971.00	0.75	22.56
Downtown East/Metrodome	115.00	2	3,749	0.71	21.30	Lindbergh Terminal	110.00	2	5,370.00	1.02	30.51
Government Center	71.00	2	1,740	0.33	9.89	Humphrey Terminal	114.00	2	5,911.00	1.12	33.59
Nicollet	60.00	1	1,272	0.24	14.45	Bloomington Central	194.00	4	7,299.00	1.38	20.74
Warehouse	71.00	2	1,169	0.22	6.64	28th Avenue	80.00	2	1,436.00	0.27	8.16
						Mall of America	203.00	4	4,151.00	0.79	11.79
Total	1,748.00	37	63,360	12.00	20.92	Total	1,748.00	37	63,360	12.00	20.92

Seconds = estimated number from station to station, without dwell time

Minutes = agreed upon schedule minutes from station to station for current schedule development (rounded to account for station dwell times)

Feet = milepost to milepost distance from station to station

Miles = Feet / 5280

Scheduled MPH = Miles / (Minutes/60)

2.07.01 Vehicle Cycle Times

Cycle times are an important component that is used to determine operating requirements for each rail line. The cycle time consists of running time, station dwells, intersection delays and layover time. Cycle times must be divisible by the proposed headway. Vehicle operating requirements are determined from proposed service frequencies, train consists and travel times. Table 2-8 represents the number of trains and Light Rail Vehicles required for Phase 1A of the 2003 rail operating plan. This plan has a peak car requirement of 16 cars.

TABLE 2-8
2004 Operating Requirements
(Phase 1A)

	Input Variable	Warehouse to Ft Snelling
Round Trip Time	Running Time	46.0 min.
	Layover and Recovery Time	14 min.
	Total Cycle Time	60 min.
Peak Period LRVs Required	Service Frequency	7.5 min.
	Train Consist	6 2-car trains and 2 single units
	Trains Required	8 trains
	Cars Required	14

Table 2-9 below shows the number of trains and vehicles required for Phase 1B of the 2004 operating plan. Phase 1B has a peak car requirement of 22 cars.

Table 2-9
2004 Operating Requirements
(Phase 1B)

	Input Variable	Warehouse to Mall of America
Round Trip Time	Running Time	74.0 min.
	Layover and Recovery Time	16 min.
	Total Cycle Time	90 min.
Peak Period	Service Frequency	7.5 min.
LRVs Required	Train Consist	10 2-car trains 2 single units
	Trains Required	12 trains
	Cars Required	22 cars

Note: Running time does not include dwell times at the end-of-line stations. The end-of-line dwell times are included as part of layover time.

It should be noted that the total cycle time includes layover time for the operators and recovery time for the vehicle (schedule). During pre-revenue simulation Metro Transit will verify running times and consist requirements. Any adjustments found to be necessary that affect the schedule or consist requirements will be incorporated prior to April 3, 2004.

2.07.02 Train Consist Requirements

Train consist requirements were determined from the ridership projections developed for the Metropolitan Council (August 1998) which reported peak hour LRT station boardings and alightings as well as peak hour line loads in the peak and off-peak directions. Using the vehicle loading standard in Section 2.04.00 and opening year ridership forecasts, two-car trains are proposed for the weekday peak/base and Saturday base periods, one-car trains are proposed for all other times. The only exception exists during the beginning and end of the weekday peak when one car trains will be utilized.

2.07.03 Peak and Fleet Vehicle Requirements

Overall, the rail plan requires 12 trainsets for peak period operations and 9 trainsets for base period operations for the opening year 2004. The peak vehicle requirement is 22 LRVs and the fleet vehicle requirement is 24 LRVs (9.1% spares).

2.07.04 Summary of Operating Requirements

Specific service frequencies, schedules and train consists by time period, for weekday, Saturday and Sunday service are currently being developed. Estimates of annual revenue train-hours and car-miles do not account for any special service that may be operated during special events (e.g., a Vikings or Twins game). The fleet vehicle requirements assume a 9.1 percent spare ratio, 22 peak LRVs and 24 LRVs in the fleet.

2.08.00 2020 OPERATING PLAN

The rail operating plan for Design Year 2020 consists of rail service from the Warehouse Station (Downtown Minneapolis) to the Mall of America (12.01 miles). The proposed operating plan for this scenario consists of the following service frequencies:

Weekday	A.M. Peak – 6 minutes	**Weekend**	Base - 10 minutes
	Base - 10 minutes		Early Evening - 15 minutes
	P.M. Peak – 7.5 minutes		Early/Late - 30 minutes
	Early Evening - 15 minutes		
	Early/Late - 30 minutes		

Three-car trains are proposed for peak and base (weekday & Saturday) periods, 2-car trains during Sunday base period, and one-car trains are proposed for all other time periods (weekdays and weekends). Operating requirements are determined from proposed service frequencies, train consists and travel times. Table 2.6 presents the number of trains and Light Rail Vehicles required for the 2020 rail operating plan. This plan has a peak car requirement of 36 cars.

2.08.01 Cycle Times

As noted in section 2.07.01 above, cycle time consists of running time and layover time. Cycle times must be divisible by the proposed headway. On weekdays during peak periods, the 2020 operating plan dictates a 6 minute headway.

TABLE 2-10
2020 Operating Requirements

	Input Variable	Warehouse to Mall of America
Round Trip Time	Running Time	74 min.
	Layover Time	16 min.
	Total Cycle Time	90 min.
Peak Period LRVs Required	Service Frequency	6 min.
	Train Consist	2-car trains
	Trains Required	15 trains
	Cars Required	30 cars

Note: Running time does not include dwell times at the end-of-line stations. The end-of-line station dwell times are included as part of layover time.

2.08.02 Train Consist Requirements

Ridership forecasts for the design year (2020) indicates an increase in the PHPD direction maximum line load. The increase in ridership levels reflected in the 2020 ridership projections dictate the need for two-car trains in the peak and base periods, weekday and Saturday, and two-car trains in the base periods on Sunday. Weekday peak headway is 6 minutes and the base headway is 10 minutes.

2.08.03 Peak and Fleet Vehicle Requirements

Overall, the 2020 rail plan requires 15 train sets for peak period operations. The peak vehicle requirement is 30 LRVs and the fleet vehicle requirement is 36 LRVs (20 percent spare ratio).

2.08.04 Summary of Operating Requirements

Estimates of annual revenue train-hours and car-miles do not account for any special service that may be operated during special events (e.g., a Vikings or Twins game). The fleet vehicle requirements assume a 20 percent spare ratio, 30 peak LRVs and 36 fleet LRVs.

3.00.00 FACILITIES AND SYSTEMS

This chapter provides an overview of the facilities and systems that are required to operate and maintain the Hiawatha Corridor Light Rail Transit Line. The following sections describe the vehicles, stations, yard and shop facilities, communications, train control, and traction power systems. Information presented in this chapter is described in detail in the project's Design Criteria Manual (Draft, March 26, 1999).

3.01.00 VEHICLES

The light rail vehicles (LRVs) for the Hiawatha Corridor LRT are Bombardier Model LF70. They are six-axle, double-ended, articulated transit vehicle capable of bi-directional operation as a single unit or in multi-unit train under manual control by an operator in the lead cab. The pantograph is located on the roof of the LRV for power collection from the overhead catenary.

Passengers will board through four low-level double doors located on each side of the vehicle. To facilitate rapid loading and to meet ADA requirements, the Hiawatha Corridor LRVs are configured with low-level boarding at approximately 14 inches above top of rail. 70% of the interior floor area is low level seating and standing. The vehicle seats a minimum of 66 persons, 4 wheelchair accessible spaces, 4 bicycles, and luggage racks.

Hiawatha Corridor LRT trains are operated by a single train operator. And each train consists of one to two car trainsets. Each vehicle is equipped for independent two-way operations, with an operator's cab at each end.

3.02.00 STATIONS

The Hiawatha Corridor LRT alignment includes 17 stations (12 stations in Phase A and 5 additional stations in Phase B). All stations are designed to comply with requirements of the American with Disabilities Act of 1990 (ADA). The majority of stations are at grade and of a straightforward design. Station amenities are standardized, to include shelters, platform features and structural elements. There are canopies over a portion of each platform. The extent of each canopy varies for each station and depends on expected patronage and platform type. Table 3-1 identifies stations, placement in right-of-way (at grade, aerial, and tunnel) and platform type (side and center).

3.02.01 Station Platforms

Station platforms have sufficient length to accommodate up to 2-car trains (approximately 200 feet to 260 feet long), with the exception of the Lindbergh and Lake Street Stations, which are designed to accommodate three car trains. All station locations are designed to allow for future expansion to three-car trains. To facilitate passenger boarding and alighting, platforms are level with the floor of vehicle. The surface of all platforms are non-skid and of long-wearing weather resistance materials. A tactile edge strip of material is provided at the

trackway edge of the platform, contrasting in roughness and color from the remainder of the platform, and complies with provisions of ADA.

3.02.02 Fare Collection Equipment

The fare collection system is based on a barrier-free proof of payment system that will be integrated with Metro Transit's bus fare collection system. The fare collection is comprised of the following features.

- Ticket Vending Machines (TVMs) provided at the entrances to each station generally on the platform near the main entry points, but determined on a station site basis. TVMs are capable of accepting debit and credit cards. TVMs will also accept electronic "smart" fare cards.

- Magnetic Ticket Processors (MTPs) will be installed on or adjacent to station platforms to provide processing capabilities for holders of magnetic tickets. Some passengers originating their trip on LRT will have magnetic tickets that must be processed prior to boarding.

3.02.03 Patron Amenities/Communications Systems

The following elements will be provided at each station.

Station Area Amenities:	Public telephones
	Bicycle storage
	Trash receptacles
Platform amenities:	Benches
	Public address system
	Passenger assistance telephones
	Readerboards
	Closed circuit television
	Signage
	Overhead heaters
	Windscreens

Table 3-1
Station Characteristics

Station	Placement in Right-of-Way	Grade Alignment	Platform Location
Warehouse	North of 5th Street	At-Grade	Center Platform
Nicollet Mall	North of 5th Street	At-grade	Center Platform
Government Plaza	Exclusive ROW between 3rd and 4th Avenues	At-grade	Side Platform
Downtown East/Metrodome	Exclusive ROW between Park Ave. South and Chicago Ave. South	At-grade	Side Platform
Cedar - Riverside	Exclusive ROW	At-grade	Center Platform
Franklin Avenue	Exclusive ROW	Aerial	Center Platform
Lake Street	Exclusive ROW	Aerial	Center Platform
38th Street	Exclusive ROW	At-grade	Center Platform
46th Street	Exclusive ROW	At-grade	Side Platform
50th Street/Minnehaha Park	Exclusive ROW	At-grade	Side Platform
VA Medical Center	Exclusive ROW	At-grade	Center Platform
Fort Snelling	Exclusive ROW	At-grade	Center Platform
Lindbergh Terminal	Exclusive ROW	Tunnel	Center Platform
Humphrey Terminal	Exclusive ROW	At-grade	Center Platform
Bloomington Central	Exclusive ROW	At-grade	Center Platform
28th Avenue	Exclusive ROW	At-grade	Center Platform
Mall of America	Exclusive ROW	At-grade	Center Platform

3.03.00 YARD AND SHOP

Storage, servicing and repair of revenue vehicles are conducted in the yard located south of Downtown Minneapolis, near I-94, north of East Franklin Avenue and west of Cedar Avenue. Access is provided to/from both mainline tracks. The yard area and maintenance facilities are designed to insure to assure the expedient and proper traffic work flow and space allocations

Yard movements are made only on radio direction from the Rail Control Center (RCC). The maximum yard speed is up to ten miles an hour. Selected switches are automatic. Other switches are manual. Interlocking signals are provided at the yard/mainline interface.

A Shop/Administration building is located at the yard site. The RCC is also housed at this building. Other functions that occur at this building include preventive and corrective maintenance, heavy repair, undercar cleaning, painting, wheel truing, vehicle body repairs, motor services, HVAC and electronic repair. The building also contains machine shop, truck and wheel shop, bridge crane, welding shop, sheet metal, tool and parts storage area, maintenance staff offices, operations staff offices, storage, lockers, administration staff offices, lunchroom, and conference and training rooms.

3.04.00 COMMUNICATIONS

The RCC contains the necessary communication apparatus and personnel for the daily operation of trains, stations, and all wayside items. The Rail Control Center serves as the focal point from which all Hiawatha Corridor LRT operations are authorized, controlled and coordinated. Communication systems required for the Rail Control Center are as follows.

3.04.01 Voice Subsystems

Voice subsystems include: radio, platform and tunnel emergency telephones, passenger assistance telephones, administrative telephones, Private Branch Exchange (PBX), public address, readerboards, communications control unit and voice recorder.

3.04.02 Supervisory Control and Data Acquisition (SCADA)

The SCADA subsystem provides a master control system at the Rail Control Center to monitor and control remote data input/output units. A graphical user interface allows the Rail Control Center Supervisor to easily discern the information being presented. The SCADA subsystem provides supervisory control of the train control, traction power systems, and electronic equipment and fire and intrusion alarm systems.

3.04.03 Closed Circuit Television (CCTV)

Stations are equipped with CCTV color cameras for remote surveillance from the Rail Control Center. Cameras are all solid-state, Charge Couple Device (CCD) units in weatherproof, vandal resistant enclosures. Cameras are capable of operating within an ambient temperature range of -20^0C to $+50^0$C.

CCTV coverage of the stations is primarily confined to station platform areas, escalators and elevators, with special attention being paid to the fare collection machines and elevators. The station areas to be monitored are monitored with stationary cameras with fixed lenses.

All video images received at the Rail Control Center are multiplexed and have the ability to be recorded for future playback.

3.05.00 TRAIN CONTROL

The Signal System for train control consists of four subsystems: Interlockings, Highway Grade Crossing Warnings, Automatic Block Signal (ABS) System, and the Train-To-Wayside Communications (TWC) System.

3.05.01 Signal Aspects

Table 3-2, below, identified the signal aspects for the Hiawatha LRT system.

Table 3-2
Signal Aspects

Rule Number – Signal Name	Aspect	Indication
Stop	Red	Stop
Approach	Yellow	Proceed on normal route prepared to stop at the next signal. If traveling in excess of 35 MPH, immediately reduce speed to 35 MPH
Primary Approach	Yellow over yellow	Proceed on primary alternate route prepared to stop at the next signal
Secondary Approach	Yellow over lunar	Proceed on secondary route prepared to stop short of any train or obstruction
Clear	Green	Proceed on normal route (displayed where the next signal displays a permissive signal)
Call On	Flashing Red	Proceed into occupied block prepared to stop short of any train or obstruction

3.05.01 Interlockings

Interlockings are provided for all power switches used on the mainline. Interlocking signals are provided to govern train movements into and through interlocking limits.

3.05.02 Highway Grade Crossing Warning

Warning devices for highway grade crossings are installed at certain locations. Each such crossing includes automatic gates, flashing lights, bells, signs, one directional approach circuits, emergency batteries and associated circuitry, cabling and cases.

The design of each crossing is specific to that site and provides a minimum of 20 seconds warning time, from the time that the lights first begin to flash until the time that a train traveling at track speed enters the crossing. The design of the crossing circuitry avoids unnecessary delays to motorists. Where necessary, the grade crossing warning system shall preempt adjacent traffic lights to avoid automobiles forming a queue across the tracks.

3.05.03 Train-To-Wayside Communications (TWC) System

LRVs are equipped with a Train-to-Wayside Communication (TWC) system. The portion of the TWC system carried by each LRV system consists of two transponders (one for each end of the LRV) and two car control units (one for each cab). The wayside portion consists of an antenna and a wayside transceiver. The wayside transceiver transmits a message, through the wayside loop antenna, asking that any transponder on an LRV in the immediate area identify itself. A LRV-carried TWC transponder receiving this message responds by transmitting a message identifying the LRV's car number, the train number, route number (destination), and other information. Thumb-wheel switches and push buttons in each cab are provided to Train Operators to enter the route number, train number and other requests.

A compatible TWC system is installed at all interlockings, at all passenger stations adjacent to highway crossings, and at selected power switches in the yard to allow Train Operators to enter switch call requests. Use of the TWC system is the primary method of entering route and switch requests at those locations.

3.06.00 TRAFFIC CONTROL

Traffic vehicle and pedestrian signals, signs and markings are in accordance with the practices of the local jurisdictions in which the system is constructed and with the *Manual on Uniform Traffic Control Devices* (MUTCD) published by the U.S. Department of Transportation.

At locations where LRT cars cross a public street, active devices provide traffic control. Primarily, this control is by means of railroad-type flashers, bells and gates. In low speed situations, intersection-type traffic signals are utilized in lieu of railroad-type devices. Interconnection with nearby traffic signals on the public streets is required in some cases. At

ungated public roadway crossings and at intersections that include a LRT trackway, standard highway type traffic signals are used to control vehicle and pedestrian traffic.

At intersections through which LRT cars operate, whether in mixed traffic or reserved lanes, bar signals are provided to control their movement. These LRT signals are physically separated from the traffic signals. LRT signals are operated by the same controller that operates the traffic signals, or by a separate, but interconnected and compatible controller.

3.07.00 TRACTION POWER

A Traction Electrification System (TES) provides electrical power to the LRVs by the means of the traction power supply system and the traction power distribution system.

The traction power supply system consists of traction power substations located along the system route connected to the distribution circuits of the local power utility company and the DC feeder cables in underground ductbanks connecting to the overhead distribution system. The substations include all the equipment necessary to transform and rectify the utility AC three-phase voltage to DC electrification voltage.

The traction power overhead distribution system consists of catenary and contact wire systems. At-grade mainline tracks use the overhead catenary system (OCS), which consists of a messenger wire and a contact wire. Along segments of city streets and in the vehicle maintenance shop, a single contact wire with feeders is used. The at-grade sections of the mainline are auto-tensioned by the means of counterweights, while the underground section, the yard, and the shop systems use fixed terminations.

The traction power supply system configuration is of the multiple-feed type with electrical continuity between substations. The LRVs collect power from the contact wire by means of pantographs and return the power to the substations via running rails. The mainline and yard tracks are isolated from ground, while the shop tracks are grounded.

The system sectioning is designed to enable the electrical protective devices to isolate faulted sections of the distribution system, perform planned maintenance, and achieve flexible operation during system emergencies.

3.07.01 Power Substations

Substations provide for the conversion and supply of traction power to the system. Substation spacing is based on a system load flow study. The substations are located so that the distribution system voltage does not drop below the minimum level required.

Each substation has one transformer-rectifier unit. Substations on the above ground sections have two DC feeder breakers. Substations located at the tunnel portals have three DC feeder breakers; substations located in the tunnel have four DC feeder breakers.

Sectioning at substations and elsewhere is performed by means of insulated overlaps where possible. Where overlaps cannot be used for sectioning, section insulators are used.

The primary connection and isolation of the system sections is performed by the substation DC feeder circuit breakers. At locations along the route, connections and isolation of the system sections is accomplished by disconnect switches.

Substation equipment includes SCADA interface equipment, fire/smoke detection and intrusion alarm, controls, and communication equipment.

3.07.02 Overhead Catenary System (OCS)

Four distinct types of OCS are used: a) auto-tensioned simple catenary system, b) auto-tensioned single contact wire system, c) fixed termination single contact wire system, and d) fixed termination simple catenary system.

A simple catenary system consists of a messenger wire supporting a contact wire by the means of hangers.

Auto tensioning is accomplished by means of counterweights, which are mounted on anchor poles located at the ends of each tension length. As the conductors contract and expand with temperature variation, the counterweights will rise and fall and thus maintain a constant conductor tension throughout the specified temperature range. Suitable anchor arrangements are used in the center of each tension length to prevent along-track movement of the OCS at that point.

An auto-tensioned single contact wire system is used in streets where the aesthetic impact of simple catenary construction is deemed to be unacceptable.

A fixed termination contact wire system is used in the yard and shop.

A fixed termination simple catenary system is used in sections of the tunnel.

In street, the single contact wire system is supplemented by along-track paralleling feeders. The feeders are insulated cables installed in raceways and are connected to the contact wire at approximately equal intervals.

Simple catenary is supported and registered by means of hinged cantilevers attached to steel poles located between the tracks wherever possible. At special locations, such as track crossovers and turnouts, cantilevers mounted on poles located on the outer sides of the track or attached to cross-span wire arrangements support the catenary system. The system in the streets is supported and registered by means of cantilevers and cross-span wires.

4.00.00 TRANSPORTATION OPERATIONS

This chapter describes the activities required to provide passenger service according to the Operating Plan for start-up year 2004. (Refer to Chapter 2.) Following the description of normal operations is a discussion of yard operations, terminal operations, special event operations, abnormal operations and strategies to minimize service disruptions and protect the safety of passengers and employees. A list of Standard Operating Procedures is included as Appendix C.

4.01.00 NORMAL OPERATIONS

A description of normal LRT operations encompasses system opening, revenue service, system closing and Rail Control Center operations. Each of these aspects of the Metro Transit Hiawatha system is generally described in the sections that follow.

4.01.01 Daily Train Operations

Daily train operation falls into three phases: system opening, revenue service, and system closing.

System Opening

Prior to the start of revenue service, there are several activities which must be accomplished: operating staff report for duty, trains prepared for service, the alignment cleared of work crews and equipment, traction power confirmed available, and trains introduced into service.

Staff Reporting

Prior to the start of service and/or their individual shift assignments, all Train Operators reporting to duty, including those assigned to relief duty, will report to the operations sign-up area located on the 3rd floor of the Light Rail O & M facility. Personnel will then obtain all operating directives, notices and bulletins and be briefed on any problems or special needs. There they will sign in certifying that they are fit for duty and that they have read, understand, and have copies of all required rule books, manuals, and notices. Train Operators will also be issued equipment (e.g., portable radio, keys, and defect cards) and the Rail Control Center Supervisor will inform Train Operators of their train number and its location in the yard and issue equipment (portable radios, keys, defect forms, etc.). A qualified Rail Transit Supervisor will determine that operations employees are properly dressed and fit for duty. The Rail Control Center Supervisor, with access to crew schedules, vehicle availability, and maintenance data will be responsible for recording the arrival times of personnel, supervising unassigned extra-board Train Operators and, as necessary, assigning extra-board personnel to fulfill the duties of absent staff. To cover other staff absences, the Rail Control Center Supervisor will contact on-call personnel and request them to report in.

Train Preparation

Trains will be prepared and assigned to runs by the Rail Control Center Supervisor based on data supplied by the Vehicle Maintenance department. In advance of staff report time, Vehicle Maintenance personnel (qualified to do so) will prepare, make up, and position the required number of trains for revenue service. Upon reporting for duty and receiving assignment, each Train Operator will inspect the exterior and interior for cleanliness, vandalism, or defects; and report any noted deficiencies. Train Operators will also perform various pre-departure inspections and tests. The Train Operator will then move the train in order to test the brakes and other equipment for proper functioning in accordance with the Metro Transit LRT pre-departure checklist. (Train preparation is described more fully below under Yard Operations, 4.02.00.)

Wayside Preparation

The Rail Control Center Supervisor will ensure that power is on and will initiate a response to any deficiencies or problems. Power start-up will be coordinated with maintenance crews working along the right-of-way. If any personnel or equipment is still on the mainline tracks, the Rail Control Center Supervisor will instruct personnel to remove the equipment or initiate alternative operating strategies.

Introduction of Trains into Revenue Service

Following their preparation for revenue service, Train Operators will request permission from the Rail Control Center to move the trains through the yard and onto the mainline (refer to section 4.02.00). The Rail Control Center Supervisor will be responsible for dispatching trains according to scheduled departure times. Revenue service will be provided whenever feasible to minimize deadheading.

Revenue Service

Normal train service on the Hiawatha LRT system will be provided according to established operating timetables (Appendix C). The normal direction of traffic will be on the right-hand track in the direction of travel, and all trains will stop at all stations along their scheduled routes.

Relief procedures will be established for shift changes. A specific relief point will be designated along the line at a location which provides necessary conveniences and which is accessible. Preliminary operating schedules for service in start-up year 2004 are included in Appendix C. These schedules were based on the assumptions regarding routes and fleet requirements identified in Chapter 2.

System Closing

At the close of revenue operations, several activities will need to be accomplished: passengers informed, trains removed from service and stored, staff must check out, and the system configured for non-revenue service activities.

Passenger Announcements

At a reasonable time before system closing, Train Operators will use the PA system to alert patrons to the scheduled end of LRT operations. Announcements will be made periodically on each train. System closing information will also be presented on the variable message signs located at each station.

Train Removal

All trains leaving revenue service will make a final stop at either Cedar/Riverside Station (southbound trains) or at Franklin Station (northbound trains), and the Train Operator will walk through the passenger compartments to make sure that all passengers have disembarked. Trains will then be taken to the yard to be made ready for service the next morning. Train operators will enter the rail yard on the run-around track and proceed to the meet-and-greet location near the car wash facility. At the meet-and-greet location, maintenance personnel will relieve the train operator and take the train to the proper storage track based on servicing and maintenance requirements (refer to section 4.03.00). Train Operators will fill out defect cards noting any defects or operating problems experienced and leave them with the Maintenance Department.

Staff Checkout

At the end of their shifts, all operating personnel will report back to the location from which they received their shift assignment, sign-out, and return all equipment that was issued to them at the beginning of their assignment.

Non-Service Hours

Non-revenue service hours will provide time for track and wayside maintenance activities that is not interrupted by scheduled revenue operations. These activities may require the removal of power from some sections of the track. The Rail Control Center Supervisor will monitor and coordinate with maintenance crews working along the main line.

4.01.02 Rail Control Operations

All mainline and yard operations will be performed under the authority and direction of the Rail Control Center Supervisor in accordance with established rules, procedures, and operating timetables. The Rail Control Center Supervisor will direct all operations from the Rail Control Center using the communications links and equipment described in Chapter 3.

Rail Control Center will be staffed 24-hours a day, seven days a week. During the AM and

PM peak periods, the facility will be staffed by two Rail Control Center Supervisors. One Rail Control Center Supervisor will be responsible for mainline operations and the other will be responsible for operations within the yard and yard leads; coordination with Transportation, Vehicle Maintenance and Facilities Maintenance personnel; monitoring of security/fire alarms; and communications with outside agencies (i.e., Police, Fire, MnDOT). During the mid-day, night shift and on weekends, one Rail Control Center Supervisor will be on duty. Transit Supervisors along the mainline and in the yard will support the Rail Control during all shifts. Rail Control Center functions during the break and lunch periods will be covered by qualified supervisory staff.

Rail Control Center Supervisors will be responsible for the movement of all rail vehicles on the LRT system. All yard movements by Train Operators or maintenance personnel will be monitored by the Rail Control Center Supervisor. Rail Control Center Supervisors will monitor equipment intrusion devices, respond to emergency telephone calls, and system alarms. Rail Control Center Supervisors also may direct Train Operators to relay pertinent information to passengers aboard trains.

Rail Control Center Supervisors will respond to emergencies reported by the radio, telephone, alarm monitoring system, or other sources by directing Train Operators and field personnel. When there is a disruption to the service, the Rail Control Center Supervisors will be responsible for implementing emergency procedures, described in section 4.05.00, depending on the nature of the problem.

4.02.00 YARD OPERATIONS

Within the yard, revenue and non-revenue train movements will be conducted with manual operations and will proceed in the forward direction. This is made possible by the provision of a loop (run-around) track that encircles the storage tracks. Yard speed is limited to a maximum of 10 mph within yard limits and 5mph over switches.

Revenue vehicle operations will include movements from the yard to the mainline (i.e., pull-outs) and movements from the mainline to the yard (i.e., pull-ins). Pullout and pull-in movements are described in the following sections for a typical weekday, based on preliminary schedules prepared for the start-up year 2004 operating plan.

Service and maintenance operations will include movements from the yard to the car-cleaning track, inspection/scheduled maintenance tracks, and major repair tracks. Train movements between the storage tracks and shop tracks will be directed by Vehicle Maintenance and monitored by the Rail Control Center.

Yard operating rules have been established to assure safety in the yard and shop area. These include "blue flag" rules to prevent trains from being moved/coupled while work is being performed in the yard/storage tracks.

4.02.01 Yard Operation Responsibility

Responsibility for LRV operations within the yard will be conducted by the Transportation (yard and mainline tracks) and Vehicle Maintenance (within the shop area) departments. Rail Control Center will monitor all LRV movements on the mainline and in the yard. LRV movements within the shop will be directed by Vehicle Maintenance staff.

Rail Control Center

All mainline operations will be performed under the authority and direction of the Rail Control Center Supervisor in accordance with established rules, procedures, and operating timetables. Yard operations will be coordinated with the Rail Control Center. The Rail Control Center Supervisor will monitor all operations from the Rail Control Center to LRVs and ground personnel using voice communications (i.e., radio) provided in the LRV cab or portable equipment, respectively. Rail Control Center will assume the following responsibilities related to yard operations:

- Monitors and coordinates all train movements within the yard.
- Controls and monitors all traction power substation equipment and motor-operated disconnect switches.
- Coordinates power start-up with Facilities and Vehicle Maintenance Departments, as necessary.
- Authorizes all inbound/outbound moves to/from yard run-around tracks and mainline tracks.
- Monitors train movement from mainline tracks to yard storage.

The Rail Control Center will implement a contingency plan in the event that there are an insufficient number of trains to satisfy the operating schedule. The contingency plan will include: (1) requesting the Vehicle Maintenance department to defer non-vital maintenance on some vehicles; (2) decreasing the number of vehicles in some trains; and (3) increasing headways during some time periods to reduce the total required number of vehicles.

Transit Supervisor

Transit Supervisors will assume the following responsibilities related to yard operations:

- Monitors yard and field operations as directed and supports Rail Control Center efforts.
- Provides on-site direction to Train Operators.
- Operates track switches as required for the AM and PM pullout operations.

- Operates trains or other vehicles when directed by the Rail Control Center.

- Maintains communication with the Rail Control Center, Train Operators, and the transportation and maintenance offices.

Rail Control Center Supervisor

Trains will be assigned to runs by the Rail Control Center Supervisor based on data supplied by the Vehicle Maintenance department. The Rail Control Center Supervisor will inform Train Operators of the number and location of their assigned trains, assign equipment and forms, and will advise yard/relief operators of their duty assignments.

- Receives documents and updates the daily car assignment information.

- Prepares car assignment lists for pull-in and pullout operations, compatible with operating schedules and Daily Vehicle Maintenance Plan, containing current information including location of all trains.

- Verifies and documents times of operators reporting for duty.

- Issues required equipment to reporting train operators.

- Receives previously issued equipment from train operator's checking-out at completion of run or pull-in of train.

- In the event there are insufficient trains or vehicles to satisfy the operating schedule, the Rail Control Center Manager will assist Rail Control Center Supervisors in developing and implementing a contingency plan.

Train Operators

Prior to the start of service and/or their individual shift assignments, Train Operators will report to the operations sign-up area. Personnel will then be informed of pertinent notices and bulletins and be briefed on any problems or special needs. A Rail Control Center Supervisor will inform Train Operators of their train number and its location in the yard and issue forms and equipment.

The Train Operator will, prior to pullout time, perform:

- Sign employee sign-in log, receives special bulletins and any required orders.

- Receive required equipment and forms from Rail Control Center Supervisor.

- Be informed by Rail Control Center Supervisor of the specific vehicle(s) assigned to run and their location in the yard.

The Train Operator then reports to the assigned vehicle(s) in the yard. Prior to being given

clearance for revenue service the Train Operator performs the following tasks:

- Conducts prescribed pre-departure inspection and tests.
- Operates train on yard run-around track according to schedule timetable, and requests permission from the Rail Control Center Supervisor to proceed to mainline track.
- Acknowledges and follows the Rail Control Center Supervisor/on-site Transit Supervisor instructions.
- If instructed to proceed to mainline, proceeds to either the Cedar-Riverside Station or the Franklin Station and begins revenue operation.

If an equipment failure is identified during the operational pre-departure test, the Train Operator will report the problem to Rail Control Center. If the problem will not affect safety or service levels, the Rail Control Center Supervisor may complete a defect report form. If the problem is more severe, the Rail Control Center Supervisor will coordinate with Vehicle Maintenance to arrange for the failed vehicle(s) to be moved to the shop or to a storage track to await maintenance. In this event, a replacement vehicle or train will immediately be moved into place, inspected and readied for service departure.

Vehicle Maintenance Personnel

Qualified Vehicle Maintenance personnel will prepare, make up, and position the required number of trains for revenue service. Vehicle Maintenance personnel will assemble the trains accordingly and position them in the yard in the order of departure priority. Prior to revenue service each day, the Vehicle Maintenance department will prepare a vehicle plan that identifies the LRVs available for service along with pertinent maintenance information on each vehicle (i.e., information that would affect coupling placement, non-safety equipment failures, etc.); vehicles available as operational spares; and those remaining for repair. Vehicle Maintenance personnel will perform the following tasks:

- Participate in power start-up and shutdown as directed by the Rail Control Center.
- Meet incoming revenue trains at designated meet-and-greet location, determines operability of LRVs , and directs trains to appropriate storage track
- Prepare a Daily Vehicle Maintenance Plan that categorizes trains according to current operating status, and indicates the current location of all trains in the yard and shop. Trains are documented as to their availability for revenue service including spares, trains scheduled for inspection, defective trains, trains being held from revenue service, and trains with movement or other equipment restrictions.

- Properly makeup and position trains for revenue operation, which includes the operation of track switches and subsequent movement of vehicle(s) from yard storage tracks through washing and maintenance cycles as required, and placement on storage tracks.

4.02.02 Yard to Mainline Operations (Pull-Outs)

After each train is prepared and positioned for departure, the Train Operators will move the vehicles from the storage yard to the yard run-around and onto the mainline upon authorization from Rail Control Center. The strategy to be followed for safe and efficient yard pullout operations includes the following:

- Vehicle maintenance will cut or add available cars to provide train consists consistent with schedule requirements. These cuts and adds will be made in the yard prior to assignment of trains to Train Operators by the Rail Control Center Supervisor.

- The AM pullout operation (i.e., 04:00 – 07:00 AM) will be monitored from the yard by a Transit Supervisor.

- Normal operation for train pullouts will be to operate trains from yard storage tracks to yard run-around tracks to mainline tracks.

4.02.03 Weekday Pull-In Operations

At the end of their scheduled revenue service, all trains will be brought back to the yard. Trains will be directed to the designated meet-and-greet location. A strategy to be followed for safe and efficient yard pull-in operations includes the following:

- Incoming trains will be met at meet-and-greet location by Vehicle Maintenance personnel, who will take the train to the wash track, over the inspection pit, and if necessary place it on the maintenance track for repairs, returning it to the appropriate storage track.

- Vehicle Maintenance personnel will operate track switches as required for scheduled pull-in operations. In the absence of Vehicle Maintenance personnel, the Rail Control Center will direct Train Operators as to the proper placement of their trains and operate track switches, as necessary.

- Normal operation for pull-ins will be to operate trains on the yard track designated by the Rail Control Center to the meet-and-greet location.

- Defective cars and other cars scheduled for placement into Vehicle Maintenance shop will be stored on designated tracks in the order of their anticipated entry into the shop.

4.03.00 TERMINAL OPERATIONS

The Hiawatha Corridor LRT system will have two end of line terminals and two stations located near the rail yard, which will be the starting and ending points for all trains in revenue service. The two end of line terminals are located at Warehouse (downtown Minneapolis) and the Mall of America. The remaining two stations are used as revenue start locations for trains departing the rail yard and are located at Cedar-Riverside and Franklin. On average, trains will have scheduled layovers of about 6 - 13 minutes at the terminals, depending on the route and time of day (refer to Appendix G for preliminary weekday train schedules and projected train activity at terminals). For Phase 1A, terminal operations will be at Warehouse and Fort Snelling stations.

4.03.01 Terminal Operation Responsibility

Responsibility for terminal operations will be assigned to the Transportation Department. The Rail Control Center will monitor all LRV movements in the field, including terminal operations. Transit Supervisors will be stationed at terminals periodically, as described below. Facilities Maintenance personnel will be responsible for maintaining track and terminal facilities.

Rail Control Center

All terminal operations will be performed under the authority and direction of the Rail Control Center Supervisor in accordance with established rules, procedures, and operating timetables. The Rail Control Center Supervisor will monitor all operations from the Rail Control Center and communicate with Train Operators and field personnel using voice communications provided in the LRV cab, portable equipment, or telephones. The Rail Control Center will assume the following responsibilities related to field operations at terminals:

- Monitors all LRT field operations, including terminals.
- Controls and monitors all traction power substation equipment and motor operated disconnect switches.
- Monitors train arrivals and departures from terminals and communicates necessary adjustments of schedules to Train Operators and field personnel.
- Dispatches Transit Supervisors, Maintenance and other Metro Transit personnel to terminals and other locations to maintain or restore service.
- Dispatches trains from terminals, when necessary.
- Assists Train Operators and other personnel with trouble shooting procedures.
- Makes proper service delay announcements to passengers at stations via Public

Address (PA) and Variable Message Signs (VMS).

- Notifies emergency response agencies when necessary.

- Authorizes abnormal or emergency operating procedures when necessary.

In addition to the above listed responsibilities, the Rail Control Center Supervisor documents and provides guidance to Metro Transit personnel and others upon being notified of the following circumstances:

- Relief train operator does not show up
- Defective vehicle or equipment
- Blockages, delays or service interruptions
- Unsafe conditions
- Metro Transit LRT involvement in collisions/incidents
- Collisions between Metro Transit LRT vehicles
- All collisions/incidents in which a person is injured
- Metro Transit LRT involvement in pedestrian incidents
- Incidents involving arrests or police action
- Fires or other emergencies involving Metro Transit LRT vehicles or Metro Transit LRT property
- Other circumstances in which the person reporting is in doubt as to the proper procedure to follow

Transit Supervisor

Transit Supervisors are responsible for supporting the Rail Control Center in the maintenance of service by resolving incidents/emergencies in the field at terminal locations. Transit Supervisors will be assigned to cover various terminals during peak periods and at other times, as necessary. Transit Supervisors responsibilities relative to terminal operations include the following:

- Maintains voice communication with the Rail Control Center at all times.

- Checks the adherence of trains to schedule, makes adjustments, and takes necessary steps to prevent or clear a service disruption.

- Uses troubleshooting techniques to move trains and utilizes restoration of service techniques to handle delays and restore service.

- Operates or moves trains in emergencies or when directed to do so by Rail Control Center Supervisor.

- Assists in loading and unloading of trains and control of passengers.

- Observes operations to detect violations of rules, verifies proper reliefs, informs

operations personnel if non-standard practices are observed and prepares violation slips.

- Interfaces with police, fire, municipal departments, Metro Transit Bus Operations, utility companies and the general public.
- When requested, monitors the flow of passenger traffic for special event operations.
- Informs Train Operators of unsafe or unusual conditions that may affect their operation.
- Operates track switches as directed in abnormal or emergency operations.

Train Operator

The general sequence of events for one or two-car trains at terminal stations which require the Train Operator to reverse direction (i.e., change cabs) are as follows:

1. Announce to passengers that the train is approaching the final station and notify them to exit the train at the station.
2. The SCADA system will automatically select route into the station (i.e., right or left-hand track) and set crossover switch.
3. Proceed to station platform. Stop the train at the appropriate berthing mark.
4. Release all doors for passengers on the train to alight and for waiting passengers to board.
5. Turn console key to "OFF" position.
6. Assure that the headlight is off and set the rear marker lights.
7. Set all other controls to the proper position and secure the cab area.
8. Board the lead cab of the train, turn the console key to "ON", activate other console controls, set destination signs, and assure that the headlight is illuminated.
9. Inform the Rail Control Center of readiness to depart via radio communications.
10. Shortly before departure, announce the departure and destination of the train to passengers on the train.
11. The SCADA system will automatically select route from the station and set crossover switch.

12. Depart at the scheduled time.

4.03.02 Revenue Vehicle Operations

Train movement into and out of each terminal will be by switch movements, switch position indicators, and voice communications. Train operation will be "on sight" by Train Operators. The term "on sight" means within range of vision. Changes in range of vision must be anticipated by the Train Operators. Trains crossing over from one track to the other will have to slow to the design speed of the turnout. Arrivals and departures are by timetable. Normal operation does not require the presence of supervisory personnel at any terminal, but a high level of supervision is recommended, particularly for AM and PM peak periods.

As trains approach each terminal, the SCADA system will select the route into the proper platform or layover track. Under normal operating conditions, track switches will be set automatically by the SCADA system and trains will pass through the switch without stopping. Terminal route selection can be programmed based on operating schedules. Because trains are subject to delays, the SCADA system is capable of detecting trains that occupy the platform or layover track and rerouting arriving trains to an unoccupied track. The estimated run times and preliminary weekday train schedules assume that switches will be set by the SCADA system, thereby minimizing delays at terminals.

Alternatively, the Train Operator approaching the terminal station must stop before the indicator signal and observe that the track on the indicated route is clear and the switch points are properly lined. If the switch points are properly aligned, the Train Operator proceeds into the proper platform or layover track. If the switch points are not properly aligned, the Train Operator will notify the Rail Control Center. After proper authorization is received from the Rail Control Center, the Train Operator activates the switch by TWC (Train Wayside Control) to the proper position, and then proceeds to the proper platform or layover track. The estimated run times and preliminary weekday train schedules do not account for the additional delay time necessitated by manual activation of terminal switches.

Alternative routing schemes for terminal stations with diamond crossovers and terminals with layover tracks are described below.

Routing Schemes for Terminal Stations with Crossovers

Three possible routing schemes are possible at the two terminal stations, which have diamond crossovers located prior to the station: Warehouse Station and the Mall of America Station. The SCADA system will select the route into the proper platform track. The three routing schemes at terminal stations are:

1. Mode 1 - The inbound train crosses over to the left-hand track, and departs outbound in a straight move. Mode 1 is the normal mode of operation at terminals served by just one route. This assures that there are no conflicts when the train departs.

2. Mode 2 - Inbound trains are routed to each platform track in alternate sequence (e.g., Train 1 - right-hand track; Train 2 - left-hand track; etc.). This routing scheme must be activated whenever more than one train is scheduled in a terminal at the same time.

3. Mode 3 - The inbound train arrives straight into the station on the right-hand track and departs by crossing to the outbound track.

It may be necessary to change the terminal route selection at certain times of the day, reflecting changes in train routing and frequency of service.

4.03.03 Normal Terminal Operations

Normal terminal operations are described for each end of the line terminal based on preliminary weekday schedules prepared for the start-up year 2004 operating plan. Train activity at each terminal, based on the preliminary schedules, is appended (Appendix G).

Warehouse Station

Description The Warehouse terminal is comprised of a center platform station and a crossover located south of the station, between Hennepin Avenue and Nicollet Mall. Two tracks continue south of station to the Nicollet Mall Station.

Operating Plan/Preliminary Schedules The Hiawatha Corridor LRT route terminates at the Warehouse Station, with trains running every 7.5 minutes during peak periods, 10 minutes during the midday, 15.0 minutes during the early evening periods, and 30 minutes during the late evening period. Based on the preliminary weekday schedules (appended), layover times will vary from 3 to 13 minutes. Unless train arrivals and departures deviate from the preliminary schedules, during some times of the day both tracks at the platform will be occupied.

Normal Operation When a northbound train approaches the crossover, the track switches line up to route the train into an unoccupied platform track. Except when the left hand track is occupied, the Mode 1 scheme will be implemented, and arriving trains will be routed to the left (or southwest side) track of the station. However, if the left hand track is occupied, the arriving train will operate under Mode 3, and will be routed to the right hand platform track. If both tracks are occupied, the arriving train will be held south of the crossover until a platform track becomes available.

To avoid conflict with an arriving train, departing trains will normally be routed straight out of the terminal on the southbound track. Before a southbound train departs the station, the track switches for the crossover are lined to route the train to continue along the southbound (right-hand) track. When both platform tracks of the station are occupied, trains will normally depart on a "first-in/first-out" basis (not scheduled to occur and will only occur under unusual conditions).

Mall of America Station

Description The Mall of America terminal is comprised of an at-grade center platform station, crossovers are located south of the station.

Normal Operation When a southbound train approaches the crossovers, the track switches line up to route the train into an unoccupied platform track. During early morning, AM peak, midday and late evening periods, the Mode 1 scheme will be implemented and arriving southbound trains will be routed to the left (southside) track of the station. However, if the left hand track is occupied (during peak periods), the arriving train will operate under Mode 3 scheme, and will be routed to the right hand platform track.

To avoid conflict with an arriving train, departing trains will normally be routed straight out of the terminal on the northbound track. Before a northbound train departs the station, the track switches for the crossovers are lined to route the train to continue along the northbound (right-hand) track. When both platform tracks of the station are occupied, trains will normally depart on a "first-in/first-out" basis.

4.03.04 Unusual Terminal Operations

Train movement and train operation at terminals under unusual or emergency operating conditions will be under the authority of the Rail Control Center or a Transit Supervisor at the terminal. Unusual train moves and train operation may include the following:

- Routing a train to an occupied track.
- Means for reverse running in an emergency.
- Means for manually operating switches in event of malfunction.
- Temporarily storing disabled trains in pocket track located south of the Fort Snelling Station.
- Temporarily storing special event trains in the pocket track noted above.

4.03.05 Terminal Staffing Requirements

Transit Supervisors will monitor the Hiawatha Corridor LRT system or be assigned to key locations, including terminals, providing on-site supervision of terminal and train operations and field response to abnormal events affecting operations. In response to anticipated delays caused by traffic congestion and other factors that affect schedule reliability, a high level of on-site supervision is planned.

4.04.00 SPECIAL EVENT OPERATIONS

4.04.01 Venues and Event Types

The Hiawatha Corridor LRT system will serve two venues that will require special event operations: (1) Metrodome events; and (2) Mall of America (MOA) seasonal service (Thanksgiving to Christmas). The following sections describe key assumptions regarding ridership demand, peaking characteristics, loading standards and event conditions; a description of the proposed operating pattern (i.e., routes, headways) for each event condition scenario; identification of storage areas and estimated "deadhead" time/distance for Metrodome events.

Metrodome

The Metrodome hosts both professional and college sporting events (i.e., Vikings and UM football and Twins baseball). The seating capacity of the Metrodome is assumed to be about 64,000 seats. The special event-operating plan is based on a "full" event at the Metrodome. It is assumed that about 20% of the event attendees would take transit, of which 75% would take the Hiawatha Corridor LRT and the remaining 25% would take Metro bus services. The special event LRT operating plan would have to accommodate a total of about 3,2002 riders arriving/departing the Metrodome. The assumed goal is to move all persons within 60 minutes after a Metrodome event.

Mall of America

The Mall of America, one of the largest Malls in America, is not only an attraction to the local community but is known by avid shoppers throughout America. During the Holiday season (Thanksgiving to Christmas) shoppers from across America converge upon the Mall of America. Visitors from outside the Minneapolis region are known to fly in just to shop for the day or weekend. To serve the peak travel demands of these visiting shoppers, Metro Transit historically has operated special Airport to Mall of America shuttle bus service. This bus shuttle service will be replaced by the implementation of LRT service between the Airport and the Mall of America. Ridership characteristics experienced in previous years support the need to operate a higher level of rail service (increased frequency) than would be normally operated throughout the day and on weekends. The additional rail service would operate between the Fort Snelling Station (utilizing the crossover and pocket track south of the station) and the Mall of America. The additional LRT service would be scheduled between the regular service resulting in an evenly spaced (improved) headway between the Fort Snelling Station and the Mall of America.

4.04.02 Physical and Operating Constraints

Fleet Size

In opening year 2004 the total fleet size is projected to be 24 LRVs (refer to section 2.07.03). Based on the LRT operating plan, a maximum of 22 peak cars will be operated in regularly scheduled service. Should an event occur during weekday peak periods, equipment could be reallocated from scheduled service to special event routes based on defined Metro Transit LRT Operating Policy.

Special events which occur during base period service hours (6:00 - 6:40 AM, 9:30 AM – 3:30 PM) would have a maximum of 6 LRVs (18 LRVs required for base period service operations) available for supplementary LRT service. During early evening and late evening, 12 and 18 LRVs respectively, would be available for special event operations. On weekends, generally when the Mall of America supplemental rail shuttle service would be operated, 6 (base period), 12 (evening) and 18 (late evening) LRVs maximum would be available for special rail shuttle operations.

Storage Tracks

Tracks for the temporary storage (pocket tracks) of special event trains are located south of the Fort Snelling Station. The pocket track is designed to accommodate up to three LRVs or one three-car train.

Station Design

Station design will affect special event operations. With the exception of Lindbergh and Lake Street station which can only accommodate one, 2-car train per platform. The Downtown East station (Metrodome) is designed as a side platform station, 12' wide by 200' long. The Mall of America station is designed as an at-grade center platform station, 24' wide by 300' long.

Vehicle Loading

The 130-passenger/LRV loading standard (66 seated + 64 standing) has been used to plan the frequency of service and train size for normal scheduled operations. Regularly scheduled rail service is designed around peak hour peak direction (PHPD) ridership demand (Metropolitan Council – August 1998), some trains may experience higher loads. Due to the highly peaked demand characteristics associated with special events, a higher vehicle loading will be used to plan for special event operations (66 seated + 124 standing = 190 passengers per LRV).

4.04.03 Operating Strategies

Rail Operations for the Hiawatha LRT system will be governed by Standard Operating Procedures (SOPs) which have been developed to outline service delivery during normal and emergency situations.

Metro Transit Rail SOPs, updated June 2004, went into effect on June 7, 2004, to coincide with the commencement of pre-revenue service.

5.00.00 LRV AND SYSTEMS MAINTENANCE

Vehicle Maintenance is responsible for making available to the Transportation department, on a timely basis the equipment necessary to operate the Rail System safely, efficiently, and economically. Controlled maintenance over the life of a system is economical; conducive to lower operating costs, and contributes to an increased availability of facilities and equipment. The primary objectives of a controlled maintenance program are to:

- Maximize the safety, comfort, and convenience of passengers and employees
- Protect property and equipment
- Minimize system downtime
- Minimize operating costs

5.00.01 Yard Description

The yard is the point of origin and termination for all mainline operations. Yard functions include vehicle storage, shop support, and routine vehicle cleaning. All rail vehicle movements within the yard will be made on radio direction from the Rail Control Center. The yard is designed to accommodate the storage of 24 LRVs. The yard also contains a Maintenance-of-Way building, Shop/Administration building, employee/visitor parking.

5.00.02 Shop Description

The building contains the equipment and facilities necessary for servicing, inspection and repair of rail vehicles. The maintenance shop is designed to provide car and subsystem maintenance, repairs, component change outs and body repair. Inspection and scheduled maintenance functions will be performed on separate tracks from heavy maintenance activities, which tend to require a much longer period of time to complete.

5.01.00 REVENUE VEHICLE MAINTENANCE

The Rail Vehicle Maintenance Department is responsible for making available the equipment necessary to successfully operate the Hiawatha Corridor Light Rail System safely, efficiently and economically. Scheduled vehicle maintenance over the life of the system is conducive to lower operating costs and increased availability of rail vehicles. Rail Vehicle Maintenance is currently working with the LRV manufacturer, Bombardier, to determine the most effective and efficient maintenance program for the vehicles.

Each LRV is scheduled to accumulate approximately 6,500 miles per month and 78,000 miles per year. The maintenance plan for this type of operation must incorporate:

- Service and Cleaning
- Preventative Maintenance Program
- Component Repair and Rebuild

Under direction, the maintenance department will perform scheduled inspections and repair and overhaul of the car interior, exterior and under car. Additional evaluation of electronically monitored sub-systems will also be performed. Operator defect cards will be reviewed and appropriate action taken.

5.01.01 Service and Cleaning

Daily service will include interior and exterior cleaning, such as sweeping, graffiti removal, damaged seat replacement, window cover replacement and sand replacement. On a scheduled basis, a more detailed cleaning of the car will be performed. Metro Transit Rail Division will continue the high standard established by the Bus Division for interior and exterior vehicle appearance.

5.01.02 Preventative Maintenance Program (PM)

The PM program consists of inspection, cleaning, lubrication and servicing which are scheduled and performed at specific intervals. The objective of this PM program will be to maximize passenger safety and to reduce service failures. Benefits from such a program will include prolonged equipment life, operational safety and system dependability, and minimized maintenance costs. The manufacturer's suggested preventive maintenance plan will be analyzed and adjusted to local requirements.

Safety inspections will consist of interior, exterior and under-car inspection for safety defects and ADA requirements. Inspections will focus on but are not limited to stored fault codes, entire brake system, sanding system, seats, stanchions, lighting, signs, doors, ADA required items, and pantograph.

Safety, A, B, C & D Inspections: Progressively more comprehensive inspections. Each inspection time shall have defect (PMDs) repair time added to required hours.

Inspection Series/Type	Schedule	Estimated Time
Safety	5,000 miles	7 hours
A	15,000 miles	32 hours
B	25,000 miles	89 hours
C	50,000 miles	132 hours
D	100,000 miles	156 hours

In addition, there will be running repair work generated from operator defect cards and abnormal component failure.

5.01.03 Component Repair and Rebuild

At established intervals, vehicles will be inspected and overhauled. Components requiring overhaul will be removed and replaced with service ready units. Unit removal and replacement will be scheduled to require the LRV to be out of service for the shortest period of time. From established past practice, the repair and rebuild time should be limited to one week. Component overhaul will include but is not limited to the following: Prolusion, HVAC, Truck Assembly, Door System, Couplers, Brake System, Pantograph, Communication Equipment and Electronic Components.

In addition, car body overhaul and repair will be required. Car body and re-paint repair programs will be established as the system develops. Usually this occurs at the ten-year interval and requires the car to be out of service for up to four weeks. Adequate replacement vehicles must be available for this task.

Ovh 1.0	240,000 miles, 105 hrs shop / 105 hrs component room
Ovh 1.1	720,000 miles, 175 hrs shop / 350 hrs component room
Ovh 2.0	480,000 miles, 175 hrs shop / 470 hrs component room
Ovh 2.1	960,000 miles, 175 hrs shop / 525 hrs component room
Ovh 3.0	Car repaint 10 yr interval, 525 hrs

One additional function of the component overhaul and repair shop will be the rebuild of component failures that occur between scheduled overhauls.

Scheduled maintenance is performed to keep vehicles clean, aesthetically pleasing and maintained in proper working order to prevent in-service failures. Components will be overhauled on schedules driven by known failure rates and life cycle expectations. Standard rail transit industry standard vehicle inspections are performed according to mileage accumulation. Rail vehicles represent a major capital investment that require meticulous maintenance at prescribed intervals, in order to maximize service life of the fleet, and thereby reduce capital and operating expenditures into future years.

5.01.04Tools and Equipment

Specific tooling requirements have been selected and are partially listed below.

Shop Tools and Equipment

- Wheel truing lathe
- Machine lathes
- In-floor Hoist
- Portable jacks
- Welding equipment
- Body & structural repair equipment
- Paint spray booth
- Electronic test equipment

- Band saw
- Central vacuum system
- Truck turntables
- Truck repair stand
- 71/2 ton overhead crane
- 2-ton overhead crane
- 2-ton jib crane
- Lathe
- Paint booth Man lifts

5.02.00 NON-REVENUE VEHICLE MAINTENANCE

A number of non-revenue vehicles will be required for the maintenance and support of the rail system. Some of this equipment is very specialized (e.g., highway/rail vehicles are used for retrieving inoperable revenue vehicles, and inspection and repair of track, catenary and the signal system).In addition, other vehicles will be required to accommodate the daily movement of operations and maintenance personnel, material and equipment. Fueling and maintenance of service vehicles is completed at a bus garage. Service vehicles and equipment that will be needed for LRT system operations include:

- Tow and car mover
- Re-railing Equipment
- General Maintenance Utility Truck
- Automobiles/vans – Supervisory personnel
- Maintenance of Way vehicles

5.03.00 FACILITIES AND SYSTEMS MAINTENANCE

A goal of the Metro Transit LRT is to provide a clean, reliable and safe environment for passengers, employees and the general public. The objective will be to maintain these assets in optimum operating condition to ensure safety, reliability and cost-effectiveness. This will be achieved through keeping the assets operating optimally and in clean and attractive condition to reduce unnecessary and unbudgeted capital and operating costs. The result will be a high level of customer satisfaction, a cost-effective operation and improved quality of service.

A maintenance management system with appropriate staffing levels for related disciplines and clear definitions for in-house or contracted functions need to be developed as part of the overall maintenance strategy. A periodic review of contracted and in-house functions will be undertaken to ascertain cost efficiency, cycle time, customer inconvenience and future expansion. In addition, a facilities and systems maintenance plan should establish a preventive maintenance system, personnel training requirements, and a plan for a capital cost replacement program for equipment nearing life expectancy.

5.03.01 Stations

The Hiawatha Corridor LRT system will include 17 initial stations. The Design Criteria requires standardization of materials and equipment, which will improve maintainability, reduce parts inventory and repair costs, and facilitate future preventive maintenance programs.

Maintenance functions for stations include the following:

- Pick-up and disposal of garbage
- Clean and re-lamp light fixtures
- Remove graffiti
- Replace broken glass
- Clean platforms, benches, windbreaks, canopies and edge markers
- Replace/repair transit information boards, as required
- Repair/replace canopies, windbreaks, waste receptacles
- Ensure platform vertical edge markings are maintained on an established schedule
- Elevator maintenance
- Landscape Service
- Bus Berthing Facilities
- Operator Rest/Toilet Facilities

5.03.02 Yard and Shop

Maintenance functions required at the yard and shop include the following:

- Service emergency batteries
- Inspect fire alarm systems and batteries
- Maintain exterior doors and mechanisms
- Maintain circuit breakers, motors, and pumps
- General plumbing, maintain O/H reels and drainage
- General repairs to walls, cabinets, doors, etc., concrete repairs and small paint jobs (structural)
- Janitorial work in the yard, maintenance shop, and Operators building
- Vandalism/graffiti control
- Landscaping services
- Elevator maintenance
- Maintain ventilation, heating and air conditioning equipment including controls
- Provide maintenance services for fire protection (sprinklers and alarms)

As the design progresses, additional maintenance functions may be defined. These could include hoists (hydraulic), recycling programs, disposal of industrial wastes and designated substances. Hiawatha Corridor LRT staff may want to contract some of the above-listed maintenance services.

5.03.03 Track

Maintenance of track and right-of-way will require a skilled workforce. Authorization from Rail Control will be required before any work can be conducted on the track and right-of-way. All maintenance personnel will be required to be familiar with LRT system safety rules and procedures, and will be required to wear appropriate safety clothing (e.g., hard hat, work shoes, safety vest).

Train Operators will be notified of any required speed restrictions through bulletins, notices and flagging procedures. Flagging will be required for maintenance work (other than inspections being performed in the trackway during revenue service hours. Any maintenance work affecting vehicular traffic will be coordinated with the appropriate governmental agency (e.g., City of Minneapolis, Minnesota Department of Transportation).

Rail Systems personnel will perform track inspections and routine maintenance. Track inspections identify any defects such as worn rail, gauge deviation, elevation or alignment change, loose or damaged ties or fastenings or other defects. Train Operators on the sweep train will notify Rail Control of any apparent defects. Rail Control will, in turn, notify the Maintenance Supervisor. In addition, track maintainers will routinely inspect the track.

Rail systems personnel will perform routine preventive and corrective track maintenance functions and emergency repairs. Routine corrective maintenance and emergency repairs will be completed by Hiawatha Corridor LRT track maintainers and laborers. Routine repairs include repair of broken rails; spot repairs of defective welds, repair of insulated joints, spot tie replacement and minor repairs of turnouts. Major and specialized maintenance and replacement work performed on an irregular basis may be contracted, such as rail grinding, major rail replacement, turnout repairs, correction of surface, line and gauge over large sections of track and major welding repairs.

5.03.04 Traction Power

15 substations will supply the necessary traction power for the operation of this system. Maintenance of traction power facilities will require a skilled workforce to perform the following tasks:

- Test, calibrate, adjust and maintain relays/interlocking devices in substations
- Wire switchboards and perform trouble shooting as required
- Calibrate and adjust meters as required
- Check, test and maintain batteries
- Clean, maintain and replace defective parts in circuit breakers
- Maintain AC and DC breakers, rectifiers, transformers and associated auxiliary equipment

5.03.05 Overhead Catenary System

The overhead catenary system includes catenary, conductors and supports. Maintenance of the overhead catenary system will involve:

- Maintaining, inspecting and repairing overhead wire, tensioning system, fittings, feeder cables, conductors, jumpers, switches, spans, insulators, cross ties, cross arms, lightning arresters, crossovers, etc,
- Inspecting and maintaining (corrosion control) suspension poles

5.03.06 Communications

The following communications systems will need to be serviced and maintained:

- Portable radios
- Public address amplifiers and speakers, intercoms and security alarm systems
- SCADA system
- Telephones and inter-office communications systems
- Rail Control Center consoles
- Computer equipment
- Variable message signs (Passenger information)

5.03.07 Signal System

Maintenance requirements for the signal system, the method of communication linking the LRVs, Intersection Signal Controllers (ISCs) and the Rail Control Center through a Train to Wayside Communication system. Maintenance requirements include a Communication and Information System (CIS), which is implemented to ensure reliable and safe operations. Signal system maintenance functions include:

- Electrically operated track switches
- Intersection Signal Controllers (ISCs), associated equipment and circuits
- Hiawatha Corridor LRT signals
- CIS-type equipment on-board the LRV and at Rail Control

5.03.08 Fare Collection Equipment

Fare collection equipment will require regular maintenance and repair, either through Hiawatha Corridor LRT staff or through a service contract depending on the failure. The Hiawatha LRT staff will perform the initial inspection of the equipment and replace failed parts. If necessary the failed part will be sent to the contact service for repair.

5.04.00 MAINTENANCE OPERATING PROCEDURES

A Maintenance Standard Operating Procedures (SOP) manual has been developed containing detailed instructions for performing all aspects of revenue vehicle maintenance and facilities and systems maintenance. Maintenance SOPs will be updated by technical and training staff, and cover maintenance administration, shop, vehicles, parts, facilities, and safety. The index of maintenance SOPs for Hiawatha Corridor LRT Project is included in Appendix C ? of

this report.

5.04.01 Shop Procedures

Standard practice manuals, with detailed instructions for removal, repair, and installation of vehicle equipment, will be developed and updated by technical and training staff. Health and safety procedures also will be established and implemented. Expected items to be covered include:

- Conducting regular safety meetings
- Health issues (such as hazardous materials identification, handling and disposal) to be handled in compliance with Hiawatha Corridor LRT policy and governmental regulations
- Vehicle movement procedures for yard and shop
- Use of protective safety equipment
- Certification of selected employees in administering first aid
- Operation of shop equipment

In addition to Maintenance Standard Operating Procedures, the Hiawatha Corridor LRT will establish and implement procedures for yard and facility security.

5.04.02 Facilities and Systems Procedures

Standard practice manuals, with detailed instructions for repair and servicing of facilities and systems, will be updated by technical and training staff. Health and safety procedures include:

- Hiawatha Corridor LRT facilities and systems
- Procedures for working with high voltage equipment
- Procedures for operating Hi-rail and other non-revenue equipment
- Procedures for handling emergency conditions, such as downed power line
- Response to accidents, injuries and sudden illness at work

A computerized maintenance management system, (Txbase), has all pertinent operating information input on a database. This computerized system will issue work orders, and these work orders will be the key to effectively managing this maintenance system. The work orders will delineate scheduled and non-scheduled maintenance activities and will provide information on:

- Tasks to be accomplished
- Workforce budget process
- Equipment affected
- Date work performed
- Parts inventory
- Duration of work (labor hours/manpower)
- Tools and material required

This information will not only track the history of the equipment but will also be the link for

cost reporting and will help in defining future budget requirements.

5.04.03 Quality Assurance

A Quality Assurance Program Plan (QAPP) has been developed to ensure a systematic and coordinated process that verifies that all items of supply or work performed on the project is in accordance with established requirements, specifications, and standards.

The QAPP addresses the fifteen quality elements described in the Quality Assurance and Quality Control Guidelines for Federal Transit Administration (FTA) grantees who are undertaking design, construction, or equipment acquisition programs. These elements are as follows:

- Management responsibilities
- Documented Quality System
- Design control
- Document control
- Procurement control
- Product identification and tractability
- Process control
- Inspection and testing
- Inspection, measuring, and test equipment
- Inspection and test status
- Nonconformance
- Corrective actions
- Quality records
- Quality audits
- Training

5.04.04 Storeroom

Vehicle maintenance spare parts, supplies and equipment are stored in a secure area of the maintenance shop building. Storeroom personnel issue parts and stock during most shift operations in the maintenance shop. When storeroom personnel are not available, the maintenance shift supervisor is responsible for the issuing of parts and accurate documentation. Storeroom personnel duties include:

- Order replacement parts, supplies and equipment
- Supervise delivery
- Verify receipt of materials
- Warehouse materials in appropriate storage locations
- Distribute materials as needed
- Document inventory and usage

Facilities maintenance spare parts are stored in a secure area of the Maintenance and Shop Building. Bulk items will be stored in a designated outdoor storage area in the Yard

6.00.00 OPERATING & MAINTENANCE COSTS AND STAFFING REQUIREMENTS

This chapter presents LRT operating and maintenance (O&M) cost estimates and staffing estimates for the Hiawatha Corridor project for the following service years:

- ✓ 2004
- ✓ 2005
- ✓ 2006
- ✓ 2007

Annual O&M costs were estimated with a model developed for the PE / EIS. The model estimates the annual budget of a mature, post-warranty system to provide and sustain light rail services. The model estimates only operating costs; it excludes all expenses associated with capital project development, such as design engineering, construction management, testing and inspection.

This chapter begins with a brief description of the O&M cost-estimating methodology. Operating characteristics associated with each service plan are then presented, followed by the cost estimates. This chapter closes with a discussion of staffing. It should be noted that Rail Operations staff conducted a comprehensive analysis of existing LRT systems in the United States during the fall of 2002. This analysis led to several refinements in the Operations and Maintenance model based on industry best practices and updated to reflect manufacturer recommended maintenance programs for all systems and technology as deployed on the Hiawatha LRT system.

6.01.00 DESCRIPTION OF METHODOLOGY

The LRT cost model was developed based on actual financial and operating data for eight U.S. light rail systems, as reported in each agency's National Transit Database report to the FTA. The systems used as a basis for the O&M cost model are located in:

San Diego, CA	Portland, OR
St. Louis, MO	Sacramento, CA
Denver, CO	Dallas, TX
San Jose, CA	Baltimore, MD

The model has specific line item costs tabulated for each LRT cost center (e.g., vehicle operations, vehicle maintenance, systems maintenance, administration). Within each cost center line items are designated as labor, services, materials, utilities, fuel, taxes, insurance, and miscellaneous.

Specific line items are dedicated to unique labor positions, such as electro mechanic and train operator, and for unique non-labor expenses, such as traction power. Because they're modeled separately, line items are mutually exclusive and cover all operating costs. O&M costs are calculated from the quantity of service supplied and other system characteristics.

To reflect potential LRT costs in the region, the model uses METRO Transit's current annual average earnings for comparable job positions and fringe benefit rate of 50 percent,

information provided by METRO staff. The model also reflects METRO's allocation of labor overhead, based on the agency's FY 1996 National Transit Database report. The overhead allocation is intended to represent functions not directly associated with operations, such as marketing and customer services.

The LRT model uses a series of interactive tables in a spreadsheet that generates an O&M cost summary table. Other spreadsheet tables address input variables, non-labor unit costs, and individual line items. Again, the initial model developed in 1999 was adjusted and refined based on practical experience of the rail operations and maintenance team considering the actual technology and systems deployed on the Hiawatha Light Rail Transit System. In addition, the rail operations and management team successfully negotiated classification consolidation in all areas to establish a single classification per systems area (signals, track, traction power, LRV maintenance) setting the framework for an efficient, flexible and effective organization.

The development and analysis of Operations and Maintenance costs were further refined through an extensive benchmarking analysis which examined seven comparable light rail transit systems in December 2002.

6.02.00 ORGANIZATION STRUCTURE

The Hiawatha LRT line will be operated directly by Metro Transit through a light rail division, responsible for all rail transportation and maintenance functions. Several elements of the system will be contracted out to third parties such as track and elevator/escalator maintenance. The Assistant General Manager of Rail Operations, reporting to the General Manager, will oversee three departments: Rail Transportation, Rail Vehicle Maintenance, and Rail Systems Maintenance.

A functional organization chart as well as a responsibility matrix for all rail functions appear in Appendix D.

6.03.00 SYSTEM AND OPERATING CHARACTERISTICS

System and operating characteristics determine, directly or indirectly, the estimated costs for all line items in the model. Some labor and non-labor expenses are linked to secondary variables, such as total wages in a cost center. System and operating characteristics used to estimate O&M costs are as follows:

Peak Cars – The maximum number of LRVs in scheduled service.

Annual Revenue Car-Miles – The total vehicle-miles that are operated in revenue service, excluding deadhead mileage.

Annual Revenue Train-Hours – The total train-hours operated in revenue service, including end-of-line layover time but excluding report and deadhead time.

LRT Passenger Stations – The number of LRT passenger stations in the system.

Directional Route-Miles – The number of revenue track-miles, excluding yard and tail track. (One mile of double track equals two directional route-miles.)

Maintenance Facilities – The number of LRT maintenance and storage yards.

The system and operating characteristics in Chapter 2 were used to develop the Rail Operations and Maintenance budget from 2004 to 2007 (Appendix E).

6.04.00 STAFFING REQUIREMENTS

The O&M cost estimates presented in Appendix E are based on an assumed staffing plan (appendix F) that reflects the following organizational divisions:

Assistant General Manager
Rail Transportation
Rail Vehicle Maintenance
Rail Systems Maintenance
Metro Transit Police
Metro Transit Facilities and Support

The model uses labor classifications and productivity rates derived from actual staffing levels of comparable LRT systems. For each labor position, the number of full-time employees was calculated as a function of system characteristics (stations, route-miles) and service levels (peak vehicles, annual train-hours and car-miles). For example, the number of train operators was related to the estimated annual revenue train-hours.

APPENDIX A

TRANSPORTATION STANDARD OPERATING PROCEDURES LIST

100.0 GENERAL AND ADMINISTRATIVE

100.1	Rail System Standard Operating Procedures Development and Distribution Attachment AB
100.2	Distribution of and Revisions to the Rail System Rule Book
100.3	Responsibility for Rail Operations
100.4	Employee Becoming Ill or Injured
100.5	Qualifying for Rail / Hi-Rail Operation
100.6	Hi-Rail Equipped Vehicle Pre-Trip Inspection and Operation
100.7	Accident / Incident Reports
100.8	Work Zone Procedures (less than 30 minutes)
100.9	Stationary Work Zone (More than 30 minutes)
100.10	Rail Transit Safety Review Program (State Safety Oversight) and National Transportation Safety Board Reporting Requirements
100.11	Wayside Restrictions
100.12	Work Permit Procedures Work Permit Form
100.13	Rail Change Review Committee (RCRC)
100.14	Rail System Configuration Management

200.0 Passenger Relations

200.1	Courtesy to Passengers
200.2	Enforcing Metro Transit Regulations
200.3	Americans with Disabilities Act (ADA)
200.4	Lost and Found
200.5	Injured or Ill Passengers on Metro Transit Property
200.6	Altercations Between Employees and / or Passengers
200.7	Bicycle Policy for LRVs

300.0 Normal Train Operation

300.1	Rules, Operating Orders and Bulletins Clearance Form A
300.2	Train Operator Reporting for Duty and Checking Out
300.3	Train Operator Assignments and Absence
300.4	Pre-Trip Inspection of LRV / Train
300.5	Yard Operation

SAFETY INSPECTION CHECKLIST FOR REPRESENTATIVE LRV
(Not more than 15 days or TBD miles)

BODY

Thorough checking of body structure and trimming.
Check window and door glass, and outside mirrors.

DOORS

Check for security and operation.

ELECTRICAL

Check all interior and exterior lights. Replace those found defective.
Check emergency light operation, turn signal, hazard light, fuses and circuit breakers.
Check emergency jumper cables and socket.
Check operation of horn, bell, defroster, sanders, cab heater, and control switches.
Check operation of windshield washer and wipers, annunciator panel, and silent alarm.
Check operation of radio and Public Address systems.

MOTORS

Check traction motors, motor cables, propulsion blowers and propulsion intake filters.

PNEUMATICS (TBD) or HYDRAULICS

Air reservoirs, piping and hoses, automatic drain valves and heaters.
Compressor operation, air pressure gauge, safety valves, and windshield wiper operation.
Latches on brake control unit.

MECHANICAL

Check truck frame and bolster for loose parts; bearing and gear units for oil leakage.
Speed sensor and housing for loose parts. Drive links.
Flexible coupling springs and shock absorbers for damage.
Center bearing for grease leakage.
Check leveling valves, hubometer, track brakes for height and operation.
Check disc brakes for shoe wear and operation.
Wheel guards.
Articulation bellows and roof linkage for damage.
Emergency drawbars, couplers, draftgear and brake wind-off tool.

PANTOGRAPH EQUIPMENT

Check pantograph and roof equipment for tightness and security.

HEAT, VENTILATION AND AIR CONDITIONING

Check operation of heat, ventilation and air conditioning units.

"A" INSPECTION CHECKLIST FOR REPRESENTATIVE LRV
(Not more than 45 days or TBD miles)

BODY

Thorough check of body structure and trim, interior and exterior. Make necessary repairs. Check portal frame for cracks and fractures. Check concertina bellows for cracks and damage. Check all windows and door glasses; all side mirrors and route signs. Check door rubbers, floor stanchions, seats. Check emergency drawbar and anti-climber opening, sun visor, operator's seat and window, air vent, and handrails.

DOORS

Thoroughly inspect all doors. Clean compartments. Check for operation and make necessary repairs. Check switches, relays, lights, and lubricator. Check warning bell and door speeds. Adjust if necessary.

ELECTRICAL

Check all lighting, fuses, switches and circuit breakers. Make necessary repairs. Check emergency relays, speed sensors, gauges, reverser switch. Blow out electrical equipment boxes, relay and resistor compartments. Check all contacts and magnet valves, resistors, capacitors, and inductors. Check main devices and associated equipment.

MOTORS

Remove covers and blow out motors. Check brushes, brush holder springs, etc. Change if required. Check for flashovers. Remove carbon build-up.

PNEUMATICS (TBD) OR HYDRAULICS

Check air compressor for security and operation. Check air reservoirs, air hoses, piping, drain valves, and heaters, three-way cock, windshield wipers, air suspension, air intake filters, pressure gauges, safety valves, cut-out cocks and brake control unit.

MECHANICAL

Check truck frame and bolster for loose or missing parts, damage, and wear. Also gear box hanger mounts. Check gearbox oil levels; fill to correct level if necessary. Remove breathers and clean. Check operation. Inspect articulation roof linkage, wheels, and wheel guards. Check center bearing, compressor oil level. Fill to correct level if necessary. Check compressor for damage. Inspect portal frame and bellows, shock absorbers springs, and leveling valves. Check disc brakes and rotors. Slack adjuster and linkages.

PANTOGRAPH EQUIPMENT

Check pantograph and roof equipment. Lubricate and carry out all necessary repairs.

HEAT, VENTILATION, AND AIR CONDITIONING

Check and clean temperature control cabinet. Check relays, fuses, and wiring. Check cab heater, foot warmer, and demits fans. Check and lubricate dampers. Check operation of ventilation units and change filters. Clean overhead grills. Check operation of heat, ventilation and air conditioning unit.

"B" INSPECTION CHECKLIST FOR REPRESENTATIVE LRV
(Not more than 90 days or TBD miles)

BODY

Thorough check of body structure and trim, interior and exterior. Make necessary repairs. Check portal frame for cracks and fractures. Check concertina bellows for cracks and damage. Check all windows and door glasses; all side mirrors and route signs. Check door rubbers, floor stanchions, seats. Check emergency drawbar and anti-climber opening, sun visor, operator's seat and window, air vent, and handrails.

DOORS

Thoroughly inspect all doors. Clean compartments. Check for operation and make necessary repairs. Check switches, relays, lights, and lubricator. Check warning bell and door speeds. Adjust if necessary.

ELECTRICAL

Check all lighting, fuses, switches and circuit breakers. Make necessary repairs. Check emergency relays, speed sensors, gauges, and reverser switch. Blow out electrical equipment boxes, relay and resistor compartments. Check all contacts and magnet valves, resistors, capacitors, and inductors. Check main devices and associated equipment. Check main capacitors for oil seepage. Check main inductors and propulsion filters.

MOTORS

Remove covers and blow out motors. Check brushes, brush holder springs, etc. Change if required. Check for flashovers. Remove carbon build-up.

PNEUMATICS (TBD) OR HYDRAULICS

Check air compressor for security and operation. Check air reservoirs, air hoses, piping, drain valves, and heaters, three-way cock, windshield wipers, air suspension, air intake filters, pressure gauges, safety valves, cut-out cocks and brake control unit. Check valves, inner and after cooler safety valves. Check and clean air mufflers.

MECHANICAL

Check truck frame and bolster for loose or missing parts, damage, and wear. Also gear box hanger mounts. Check gearbox oil levels; fill to correct level if necessary. Remove breathers and clean. Check operation. Inspect articulation roof linkage, wheels, and wheel guards. Check center bearing, compressor oil level. Fill to correct level if necessary. Check compressor for damage. Inspect portal frame and bellows, shock absorbers springs, and leveling valves. Check disc brakes and rotors. Slack adjuster and linkages. Inspect articulation mechanism for cracks and damage. Lubricate center bearing on every truck and cross roller bearing on articulation mechanism.

PANTOGRAPH EQUIPMENT

Check pantograph and roof equipment. Lubricate and carry out all necessary repairs.

HEAT, VENTILATION, AND AIR CONDITIONING

Check and clean temperature control cabinet. Check relays, fuses, and wiring. Check cab heater, foot warmer, and demits fans. Check and lubricate dampers. Check operation of ventilation units and change filters. Clean overhead grills. Check operation of heat, ventilation and air conditioning unit.

"C" INSPECTION CHECKLIST FOR REPRESENTATIVE LRV
(Not more than 180 days or TBD miles)

BODY

Thorough check of body structure and trim, interior and exterior. Make necessary repairs. Check portal frame for cracks and fractures. Check concertina bellows for cracks and damage. Check all windows and door glasses; all side mirrors and route signs. Check door rubbers, floor stanchions, seats. Check emergency drawbar and anti-climber opening, sun visor, operator's seat and window, air vent, and handrails.

DOORS

Thoroughly inspect all doors. Clean compartments. Check for operation and make necessary repairs. Check switches, relays, lights, and lubricator. Check warning bell and door speeds. Adjust if necessary. Check door relay contacts for pitting and burning. Clean or replace as required.

ELECTRICAL

Check all lighting, fuses, switches and circuit breakers. Make necessary repairs. Check emergency relays, speed sensors, gauges, and reverser switch. Blow out electrical equipment boxes, relay and resistor compartments. Check all contacts and magnet valves, resistors, capacitors, and inductors. Check main devices and associated equipment. Check batteries; clean and top up if required. Check track brake current draw. Remove light lenses and clean thoroughly. Vacuum out relay compartment as well as operator console and side console.

MOTORS

Remove covers and blow out motors. Check brushes, brush holder springs, etc. Change if required. Check for flashovers. Remove carbon build-up. Blow out overhead ventilation motors and floor heater motors. Inspect and make necessary repairs.

PNEUMATICS (TBD) OR HYDRAULICS

Check air compressor for security and operation. Check air reservoirs, air hoses, piping, drain valves, and heaters, three-way cock, windshield wipers, air suspension, air intake filters, pressure gauges, safety valves, cut-out cocks and brake control unit. Clean sludge from compressor unit. Remove and check crank case breather; replace if necessary. Check leveling valves and after cooler bypass valve. Change compressor oil.

MECHANICAL

Check truck frame and bolster for loose or missing parts, damage, and wear. Also gear box hanger mounts. Check gearbox oil levels; fill to correct level if necessary. Remove breathers and clean. Check operation. Inspect articulation roof linkage, wheels, and wheel guards. Check center bearing, compressor oil level. Fill to correct level if necessary. Check compressor for damage. Inspect portal frame and bellows, shock absorbers springs, and leveling valves. Check disc brakes and rotors. Slack adjuster and linkages. Check wheel shunts for breakage. Lubricate axle transmission housing with approved lubricant.

PANTOGRAPH EQUIPMENT

Check pantograph and roof equipment. Lubricate and carry out all necessary repairs.

HEAT, VENTILATION, AND AIR CONDITIONING

Check and clean temperature control cabinet. Check relays, fuses, and wiring. Check cab heater, foot warmer, and demits fans. Check and lubricate dampers. Check operation of ventilation units and change filters. Clean overhead grills. Check operation of heat, ventilation and air conditioning unit.

"D" INSPECTION CHECKLIST FOR REPRESENTATIVE LRV
(Not more than 360 days or TBD miles)

In addition to items on "B" inspection, complete the following when a "D" inspection is indicated:

DOORS

Make thorough inspection of door seals; replace as required. Inspect door center bearing. If necessary, replace the nylon-split bushing. Inspect all hardware and fastenings. Remove air strainer elements on front and rear doors and clean thoroughly. Replace strainer with new hair moss. Build up air and check for leaks after re-installation. Remove and clean air line filter.

ELECTRICAL

Focus headlight and track switch lights.

MOTORS

Check cab heater motor brushes for length and condition. Inspect commutator for flashovers and burn marks. Check motor operation. Make necessary repairs.

PNEUMATICS (TBD) OR HYDRAULICS

Check compressor motor resilient bushings for wear and damage. Check all bolts for looseness and wear. Remove day element filter and change. Check at pressure reducing valve for manufacturer-recommended air pressure reading. Change inner and after cooler safety valves.

MECHANICAL

Drain gear cases and refill with approved lubricant. Lubricate axle journal bearings. Inspect axle drive units coupling links for wear. Inspect truck frame and bolster for corrosion, wheels for cracks, slew rings and cross roller bearings for corrosion damage and security. Inspect track brake components and also disc brake. Check shock absorbers and air suspension and emergency spring. Inspect torsion bar supports, resilient bearings and levers for security and damage. Inspect traction motor cooling system. Check ground brushes, traction linkages and pneumatic piping hoses, clips and airleads for damage and security.

APPENDIX C

MAINTENANCE STANDARD OPERATING PROCEDURES LIST

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HIAWATHA CORRIDOR LIGHT RAIL TRANSIT PROJECT
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June 2004