ST Link Light Rail Project

Central Link Operations Plan
Initial Segment and Airport Link

Westlake to SeaTac/Airport

Rev 4
July 29, 2008

Revision	Date	Description of changes
0	2004 Jan 30	Initial Segment from Westlake to Tukwila International Blvd
Draft 1	2006 Feb 27	Added University Link and Airport Link Extensions
Draft 2	2006 March 24	Incorporated review comments of Draft 1; removed reference to University Link
Draft 3	2006 April	Incorporated Draft 2 review comments
Rev 1	2006 Aug 11	Final Initial Segment /Airport Link Operations Plan; incorporated Draft 3 comments
Rev 2	2007 Sept 30	Incorporate rev 1 review comments Incorporate 2007 Fleet Management Plan information
Rev 3	Jan 2008	Incorporate review comments update to rev 5 Fleet Plan
Rev 4	July 29, 2008	Incorporate March 3, 2008 review comments and rev 6 of RFMP

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EXECUTIVE SUMMARY

The 2007 Operations Plan is a revision to the Central Link Initial Segment operating plan issued August 11, 2006. This updated version covers the Initial Segment,(IS) plus a extension south to SeaTac/Airport (AL) The Initial Segment (IS) is defined as Westlake to Tukwila International Blvd Station.

It is the intention of this plan, that the information supplied concerning the IS and AL will be used by King County Metro to develop their operating plans.

Studies have identified that ridership and related benefits to the mobility for the regional transportation system increases as the Initial Segment light rail system length expands towards SeaTac/Airport and and then will continue north to the University of Washington area.

The Central Link Initial Segment (IS) passenger service date (PSD) is scheduled for operation in mid-2009. The Initial Segment is 13.9 miles, running from Westlake station in the Down Town Seattle Transit Tunnel (DSTT) to Tukwila International blvd station. The IS is double tracked and contains 12 passenger stations. (One planned station at Boeing Access Road has been deferred)

Airport Link (AL) extension to the south of Tukwila International blvd station is scheduled to be ready for operation in late 2009. The Airport Link Extension will add another 1.7 miles of track and one additional station. The IS/AL combined will comprise 15.6 miles and will serve 13 stations. (Since the IS will only be operational for about 6 months before the AL is added, the balance of this plan will discuss the IS/AL except when it is necessary to describe attributes separately.)

The IS/AL train service will be provided using a two car consist, operating at various design headways to meet ridership demand. Initial schedules have been developed allowing for 6 minute peak period headway with a 10 minute service during the midday off peak and 15 minute early/late service.

The IS/AL will be supported by an Operations and Maintenance Facility (OMF) capable of supporting a 104 vehicle fleet at full build out. Initially, when the IS/AL first goes into service, the Operations and Maintenance Facility will have the yard built out only to support 40 vehicles. The OMF is located in south Seattle adjacent to the mainline and south of Forest Street and west of Airport Way.

The Link light rail vehicles (LRVs) purchased to provide the service are manufactured by Kinkisharyo of Japan and are 95 feet in length and double articulated with a three-truck (six-axle) configuration. The floor of the LRV will be at platform height, 14 inches from top of rail at all 4 door entries and along approximately 70% of the length of the car. Trains can be coupled to run in one to four vehicles in length. Vehicles will be powered by an overhead contact wire energized at 1500 volts dc, and propelled with ac motors. Each vehicle will seat 74 passengers and have room for 74 standees the vehicle is designed to meet all current ADA standards, supporting a capacity of 148 passengers. (This is the figure used for scheduling purposes). During special events loading will be much higher. The IS service will commence revenue service with a fleet of 31 vehicles. Four additional vehicles will be used for AL, requiring a projected fleet size increase to 35 vehicles. This number of vehicles is based on supporting 2020 ridership projections.

The IS/AL will share the Downtown Seattle Transit Tunnel (DSTT) with hybrid diesel/electric buses operated by King County Metro. This shared use will continue until such time that increases in Link service and frequency requires exclusive use of the DSTT tunnel by light rail operations only.

For purposes of developing ridership projections and other planning activities, we have used a 6-minute peak period headway based on a design year of 2020 for the Initial Segment and Airport Link. Typically, peak hour headways developed for the initial years of operations will be different from the design year.

This recognizes that while initial year demand may be lower than design year demand, ridership growth is expected to rapidly increase within the first few years of operations and therefore the need to be able to respond to changing headway requirements to match demand. All decisions about levels of service including headways will be subject to ST Board approval.

For the first year of operation of the Initial Segment starting in mid 2009, ridership demand is based on projected peak hour boardings and is met by operating 2-car trains at 6-minute headways with a fleet size of 31 light rail vehicles and with joint bus/rail services in the DSTT. For planning purposes, the Rail Fleet Management Plan RFMP used the design year 2020 ridership projections and estimated the initial year 2009 projections based on linear interpolation.

The Airport Link is scheduled to start operating in late 2009 or early 2010 with 2-car trains and like the Initial Segment will operate at 6-minute headways with the addition of four light rail vehicles and with joint bus/rail services in the DSTT. This increases the total fleet size to 35 cars. For planning purposes, the RFMP has used the design year 2020 ridership projections and estimated the initial year 2010 projections based on linear interpolation and applied the same formula for years 2010 to 2015.

Sound Transit has entered into an Intergovernmental Agreement (IGA) with King County Metro (KCM) the major bus operator in King County in the State of Washington, and have contracted the operations and maintenance functions of Central Link to King County Metro. Sound Transit, as owner, will have fiscal and performance oversight for this contract. The IGA defines performance and maintenance standards and requirements for the operator and maintainer.

INTRODUCTION

In 1996 voters in the Central Puget Sound region approved Sound Move, the Ten-Year Regional Transit Plan. One element of the Sound Move program was a Central Link Light Rail system. The Initial Segment of the Central Link extends from Westlake Station in downtown Seattle to Tukwila International Blvd station. A one station extension to the SeaTac/Airport will be constructed with plans to continue in the future south to 200th street at a later time. The Initial Segment is scheduled to begin service in 2009 with the extension to SeaTac /Airport opening later that same year.

1.1 Purpose

This Operations Plan describes two segments of the light rail line, the physical characteristics for each segment, the systems that will be used to support operations, ridership projections and the service plans for each segment describing service frequency, train length, run times and fleet size requirements. The plan also describes how King County Metro Buses and Sound Transit light rail trains will share common use of the Downtown Seattle Transit Tunnel (DSTT).

The IS/AL operations plan serves as the base line document to be used for all further development of other documents related to the operation of the Light rail system, including documents such as the Maintenance Plan and the Rail Fleet Management Plan. The Operations Plan is also to be used as the baseline document for setting operating ideology to be implemented for the day to day operating of the Link light rail system.

Development of detailed operational documents such as Standard Operating Procedures (SOPs) and the System Rule book will be based on the Operations Plan. Development of the final operating procedures is the responsibility of the contracted operating agency. For the IS/AL, King Country Metro are the contracted agency for operations and maintenance of the Sound Transit owned Light rail system . Sound Transit maintains oversight responsibility over King County Metro. Responsibilities for both agencies are defined in the Intergovernmental Agreement.

The IS/AL operations plan will be reviewed and updated as needed, to incorporate all system design modifications and upgrades that affect the plan. An update will be done after the opening of the IS so lessons learned can be applied to the combined IS/AL LRT system.

1.2 Scope

The plan provides information about the Initial Segment and Airport Link.(IS/AL). Information contained in the document is based on information and ridership projections contained in the RFMP and describes projected hours of service, headways, projected ridership, estimated run times and guideway route miles for the various line segments. Included in the plan is a short description of the various station locations, designs, and types of platforms.

1.3 Policy Issues

The following policy issues have been addressed for the IS/AL.

- DSTT Control Room:

  Sound Transit and King County Metro have agreed that the preferred method of controlling the DSTT is for one agency to have control of facilities and equipment for all movements of buses and trains in a single location. KCM Link light rail staff will operate a single control room located at the new Metro Communication Command and Control Center. (MCC&C)

- Bicycle Policy:

  King County Metro restricts loading and unloading of bicycles to IDS and CPS stations only. A uniformed policy will be developed to meet both agencies needs before PSD date.

- Ride Free Zone:

  Both agencies will continue to operate the free ride zone in the DSTT during the ride free hours

- Security within the DSTT:

  King County Metro is responsible for security in the DSTT.

  Sound Transit has contracted private security to cover the areas outside the DSTT tunnel. The Security Plan is under development and will deal with the issue of uniformed law enforcement officers and address any jurisdictional issues.

- Lost and Found:

  King County Metro will manage and administer all Link lost and found articles.

1.4 Related Documents

The Link Operations Plan relies on information contained in several other documents developed for the Initial Segment and Airport Link. These include the latest revisions of the following:

- Rail Fleet Management Plan (RFMP)
- Bus Fleet Management Plan (BFMP)
- IS/AL Maintenance Plan (MP)
- Intergovernmental Agreement between Sound Transit and King County Metro, June 2003 (IGA)
- Link System Safety Program Plan (SSPP) (Under development)
- Link System Security Plan (SSP) (Under development)
- Systems Integrated Test Plan (SIP)
- Design Criteria Manual (DCM)
- IS / AL Project Management Plan (PMP)
- Joint Bus /Rail Operations in the DSTT Operations Plan
- Rail Activation Plan

2.0 LINK INITIAL SEGMENT / AIRPORT LINK SYSTEM DESCRIPTION

The Initial Segment and extension to the Airport is the backbone of a regional light rail transit system with future plans for extending into Pierce and Snohomish counties which will link the downtown area of Seattle, Tacoma and Everett together. The first constructed segment of the line extending from Westlake Station to SeaTac/Airport is entirely within King County. An extension north to the University of Washington is now in final design phase engineering with an additional extension south of the airport station to south 200th street proposed.

2.1 Alignment

The Central Link Initial Segment is 13.9 miles from Westlake station in downtown Seattle to Tukwila International Blvd station in the city of Tukwila. The line will then be extended 1.7 miles to SeaTac Airport in the City of SeaTac. The extension will result in a baseline IS/AL system of 15.6 miles.

The Initial Segment alignment consists of various types of rights-of-way, which include exclusive at-grade, tunnel, aerial sections, street median and gate-protected semi-exclusive sections. The light rail link utilizes the existing Downtown Seattle Transit Tunnel (DSTT) and the newly constructed Pine Street Stub Tunnel to travel under the downtown business district. South of the DSTT the line continues for a short distance at grade, turns east on aerial structure and into a dual tunnel under Beacon Hill, exits onto aerial then transitions to grade. Continuing south, the line runs in street median along Martin Luther King Jr. Way (MLK Way) in the Rainier Valley where once again it transitions to aerial and at grade, operating through the City of Tukwila. A short extension to the Airport in the city of SeaTac will consist of aerial guideway and exclusive at-grade sections The IS/AL line is double tracked for the full length and the tracks are of standard gauge.

The IS/AL takes advantage of the flexibility of light rail technology by incorporating several types of right-of-way including sections of fully separated tunnel and aerial guideway, partially separated at-grade, highway medians, and street operation. The types of right-of-way on which the IS/AL line will operate are described below and shown in the Table 2.1.

Exclusive: The right-of-way is separated from and completely inaccessible to non-rail transit vehicles and the general public. Includes subways, aerial structures, and at-grade segments

Semi-exclusive (protected): This at-grade private right-of-way is separated from parallel traffic, but crosses intersecting streets. Light rail trains have priority at all grade crossings, which are protected by crossing gates, lights and bells.

Semi-exclusive (street median): This at-grade right-of-way is separated from parallel traffic, but crosses streets at grade. Street crossings are furnished with traffic signals to govern vehicular, pedestrian and train movement, but are programmed to grant priority to light rail trains. The right-of-way may be protected from parallel traffic by high unmountable curbs, barriers, or safety fences; or separation may be indicated by mountable curbs, striping, or signage.

Mixed bus/rail in the twin bore tunnel: Light rail trains share the existing downtown Seattle transit tunnel (DSTT) with transit buses. Safe separation between trains, buses and other trains are governed by SOP's and rules and proper use of the wayside signal system. Trains may not enter a tunnel segment between stations when that segment is occupied by a bus. Buses may be platoon with the authorization of the OCC.

Table 2-1 Central Line IS/AL Alignment by Section

Section	Miles	Stations	Alignment Type	Description
Downtown Seattle	1.3	Westlake University Street Pioneer Square International District/Chinatown	Bus Shared Exclusive tunnel	Downtown Seattle Transit Tunnel (existing)
South Seattle	2.3	Stadium SODO Beacon Hill	Semi-Exclusive Gate crossing Exclusive Aerial : tunnel Portal to Portal	Along E3 bus way Aerial on Forest; Tunnel under Beacon Hill
Rainier Valley	4.7	Mount Baker Columbia City Othello Rainier Beach	Exclusive: Aerial Semi –Exclusive: Street median	Aerial at MT Baker Street Median on MLK Jr. Way
City of Tukwila	5.6	Tukwila International Blvd	Excusive: Aerial and at-grade	Aerial: Boeing Access Road to Tukwila Internat'l Blvd w/ some exclusive at-grade ROW
Sea-Tac /Airport Station	1.7	Sea Tac /Airport station	Exclusive; Aerial and at grade	Aerial from Tukwila Internat'l to airport property down to grade and aerial again at 170th Street to airport Sea/Tac station
Total	15.6			

Figure 2-1 IS/AL Alignment Map

Operating speeds will vary according to the type of right of way, civil alignment characteristics and special local conditions. In general, maximum designed allowable speeds along the Central line will be:

- Exclusive right of way: 55 mph
- Semi-exclusive right-of-way (protected): 45 to 55 mph
- Semi-exclusive right-of-way (street median): posted speed limit of parallel street; on MLK Way, the posted speed limit is 35 mph.
- Mixed bus/rail downtown twin bore tunnel 35 mph or less operational speed will be the posted speed. There is a 10 mph protected at the un-gated DSTT merge points.

2.2 Downtown Seattle Transit Tunnel

In the Seattle Central Business District, trains will operate through the existing Downtown Seattle Transit Tunnel (DSTT), making stops at the existing International District/Chinatown Station, Pioneer Square Station, University Street Station, and Westlake Station. King County currently uses the tunnel for Metro bus service and operates some of Sound Transit's routes. When light rail services starts, both buses and trains will jointly operate in the existing tunnel. South of the DSTT tunnel portal, the E3 Bus way continues on a reserved right-of-way for 1.1 miles. The light rail tracks will be located on a parallel right-of-way directly to the east of the bus way alignment. There are two stations located along the E3 bus way . Stadium light rail station is located in the area just south of Royal Brougham Street, the first crossing street reached from the DSTT south portal. SODO station is the other station located south of Stadium. The track along this area is the test track area for the Light Rail system.

2.3 Stations

The IS/AL will have 13 operational passenger stations with a deferred station at Boeing Access Road.

Stations are located in tunnels, on aerial segments, and at ground level. The stations will have either a center platform served by both tracks, or two side platforms, one for each direction of travel. Table 2-2 provides information for each station. Average station spacing by area is shown below.

Average station spacing (miles between stations)

Downtown Seattle (Westlake – International District)	0.3 miles
South Seattle (International District – Rainier Beach)	1.1 miles
Tukwila (Rainier Beach – Tukwila International blvd)	5.6 miles
Airport Link (S154th to SeaTac-Airport)	1.7 miles

All stations will have platforms that are a minimum of 380 feet long (existing stations in the DSTT have 400-foot long platforms). Station platforms will be 14 inches (350 mm) above top of rail, to match the level of low-floor LRVs and hybrid diesel/electric buses in the DSTT. All at-grade stations have passenger access walkways and ramps. Aerial and tunnel stations will be furnished with stairs, elevators, and escalators. Each station will have ticket vending machines, smart cards, closed-circuit television and public address systems and variable message signage. Tunnel stations have systems that monitor and control ventilation and emergency phones using the SCADA (Supervisory Control and Data Acquisition) system that allow the Operations Control Center (OCC) to perform the majority of Fire/Life safety functions. The SCADA system will automatically respond to defined fire /Life safety alarm points.

2.4 The DSTT

The DSTT is 1.3 miles long. Prior to the tunnel closure for Link light rail modifications in September 2005, twenty one bus routes utilized the tunnel with a peak of up to 70 buses per hour in each direction. All buses in the tunnel are operated by King County Metro. The existing tunnel is being modified by addition of a 750' stub tunnel north of Westlake Station to provide a crossover and turnback track under Pine Street. The four LRT/Bus stations in the DSTT alignment, and one bus only station just outside the north portal, are:

- International District /Chinatown Station (IDS): the southernmost station. It is a partially covered station beneath a plaza adjacent to 5th Avenue at Jackson Street.
- Pioneer Square Station (PSS): an underground station under 3rd Avenue at Yesler Way.
- University Street Station (USS): an underground station under 3rd Avenue at University Street. The station has direct access to Benaroya Hall (Seattle Symphony venue) above.
- Westlake Station (WLS): is an underground station under Pine Street at 5th Avenue. This station has direct access to the Macy's and Nordstrom department stores and the Westlake Center via a mezzanine.
- Convention Place Station (CPS): is an open-air station just outside the north portal (at 9th Avenue and Pine Street). The station facilities are located in open cut beneath street level. This station is not being served by light rail.

Buses access and exit the DSTT from the south by three routes:

- A surface roadway that is part of the E3 Bus way, just north of its intersection with Royal Brougham Way.
- Exclusive express bus ramps from the I-90 Transitway.
- Buses completing a southbound trip terminating at IDS turnback in the staging area to layover or begin a northbound trip.
- Buses completing a southbound run through the DSTT can be scheduled to use this area to turn around and layover prior to commencing a northbound run through the tunnel.
- When the tunnel re-opens there will be no bus trolley operation required in the tunnel. All buses that use the tunnel will be diesel/electric.
- Bus operation will remain relatively unchanged with the exception of stringent adherence to signal light indications and the ability with Operations Control Center to authorize platooning of buses.

Buses access and exit the DSTT from the north via three routes as well:

- Reversible ramp leading directly from the express lanes of I-5.

- Surface access entrance ramps at the corner of 9th and Olive Way and an exit ramp to Olive Way.

- Buses completing a northbound trip terminating at CPS turnback in the staging area to layover or begin a southbound trip.

- At the north end of the tunnel, buses change modes at CPS either in the staging area or at the platforms. Bus layover area and turnaround lanes are provided immediately north of the CPS platforms in the open cut commonly referred to as the CPS staging area.

The four underground stations – IDS, PSS, USS and WLS – have two side platforms, each 380-390 feet long. Each platform has two designated stopping locations ("bays") for specific bus routes. There is a passing lane in the center of each of the four stations, to enable buses in either direction to operate around other buses stopped in the station. CPS has four side platforms, a long one for all northbound buses, and three shorter platforms with bay designations for southbound service entering the tunnel. A passing lane is provided between outbound Bays A/B and inbound Bay # 1.

The tunnel between IDS and WLS is composed of two single mined bores, each bore accommodating one lane. The alignment between WLS and CPS is two-lane cut/cover.

2.5 Continued Link Use of DSTT Tunnel

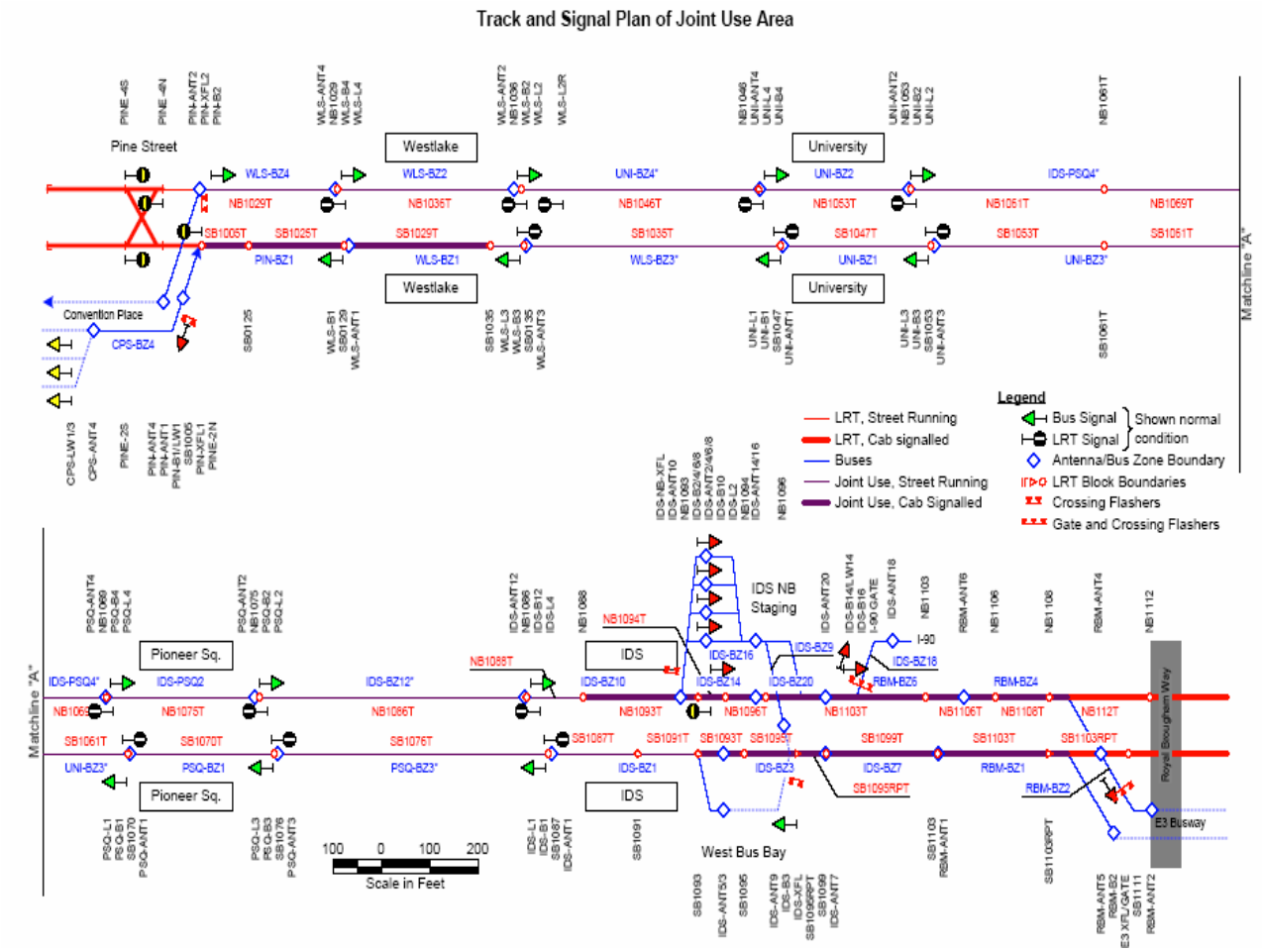
The IS/AL base line segment runs from a terminal train turn-back facility in exclusive tunnel east of Westlake station under Pine Street referred to as Pine street stub tunnel, to SeaTac/Airport station. The planned turn back arrangement for the Pine street stub tunnel cross over is displayed in figure 2.2.

In the DSTT, one track will be located in each tunnel bore and serve each side platform. A platform height of 14 inches (measured from top of rail) will permit level boarding of both low-floor buses and light rail vehicles. CPS station is a bus only station just outside of the DSTT's north end of the tunnel. There are two bus/ rail merge points identified for the DSTT one is at IDS and the another at CPS. There is one bus turn around location just south of the IDS platform. This turn back point is protected by railway crossing flashing lights but has no gates due to no clearance issues .

There are gates and railway type flashing light protection for bus merge points south of IDS which is considered part of the IDS merge points. These locations protect buses merging from the I 90 and buses coming off the E3 bus way.

Figure 2-2 below details the layout for the DSTT both bus and trains routes are indicated in the figure.

Figure 2-2 Light Rail and Bus layout for the DSTT tunnel area.



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Figures 2-3 Initial Segment – SeaTac/Airport Stations

Westlake Station:
Primary station serving the retail area of downtown Seattle. Side platform tunnel station with full mezzanine access from numerous retail establishments.

Pioneer Square Station:
This station serves the historic area of old Seattle and jurisdictional facilities. Side platform tunnel station with mezzanines at each end.

University Street Station:
Station serves numerous offices in the downtown core, the Public Market, the Seattle Art Museum and Benaroya Hall. Side platform tunnel station.

International District Chinatown Station:
Station accesses the International District of Seattle, Qwest and Safeco stadiums. Side platform retained cut station with direct access to plaza at street level. Closest station to connect to/from Sounder Commuter rail and Amtrak at King St station.

Figure 2-4

Stadium Station
Serves Qwest Field and Safeco Field Stadiums at Royal Brougham Blvd.

SODO Station:
Serves the SODO District of Seattle. Side platform at grade station. Station is adjacent to a bike trail and a greater number of bicycle storage is provided at this station.

Serves the primarily residential Beacon Hill neighborhood and neighborhood businesses and services. Deep tunnel station with twin tube tunnels. Single entry station with high-speed elevator only access.

Mount Baker Station serves North Rainer area

Columbia City Station serves Rainer Vista

Figure 2-5

Othello Station:
Located in the heart of a neighborhood commercial area. Double end loaded, side platform at grade station with two adjacent plazas at each end.

Rainier Beach Station:
Serves residential and the industrial area to the south of the station. Single entry center platform at grade station. Operator's building is located at the south end of the platform with staff washroom, janitor's closet, supervisor's office and staff workroom. One plaza is located to the north of the station

S. Tukwila International Blvd:
Transit facility accommodates park and ride, bus layover and bus bays, passenger drop off.

SeaTac/Airport
Terminus station bus loop and passenger drop off area.

Table 2-2 Central Line Passenger Stations

STATION	Miles from last station	Station type	Platform Type
Westlake		Tunnel	Side
University St	0.3	Tunnel	Side
Pioneer SQ	0.4	Tunnel	Side
International District/ China Town	0.4	Tunnel	Side
Stadium	0.5	At Grade	Center
SODO	0.7	At Grade	Side
Beacon Hill	1.0	Tunnel	Separated Center -Side
Mount Baker	0.7	Aerial	Side
Columbia City	1.2	At-Grade	Side
Othello	1.6	At-Grade	Side
Rainier Beach	1.1	At-Grade	Center
Tukwila Int Blvd Station	5.6	Aerial	Side
SeaTac/Airport	1.7	Aerial	Side

2.6 Crossovers, Pocket Tracks, Tail Tracks

Crossovers, pocket tracks and tail tracks are referred to as "special trackwork." This distinguishes them from the regular tracks that guide trains from point to point. Strategic placement of special trackwork is critical to dependable and efficient operation of train service.

Crossovers are composed of track switches that enable trains to move from one track to another. Crossovers are located at terminal stations to enable trains arriving on the inbound track to cross over to the other, outbound track for departure in the direction from which it arrived. Additional crossovers are placed along the line to enable trains to be routed around system blockages or scheduled maintenance that requires removing one track from service. Crossovers have been spaced two to three miles apart to support the 15 minute single-tracking headway specified in the design criteria.

Pocket tracks are storage tracks located between and having access to the two mainline tracks. They are used to turn back trains at intermediate points or at a terminus to store gap or build-up trains, store trains with critical faults off the mainline track, or store non-revenue maintenance equipment.

Tail tracks are typically provided at the ends of the line to enable trains to be stored temporarily at these terminal stations without occupying the platform tracks needed for revenue service. Tail tracks also enable trains to enter terminal stations at higher speeds, as they provide a longer "safe braking distance"

(i.e., the distance considered necessary for all trains, including those experiencing baking problems, to safely stop). Tail tracks can also be used to store gap trains and trains with critical faults.

For the Pine Street Stub tunnel there is a 300 feet long stub track to support 3 car train movement. (This is not significant since four car consists will not be used north of Stadium Station until the Central Link extends north out of Westlake station ,).

Two midline pocket tracks are located on the IS/AL line – one just south of the Stadium and another in SODO just south of Rainier Beach station on MLK Way at Henderson, Both locations are in at-grade areas. Their location places them at intervals approximately five miles apart and close to passenger stations. The pocket track at Stadium station is 400 feet—long enough to accommodate the longest train operated on the system. Stadium pocket location will be strategic for staging trains to accommodate stadium special event crowds. The pocket track at Rainier Beach is 800 feet with the capability of accommodating two 4 car trains. For failure management and optional peak service the pocket tracks can be used for scheduled turnbacks.

For SeaTac /Airport station a crossover is located north of the station platform. This will enable southbound trains to enter the station at either side of the center platform. Train operators will reverse train direction while at the platform. At the scheduled departure time trains will leave the station on the northbound track. Due to the Airport station status as a temporary terminal and due to civil constraints, no tail track is being provided for at SeaTac/Airport station. There is 103 feet of track beyond the platform to allow trains to enter the platform at reasonable speed while still meeting safe braking distance requirements. See appendix A for track alignment showing all special track work .

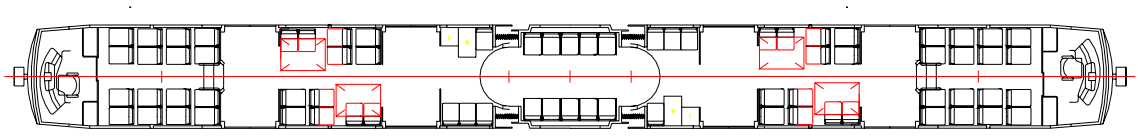
2.7 Vehicles

2.7.1 Light Rail Vehicle

The light rail vehicles for the system are electrically-powered cars that can be operated individually or in multiples of up to four. For the IS/AL 2 and 3 cars are supported for a Westlake to Airport trip. A drawing of the light rail vehicle is shown in figure 2-7 below. A Kinkisharyo design vehicle has been selected for the system. The car is 95 feet long with an articulation in the center to enable the car to negotiate tight radius curves. It is a low-floor vehicle, with four sets of doors on each side and an operator cab at each end for operation in either direction. The vehicle has a railway high intensity light over each cab which operates during all operating hours. The car draws its power by roof-mounted pantographs from an overhead contact wire, energized at 1500 volts DC and converted to three-phase AC using inverters on board the vehicles. Motorized trucks (wheel assemblies) are of conventional two-axle, four-wheel design. Each powered axle has its own AC traction motor. Over the motorized trucks, the car floor is roughly 39 inches above the rail. The car's mid-section, roughly 70% of the passenger compartment, including all passenger entryways, has floors approximately 14 inches above the rail to provide level boarding from platforms of the same height. The center truck under the articulation section is not powered and is designed with four stub axles to enable the 14-inch floor height to continue through the articulation section. Steps in LRV aisles enable passengers to move from entries to end-of-car seating areas above the motored trucks.

Interior seating is arranged mostly in a 2 + 2 transverse pattern, with half the seats facing one way and the other half in the opposite direction. Inward-facing longitudinal seats are furnished where required to facilitate passenger circulation around entries and through the articulation sections. Flip-up seats adjacent to each door open up to four areas for patrons in wheelchairs. Racks are also provided near inner door vestibules for stowing bicycles and luggage.

Figure 2-6 Central Link Low-Floor Light Rail Vehicle



High Floor Low floor High floor

2.7.2 Buses

Hybrid diesel-electric battery low floor coaches will be used in the DSTT. The power source will not interfere with the overhead contact wire of the light rail system and will be compatible with ventilation of the DSTT.

The low floor bus is designed to enable wheelchair users to directly board the bus from the DSTT 14" high platforms using wheelchair ramps instead of lifts.

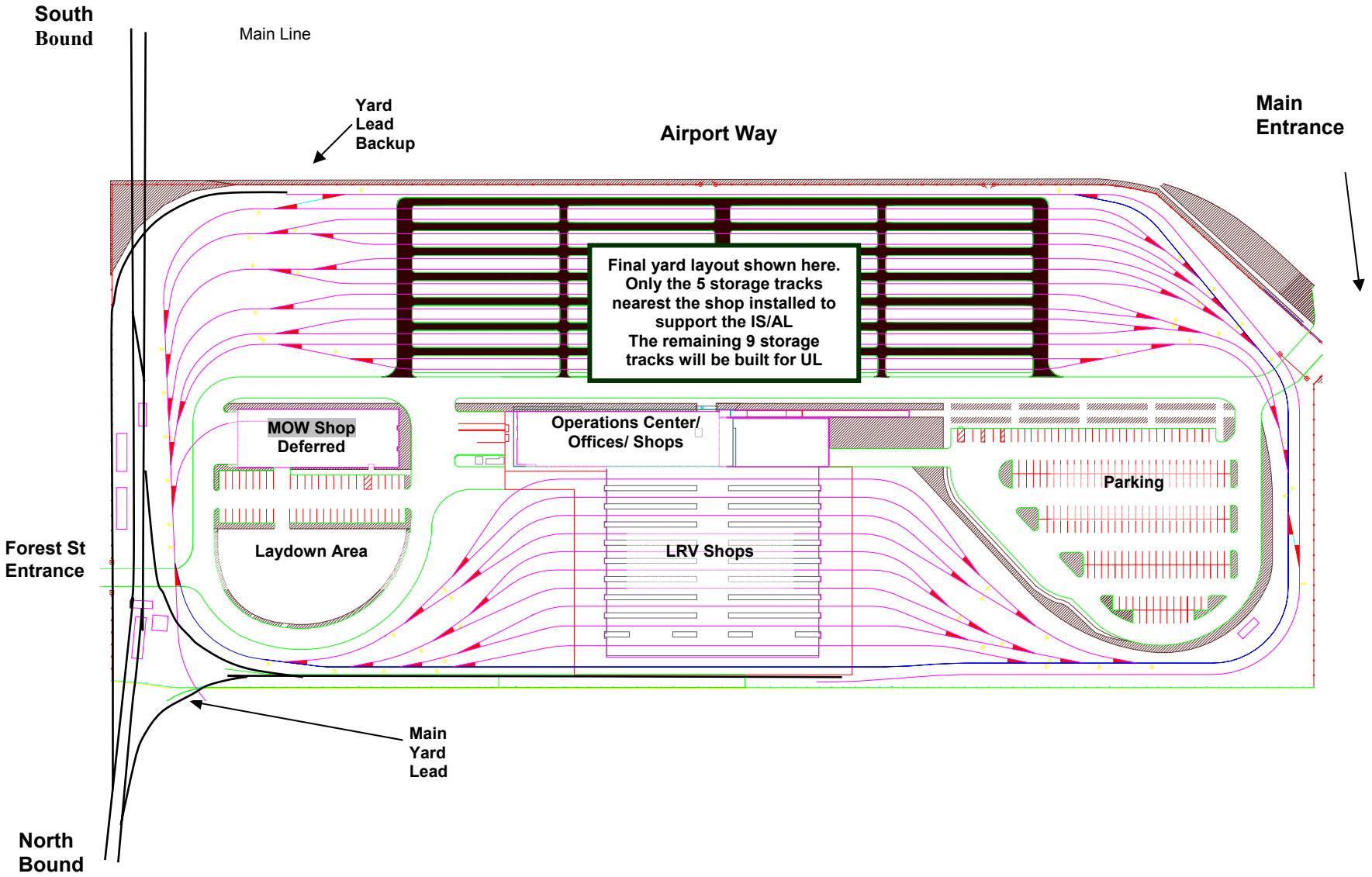
Figure 2-7 Hybrid Bus

2.8 Operations and Maintenance Facility

An OMF located at Forest and Airport Way immediately adjacent to the mainline in south Seattle houses all maintenance and most operations functions. With the facility fully built, the yard is capable of storing 104 95-foot vehicles. It will be initially built to accommodate 40 vehicles sufficient for storage for the IS/AL fleet through 2020. The yard is equipped with a car wash. The main shop building is fully equipped to undertake service, inspection, and heavy repair functions for the light rail vehicles. Rail Operations and Fleet Maintenance offices are located in the building. Vehicle and ROW maintenance activities and staff are also based at this site. Indoor and outdoor storage are provided to store spare parts for vehicles, support systems. The back up Link Operations Control Center (OCC) is also included in this complex.

For the IS/AL, storage tracks are provided to support up to 40 cars, while the initial IS/AL fleet will only be 35 vehicles. With an ultimate design capacity of 104 cars, the yard track may be expanded as need arises. Included in the yard design is a run-around track to ensure that cars can always be routed around the yard without obstruction. Two access points are provided for all locations in the yard to ensure that a single obstruction will not block in any vehicle. Dual access points are provided for entry to and from the mainline, and for each yard track and each shop track. A site plan of the Operations and Maintenance Facility shown as figure 2.9 The plan shows the facility at full build-out, identifying those tracks and buildings that will be required for further extensions.

Figure 2-8 Central Link Operations and Maintenance Facility



2.9 Traction Power System

For the IS/AL power for trains will be provided by a series of 11 traction power substations and 1 tie station distributed along the line which converts commercial power to 1500 volts direct current (Vdc). Substations are designed to permit power to be provided to a line segment by the adjacent substation in the event of loss of one substation. Light rail substations for a 1500-volt system are typically spaced approximately one mile apart.

Power is distributed from substations to trains by means of the overhead contact system (OCS). The design of the OCS is matched to the type of right-of-way:

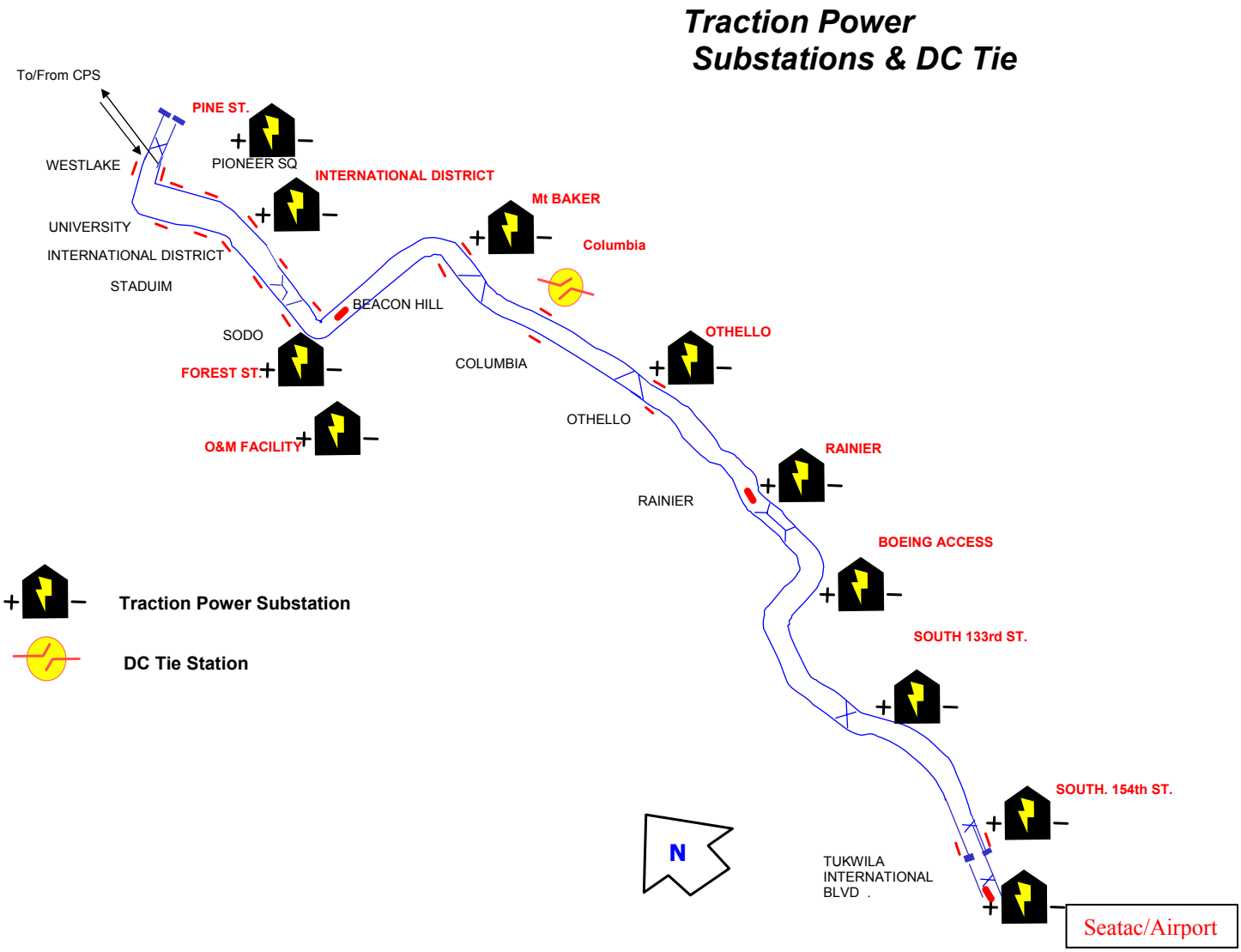
- New tunnel sections and DSTT: A very low profile fixed-terminated OCS, with span lengths of 60 feet and contact wire height of 13 feet 6 inches.
- Aerial structures: Auto-tensioned OCS, with span length of 200 or more feet on tangent track, and a contact wire height of 16 feet.
- Street running sections: Auto-tensioned OCS design.
- Yard and shops: Single contact wire fixed-terminated OCS.

The OCS is sectionalized to enable particular sections of catenaries to be isolated and de-energized, without forcing a curtailment of train operations on other adjacent sections of the line. Sectionalizing is normally located at substations, crossovers, and pocket tracks. Power is monitored and controlled through the SCADA system from the OCC.

Table 2-3 Traction Power

Facility Name	Station	Jurisdiction	Physical Location
Pine Street	TPSS	Seattle	100FT. W. Boren Ave. beneath Pine Street
International District/Chinatown	TPSS	Seattle	IDS Tunnel South Staging area beneath Airport Way
Forest Street	TPSS	Seattle	O&M Facility - South of S. Forest St., West of Airport Way under aerial guideway
O&M Facility Shop	TPSS	Seattle	Inside O&M Facility - South of S. Forest St., West of Airport Way
Mt Baker .	TPSS	Seattle	West of 26th Ave. S. between S. Forest St. & McClellan St.
Columbia City	TIE	Seattle	Columbia City Plaza – E. of MLK Jr. Way S., North of S. Columbia City St.
Othello	TPSS	Seattle	Myrtle Plaza - East of MLK Jr. Way S., North of S. Myrtle St.
Rainier Beach St.	TPSS	Seattle	East of MLK Jr. Way S., South of S. Rainier Beach St.
Boeing Access Rd.	TPSS	Tukwila	East of E. Marginal Way S., South of Boeing
South 133rd St.	TPSS	Tukwila	West of SR 599, South of S. 133rd St.
South 154th Street	TPSS	Tukwila	East of International Blvd. South of S. 154th St.
SeaTac/Airport Station	TPSS	SeaTac	North of Airport Station under crossover

Figure 2-9 Traction Power Substations



2.10 Signal System and Onboard Train Control

Each light rail train is operated by a train operator from the vehicle cab. The trains are operated in accordance with established operating rules as described in Standard Operating Procedures (SOP's) and Emergency Operating Procedures (EOP's) and the Operating Rule Book. Operators will conform to signaling and other control systems that vary by line segment and type of alignment.

For the DSTT area two distinct types of wayside signals will be required. One will govern train movements, while the other will govern bus movements. Both types will be interconnected and governed by an interlinked signal processor that will govern signal progression for both buses and trains in the DSTT using operating rule logic necessary to maintain safe vehicle spacing. This combined control system will be able to identify individual trains (via track circuits) and buses (via automatic vehicle identification [Amtech] tags). SeaTac/Airport extension is designed for cab signal controlled territory. The general types of alignment and signaling are shown in Table below:

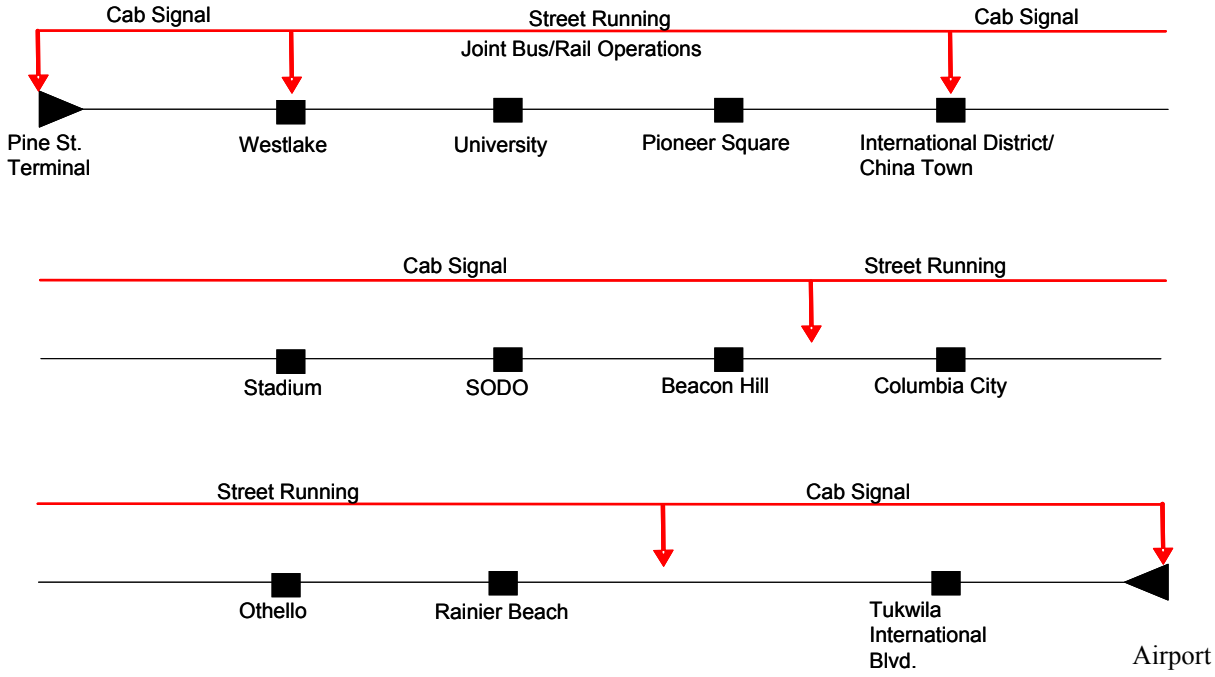
Table 2-4 Signaling by Type of Alignment

Type of Right-of-Way	Line of Sight	Traffic Signals	Gates/Flasher	Cab Signals
Exclusive (excludes DSTT)	No	No	No	Yes
Semi-exclusive (protected)	No	No	Yes	Yes
Semi-exclusive (street median)	Yes	Yes	No	No
Mixed bus/rail DSTT	No	Yes	Yes**	No *

*Cab Signals will be in use in Pine Street pocket track to Westlake and south of International District Chinatown station at 10mph

** For bus/rail merge at each end of DSST

Figure 2-10 Initial Segment and Airport Link Signal Block Layout and Type



On segments of the line that are on either exclusive or gate-protected rights-of-way, a cab signal system enforces allowable speeds and maintains safe train separation. A unit in the train operator's cab indicates the allowable speed to the operator and automatically brakes the train if the operator does not respond to a reduced speed signal within a specified time.

The section of the line from Westlake pocket track to Stadium pocket track is designed for a 90-second design headway, to enable an ultimate two-minute operating headway. The segment south of Stadium to Rainier Beach has design headway of 120 seconds, while the segment south of Rainier Beach has a design headway of 150 seconds.

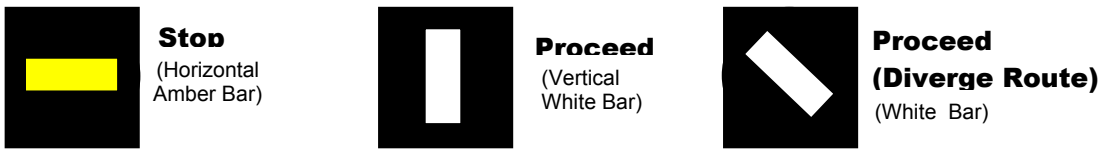
On street median and mixed traffic rights-of-way, trains operate by "line of sight." Train operators operate trains at the designated speed, which will not exceed the posted speed limits for parallel traffic. Train operators will follow operating rules to maintain safe train separation. The cab signal system provides a positive train separation and train stop protection in all cab signal territory.

Movement through street intersections is governed by traffic signals. A type of priority progression is designed to allow trains on at-grade segments to operate within a "green band" provided by a sequence of coordinated traffic signals. The objective is to maintain uninterrupted train movement in the peak direction and a minimum of delay in the opposite direction. Trains approaching an intersection will be detected by trainway detection loops tied to the traffic signal system. Within the priority progression window, trains will receive priority in the form of early or extended clear signals to minimize the likelihood of getting stopped at an intersection. When the train is given priority, conflicting auto traffic receives a red light.

Special "bar signal" indications will govern the movement of trains through intersections (white vertical bar for proceed, amber horizontal bar for stop). These signal indicators will be integrated with the traffic signal system. A train-to-wayside communication (TWC) system will provide the interface between light rail vehicles and the traffic signal system. TWC will also be used to request routes on the main line, and, for switch control in the yard.

Appropriate interlocking signals are installed where necessary to control movements through track switches and at crossovers. See figure 2-12 .

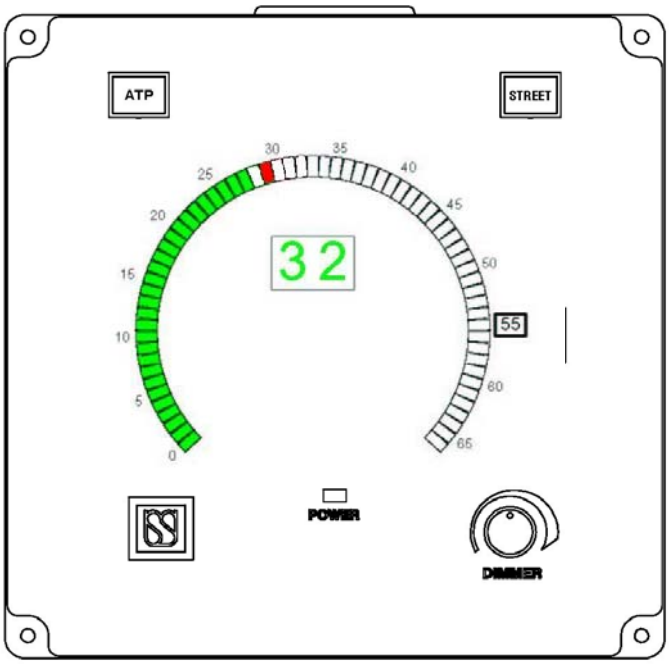
Figure 2-11 Light Rail Train Signal Aspects



Train movement in designed track areas will be governed by a combination of the light rail cab signal system and train wayside signals at stations. The cab signal system will be utilized for train control on approach and in the merge points to the joint operation areas in the DSTT, also in other designated areas. Speed indications provided in the operator cab will inform the train operator of the permitted speed as the train approaches the merge point within the DSTT. See figure 2-13. When a reduced speed is indicated, the train operator will slow the train to that speed. If not executed in a given amount of time, the train will brake automatically. Only one train at a time for each direction will be permitted to occupy a tunnel bore in the DSTT.

Once in the DSTT joint operation area, trains will be operated by wayside signals. At merge points and entrances to stations and tunnel sections, wayside signals will ensure that buses and/or trains are clear of the next track block. At each station and within each tunnel section, train wayside signals will indicate whether or not the next block is clear for the train to proceed. Track circuits will detect train location in the joint operation area. Wayside signals for train operations will utilize a two-lens system with semaphore-style bar aspects: 1) amber horizontal bar indicates stop; 2) white vertical bar indicates proceed normal; 3) 45°-angled white bar indicates proceed through crossover. See figure 2-12.

Figure 2-12 Onboard Vehicle Cab Signal



2.10.1 Airport Segment

The entire length of the SeaTac/Airport segment will be under cab signal control. The entire section is an exclusive right of way to the SeaTac/Airport station.

2.10.2 Bus Signals in the DSTT

An integrated signal system will provide vehicle separation between buses as well as trains in the DSTT using on-board radio tag equipment that will be installed on all new tunnel buses. This equipment is part of a radio tag system that communicates with detectors at specific locations in the roadway. Driving past these detectors will track bus location. The tag on each bus will be programmed with the static vehicle number and will contain dynamic route and run data from the operator's log-in. Roadside detectors read and store this data as the bus drives by, which in turn provides an accurate record of the vehicle movement. Bus movements will be controlled at the staging areas/merge points, stations and within tunnel sections. Bus wayside signals will indicate to bus operators whether they may enter the next station or tunnel segment. Bus operators will observe standard bus safety (line-of-sight) rules within the tunnel at all times. At the merge/crossing points, flashing lights (as at a railroad grade crossing) or traditional traffic control (red, yellow, and green) signals will notify bus operators of permitted moves. The bus signal system will extend to the portal at CPS to fully integrate the merge of train and bus traffic at Westlake. Wayside signals for bus operations utilize a circular single-lens system with two-color aspects: green/red at the mode change points to protect buses in the turnaround lanes from approaching buses that are entering the mode change area. The colors: 1) red indicates stop; 2) green indicates proceed.

Figure 2-13 Bus Signal Aspects in DSTT

2.11 Communications

The voice and data communications network is essential to managing transit operations. It is vital that communications to buses and trains in the DSTT originate from one facility allowing coordination and ease of communication between bus and train. The Operations Control Center (OCC) communications system will include the following elements for the IS/AL segment:

- A reliable high-speed fiber-optic communications transmission system (CTS) implemented for the transmission of video, voice and data communications. The CTS will also provide communications links for other systems.

- A system wide Supervisory Control and Data Acquisition (SCADA) system will provide OCC staff with monitoring and control capability over systems and facility equipment. In conjunction with the signal system and the train-to-wayside communications system, the SCADA system will provide train and bus tracking and supervision.

- Radio will be the primary means of communication between the OCC and train operators, bus drivers and field personnel. Link will be a part of the King County Radio System (KCRS). KCRS is an 800 MHz trunked radio system which is shared by several municipalities and agencies. KCRS coverage is for most of the King, Pierce and Snohomish Counties. For the DSTT, KCRS provides emergency services radio coverage within the public areas, for police and fire departmental use. King County Metro bus is not a member of KCRS radio system. King County Metro operates its own separate 450 MHz radio system throughout its service area, including the tunnel. A radio system replacement is planned and will use a 700 MHz system by the year 2009. Currently the KCRS and King County Metro radio systems are not compatible. However the OCC control room will be equipped to communicate with train operators, bus drivers and field supervisors in the tunnel. Software will synthesize a single integrated radio system at the OCC console, although the two radio systems will continue to operate independently. The

console will be designed to optimally integrate communications and graphical information about train operations and the safety critical systems used in the DSTT and Beacon Hill tunnel. Operating procedures for King County Metro buses is a Metro responsibility. The design of the Link radio communications system allows for various talk groups to be used that are assigned to the OCC.

- A private PABX telephone system will provide internal and external telephone access for staff. The telephone system will include emergency telephones located in passenger stations and other selected wayside facilities, and passenger assistance in the public areas of stations.

- An emergency phone system will provide emergency back-up phone service in tunnel areas for use by the Fire Department and tunnel personnel responding to emergencies. The phones will be connected to the OCC. Emergency phones will be connected to the CCTV system for the OCC to view a caller when the phone is activated.

- A General Electric system provides the public address (PA) systems including variable message signs (VMS), give passenger information, emergency instructions (including evacuation and other related information) and will be provided in each station. It will be visible by all passengers at the platform level of each station.

- Closed-circuit television (CCTV) coverage will be provided in most public areas. This includes, but is not limited to: elevators, elevator lobbies, escalators, stairs, platforms, platform edges, vending areas and station entrances and exits. Images from the cameras will be recorded and available for live monitoring for security purposes and emergency evacuation. A intrusion protection camera system will be used to protect areas of the system defined as restrictive access areas. These include entrances to tunnels and elevated guide way sections. At the CPS bus stop area, link support systems will be integrated with those of the shared-use tunnel facilities with Metro.

2.12 Operations Control Center

2.12.1 Link OCC

The primary rail OCC is located in the new King County Metro Communication and Control Center located at 1263 6th Ave S along the E3 bus way . The primary rail OCC location may change once the DSTT is dedicated to train service only, which is anticipated with the completion of North Link to Northgate station.

The Link Operations Control Center (OCC) is the nerve center for all segments of the system. The OCC staff will direct, coordinate, and monitor all train operations, including bus movements in the DSTT, mainline maintenance activities, and other maintenance activities that may effect operation. The OCC is responsible to direct yard operations that require movement of trains and maintenance equipment between the mainline and the yard. In addition, the OCC will monitor the status of a wide range of support systems and station equipment, including traction power, tunnel ventilation and fire life safety systems.

OCC personnel will use radio, telephone, PA communications, and visual displays to assist in the monitoring of train service. OCC will be responsible to respond to abnormal alarm conditions on the IS/AL system.

The OCC will constantly monitor and control all train movements for the entire IS/AL segment including the DSTT. The control consoles located at the OMF are designed to serve as a back up control center in case of an emergency.

2.12.2 King County Metro Combined Bus/Rail Metro Communication and Control Center

For efficient use of manpower and coordination, a combined control center concept using one single location will be implemented. This will facilitate joint operations between bus and train and be more effective in responding to all incidents and events. All activities for monitoring service will be directed from this combined OCC control center. This concept will ensure immediate and efficient communication among personnel responsible for the DSTT facility, bus operations, and link light rail movements plus emergency incident handling. A combined rail/bus supervisor controller position will be responsible to accommodate and coordinate both light rail and bus control for all normal and failure management operations. The Rail Supervisor Controller position will provide all first line communication, monitoring, command and control functions for supporting light rail. Sound Transit has contracted King County Metro to be the responsible agency to staff and operate the entire Link light rail system.

The OCC Rail Supervisor will be furnished with CCTV consoles that have digital recording capabilities. Control consoles will also be equipped with the following: SCADA terminals and monitors; a communications panel providing telephone, public address and radio access and control (both 700 MHz and 800 MHz),and PA/VMS controls and workstation computers tied to King County Metro and Sound Transit networks, for entering incident reports and for accessing procedures and troubleshooting guides. The OCC will be able to perform failure management duties necessary to be proactive in using the signaling system and route setting capabilities designed in the train control system.

2.12.3 Emergency Backup OCC

The OCC located at the OMF will serve as an Emergency Back-up for the King County Metro OCC as long as there is joint bus/rail operation in the DSTT. Once the DSTT becomes a LRT only tunnel, the OMF OCC may become the prime facility, with the King County Metro OCC as the back-up. Whenever an emergency situation disables the primary location, the other will be used to control the system.

2.13 Fare Collection System

A self-service, proof-of-payment fare collection system will be implemented for the entire Central Link IS/AL. Each passenger will be responsible for being in possession of a valid ticket, pass or transfer, and may be asked to show this proof of payment to a roving fare inspector on board a train or in a station platform area designated as a paid zone area. Fare Inspectors are under the direction of Sound Transit. Failure to have valid proof-of-payment will result in the fare inspector citing the passenger for fare evasion, for which the passenger may be assessed a fine payable in court.

This type of fare collection system is also referred to as “barrier-free” because it allows an open station design, without barriers or gates to control access to station platforms. Status of all Ticket Vending Machines (TVM) will be monitored by an independent TVM network controller (Central Data Collection System or CDCS), which will pass pertinent information on status to OCC consoles via SCADA. The CDCS will also upload sales data from the TVMs and download changes in fare tables, and other information. Credit card and debit card transactions will be cleared via the CDCS. An outside contractor will handle collection of revenue deposited into the TVMs.

Tickets and passes will be purchased from self-service (i.e., passenger-operated) ticket vending machines (TVMs) placed at station entries and mezzanines. Passes will also be available by mail and at customer service centers staffed by King County Metro. A regional Smart Card project will be in place by PSD date and will have the TVMs modified to reload any smart cards. Equipment will be installed in the stations to validate the Smart Cards, as necessary.

The Sound Transit Board of Directors has approved a policy to incorporate the “Ride Free” fare zone currently used by transit buses in downtown Seattle during the day as part of the fare policy adopted for Link.

A total quantity of 57 TVMs will be installed for the IS/AL segment, a minimum of 2 TVMs for each station.

2.14 Passenger Service Information

All stations in the IS/AL line segment will be equipped with information panels displaying both rail and bus printed schedules. Each station has a public address (PA) system on the platforms and variable message signs (VMS). Signs on the platforms will indicate next train times. Together, the PA and VMS will be capable of providing audible and visual messages, both prerecorded and live including service information and emergency management announcements.

The PA system is capable of performing next train announcements to patrons automatically if enabled by OCC. Primary responsibility for making late train announcements lies with OCC personnel. Field personnel have the ability to use both the PA and VMS systems from the emergency management panel at each station. Emergency response agencies also have the capability to make announcements from the emergency management panel.

The OCC will be capable of making one station or all stations PA announcements. Local news services will be notified of delays, and King County Metro and Sound Transit will post notices to their Internet web sites informing passengers of service disruptions.

King County Metro customer service is responsible to handle any information request calls from passengers at stations through the use of the public telephone system. The public phone will have a free direct dial number.

All lost and found functions will be handled by King County Metro. Articles found on either a bus or train will be controlled by one agency. The IS/AL will use King Country Metro lost and found department policy to return items to passengers.

Articles found at the SeaTac/Airport station will follow policy set by the Seattle Port Authority Police.

3.0 Ridership Initial Segment

Ridership projection models using data for the years 2020 form the bases for development of the level of service needed to meet the IS/Al requirements in 2009. Annualization factors using the model years as a base line were used to determine fleet size requirements, headways, and station circulation and egress, as well as quantities of ticket machines and other passenger support equipment.

Headways are determined either by ridership demand or by policy. During the planning and design phases, Link has consistently shown a six-minute peak period headway for the Initial Segment based on 2020 year ridership. For planning purposes, the RFMP has developed headways and fleet sizes based on ridership demand which are reflexed in this plan. The final decision on headways will be made by the Sound Transit Board at a later date.

3.1 Ridership Serving Major Employment Concentrations

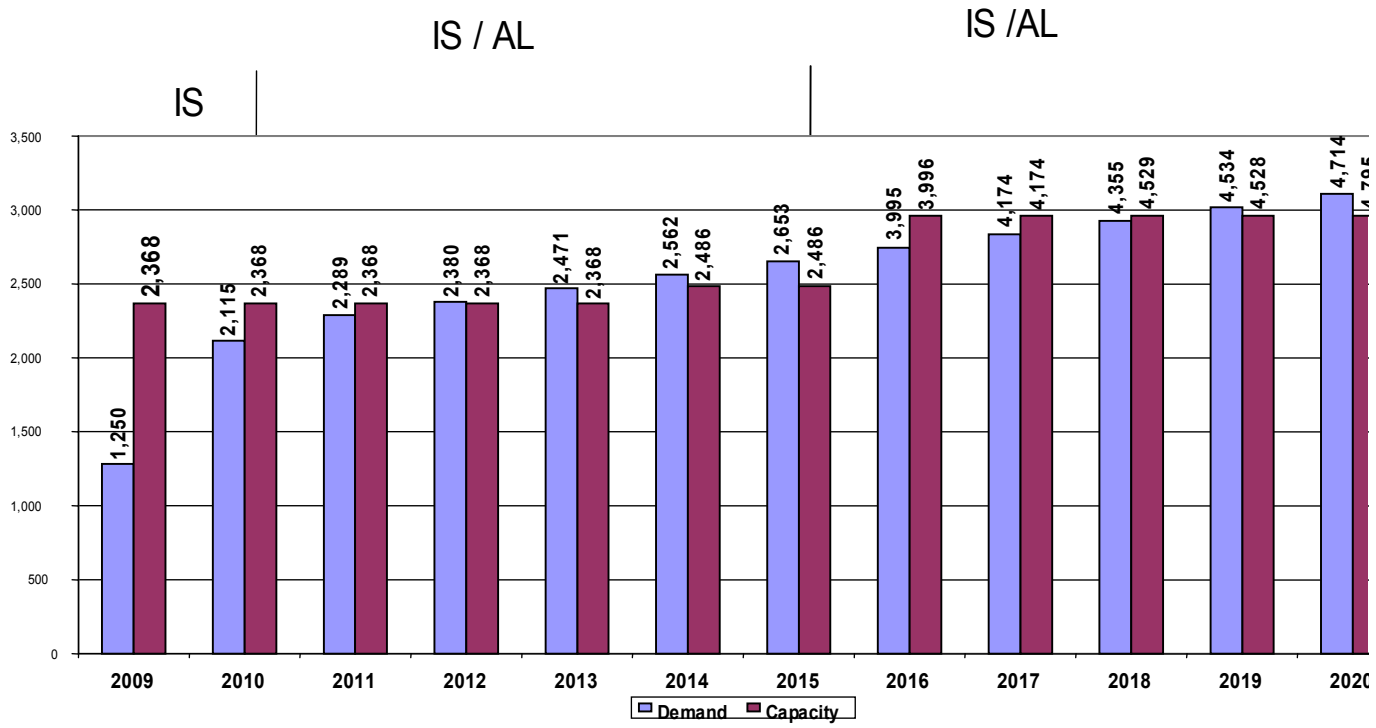
The IS/AL serves the region's primary central business district, major medical complexes and other large centers of activity to attract more riders. Initial Segment ridership projections reflect this pattern, including major downtown stations, Westlake and University Street. The temporary southern terminal of the Initial Segment at International Blvd Station in Tukwila has a 600 space parking lot constructed to serve the LRT riders. Combined with the completion of the Airport Link in 2009 the IS/AL segment is expected to experience higher patronage.

The Seattle waterfront and the Seattle Art Museum downtown draw visitors from throughout the region. Benaroya Hall and the Paramount Theatre downtown, as well as numerous smaller venues throughout the corridor host frequent performances and will provide higher off peak requirements for various special events The SeaTac/Airport station will incur higher seasonal ridership during holidays periods.

3.2 Weekday Ridership at the Peak Load Point

Ridership at the peak load point (PLP) the highest number of riders between two stations in the peak direction determines the amount of service that must be provided in order to meet projected demand. The following tables show ridership peak load demand and capacity in the PM for the IS/AL section for the year 2009 thru 2020. The peak load point will be southbound between University Street station and International District Station for the PM peak hour.

Figure 3-1 Demand and Capacity IS/AL 2009 to 2020 One Hour PM Peak Passenger



4.0 Weekday Ridership by Time of Day and level of service

While peak period ridership projections are most critical for determining fleet size and system design requirements, off-peak ridership provides necessary information for planning service for the remainder of the day and for determining operating statistics and staffing requirements. Assumptions and percentage factors used to determine fleet size are shown in the tables below, for weekday service, and for weekend service for all service years.

Table 4-1 Estimated Ridership throughout the Weekday

Weekday	Factor	Basis of Assumptions
Early / Late	25%	Weekday Peak
AM Peak	100%	__
Base	50%	Weekday Peak
PM Peak	100%	__
Base	50%	Weekday Peak
Early / Late	25%	Weekday Peak

Table 4-2 Assumed Ridership on Weekends for Service Planning

Day of Week	Factor	Basis of Assumptions
Saturday		
Early / Late	50%	Saturday Base
Base	50%	Weekday Base
Early / Late	50%	Saturday Base
Sundays		
Early / Late	50%	Sunday Base
Base	33%	Weekday Base
Early / Late	50%	Sunday Base

5.0 Ridership Projections for Airport Link

Ridership projections for the Airport Link extension used projection models for years 2011 and 2020 to determine requirements for the IS/AL. 2009. Annualization factors were used on the 2011 and 2020 model to convert average weekday ridership forecasts from planning models into annual ridership. The current annualization factor applied to link forecasting is 304.

Table 5-1 Summary of Initial Segment and Airport Link Weekday Boardings

Period	Year 2009 Westlake to International BLVD	Year 2010 Westlake to Airport
Total Daily Boarding	19,800	32,600
Annual Ridership	3,000,000	9,000,000
Note : 2009 numbers reflect partial year 6 month operation		

6.0 SERVICE CHARACTERISTICS

This section describes the service plan for the Initial Segment and Airport extension. It includes service standards, hours of revenue service, running times, headways, fleet size, and other operating parameters. The service plan reflects forecasted ridership, the civil characteristics of the line, estimated train running times, and service policy assumptions. Changes to any of the basic elements will affect fleet size, staffing, operating statistics, and operating and maintenance costs.

Table 6-1 Summary 2009/ 2010 Joint Bus / Train Operations Plan

Service Elements	IS	IS/AI
Service Elements		
Ridership Year	**2009**	**2010**
Consist Size	**2**	**2**
Cycle Time in Minutes	**82**	**86**
Route Miles	**13.9**	**15.6**
Tukwila Int Blvd to Airport		**1.7**
Headways		
Peak	**6.0**	**6.0**
Base Period	**10**	**10**
Early / Late	**15**	**15**
Line Load PM Pk Hour	**1,250**	**2,115**
Daily Boarding's	**19,800***	**32,600**
Annual Ridership	**3,000,000***	**9,000,000**
Projected Load Factor	**1.06**	**1.79**
Design LF 2.0 Car miles	**2,350,268**	**2,662,797**
Minimum needed fleet size in service	**28**	**30**
Gap Train	**0**	**2**
PVR	**28**	**32**
Mtce spares	**3**	**3**
Total Fleet size	**31**	**35**

* Partial year of operations 6 months

6.1 Hours of Revenue Service

The IS/AL will operate seven days per week and will provide service approximately 20 hours per day. Weekday service on the Central Line will begin at approximately 5:00 AM and end at approximately 1:00 AM. Saturday service will span the same hours. Sunday and holiday service will begin at 6:00 AM and end at midnight. Facilities and systems are designed so as not to preclude 24-hour operation in the long-term.

6.2 Definition of Weekday Service Periods

Service levels will vary during the day according to the peaking characteristics of the projected ridership. Weekday peak commuting periods for the Central Line are defined as 6:00 am to 8:30 am and 3:00 pm to 6:30 pm. Table 6-9 shows the service periods for weekdays. Weekend and holiday service will be at base and early/late levels of service depending upon time of day.

6.3 Load Factors

The load factor, or the ratio of riders to available seats, is a key element in determining service frequency and fleet size. Transit services are typically sized for some standing passengers on vehicles during peak hours, and a target maximum load factor is used to avoid excessive crowding on trains. For midday levels of service, a load factor of 1.0 is used to represent a seat for every rider. A load factor of 2.0 has been established as a standard for Central Line peak period service.

The 2.7 load factor produces a maximum assumed vehicle capacity of 200 persons for the 95-foot articulated light rail vehicle, equivalent to 800 persons for a four-car train.

With an estimated 313 square feet of standing area anticipated for each car, the 74 standees will have approximately 4.2 square feet of standing area per person. This standing density will be sufficient for passengers to move to and from the doorway vestibule for boarding and alighting and for fare inspectors to circulate through the car. (See table 6-2)

Table 6-2 Light Rail Vehicle Capacity

LRV Type	Seats	Load Factor	Passengers Per Car	Maximum Cars Per Train	Passengers Per Train
Peak Hour Capacity for Planning	74	2.0	148	2	296
MAX Capacity	74	2.7	200	4* For special events from Stadium station south DSTT will not support 4 car services at this time due to Stub tunnel cross over length.	800

6.4 Dwell Time and Terminal Time

Dwell time the time trains spend stopped at stations has been set at 20 seconds per station. The actual time required for a station is normally expected to be somewhat shorter. A longer dwell time will be used for those stations at which peak hour boarding and alighting require such longer dwells. Station dwells will be adjusted during the first year of ridership.

Terminal time or layover time is the time trains spend waiting between runs at end-of-the-line or mid-line turnback stations. The terminal time built into a train schedule typically provides for two things: sufficient time to enable train operators to change ends and reset destination signs; and a schedule recovery allowance that enables trains arriving late to begin their next run on-time. Schedule recovery is normally a portion of no more then 5 percent or more – of the one-way running time. A terminal time of five minutes for the south terminal and seven minutes for the north is established for the IS section; Tukwila International Blvd and SeaTac/Airport station have front-end crossovers and trains will turnback at the platform. Terminal time of three minutes is estimated for any possible turnbacks at the Pine Street pocket track, providing time for direction reversal and some small schedule recovery. These estimates do not include the 90 seconds provided for movement between Westlake station and the pocket track.

It is anticipated that train operators may require more terminal time than that built into the train schedule. Train operators may be scheduled to "drop back;" an operator for bringing a train into the terminal which then may be assigned to operate a different train later in the outbound direction, thus providing additional terminal time for the operator. This can be done with the use of extra operators at the terminal stations. The final decision to use drop back or not will be determined after the actual runs times are verified and after commissioning and testing of the trains using the entire IS/AL system during integrated testing.

6.5 Running Time

6.5.1 Link Trains

Station-to-station and end-to-end train operating times were estimated using a computerized model. The model uses inputs for route characteristics, speed limits, grades, vehicle characteristics and other features. Output reports include link-by-link summaries of running times and detailed half-second tracking of one or more trains. Based on the results of the simulation, one-way running time is 34 minutes (rounded up) for the IS from Tukwila International Blvd Station to the Westlake for 2009. The 36-minute one way run time is used for the Initial Segment with a 6-minute headway during the peak periods. These assumptions are based on computerized simulations. Included in the travel time is an allowance of 100 seconds for the uncertainty of how automobile signals will work in the Rainier Valley and an additional 120 seconds for bus/rail interface in the DSTT. These travel times will be verified in simulated pre-revenue service and inter-station travel time adjustments made accordingly. The contracted operating agency has developed a first draft of potential train operator run cuts using a 6 minute headway. The total includes station-to-station running, a 20-second dwell time per station stop, and projected delay time for traffic signals at street intersections on MLK Jr. Way. Table 6.6 is an estimation for the run times for the IS which will be operational in 2009. These times will also be verified in simulated pre-revenue service before changes are made to the operating plan. Table 6-7 shows the projected run times for the IS/Al in 2010. The project run times for the IS/Al is now 38 minutes using a 4 turn-around time.

Table 6-3 Central Link Travel Times –Initial Segment Westlake to Tukwila

Southbound

Station	End to End Run Time	Station Dwell Time	Cumulative Time
	(secs)	(secs)	(hr:min:secs)
Westlake			
	62		00:01:02
University St.		20	
	62		00:02:24
Pioneer Square		20	
	58		00:03:42
Int'l District		20	
	91		00:05:33
Stadium		20	
	81		00:07:14
SODO		20	
	142		00:09:56
Beacon Hill		20	
	88		00:11:44
Mount Baker		20	
	158		00:14:42
Columbia City		20	
	203		00:18:25
Othello		20	
	144		00:21:09
Rainier Beach		20	
	511		00:30:00
Tukwila Int'l Blvd.			
Allowance for Joint bus/rail ops	120		00:32:00
Allowance for MLK Traffic delay time	100		00:33:40

Northbound

Station	End to End Run Time	Station Dwell Time	Cumulative Time
	(secs)	(secs)	(hr:min:secs)
Tukwila Int'l Blvd.			
	511		00:08:31
Rainier Beach		20	
	144		00:11:15
Othello		20	
	203		00:14:58
Columbia City		20	
	158		00:17:56
Mount Baker		20	
	88		00:19:44
Beacon Hill		20	
	142		00:22:26
SODO		20	
	81		00:24:07
Stadium		20	
	91		00:25:58
Int'l District		20	
	58		00:27:16
Pioneer Square		20	
	62		00:28:38
University St.		20	
	62		00:30:00
Westlake			
Allowance for Joint bus/rail ops	120		00:32:00
Allowance for MLK Traffic delay time	100		00:33:40

Note:
The following have been used for planning purposes:

- An allowance of 120 seconds additional run time is included for bus/rail interaction in the DSTT.
- To reflect potential delays due to auto traffic signal system and/or missed traffic signal phases, an allowance of 50 seconds additional run time has been added to Mount Baker to Columbia City and 50 seconds additional run time added to Columbia City and Othello.
- Station to station run times are based on computer simulations and do not include the added allowances for DSTT joint bus/rail operations or potential delays on MLK
- Cycle time = 84 minutes based on the following
  34 minutes end to end
  5 minutes terminal layover at Tukwila International Blvd. Station
  11 minutes terminal layover in Pine Street tail track (includes 7 minutes actual layover time plus 90 seconds travel time each way Westlake to tail track and back, plus 20 seconds dwell time at Westlake northbound and 20 seconds at Westlake southbound)
- Travel times and turn round times will be verified in simulated pre-revenue service before final changes are made to the operating plan.

Table 6-4 Central Link Travel Times Airport Link--Westlake to SeaTac/Airport

Southbound

Station	End to End Run Time (secs)	Station Dwell Time (secs)	Cumulative Time (hr:min:secs)
Westlake			
	62		00:01:02
University St.		20	
	62		00:02:24
Pioneer Square		20	
	58		00:03:42
Int'l District		20	
	91		00:05:33
Stadium		20	
	81		00:07:14
SODO		20	
	142		00:09:56
Beacon Hill		20	
	88		00:11:44
Mount Baker		20	
	158		00:14:42
Columbia City		20	
	203		00:18:25
Othello		20	
	144		00:21:09
Rainier Beach		20	
	511		00:30:00
Tukwila Int'l Blvd.		20	
	144		00:32:44
SeaTac/Airport			
Allowance for Joint bus/rail ops	120		00:34:44
Allowance for MLK Traffic delay time	100		00:36:24

Northbound

Station	End to End Run Time (secs)	Station Dwell Time (secs)	Cumulative Time (hr:min:secs)
SeaTac/Airport			
	144		00:02:24
Tukwila Int'l Blvd.		20	
	511		00:11:15
Rainier Beach		20	
	144		00:13:59
Othello		20	
	203		00:17:42
Columbia City		20	
	158		00:20:40
Mount Baker		20	
	88		00:22:28
Beacon Hill		20	
	142		00:25:10
SODO		20	
	81		00:26:51
Stadium		20	
	91		00:28:42
Int'l District		20	
	58		00:30:00
Pioneer Square		20	
	62		00:31:22
University St.		20	
	62		00:32:44
Westlake			
Allowance for Joint bus/rail ops	120		00:34:44
Allowance for MLK Traffic delay time	100		00:36:24

Note:
The following have been used for planning purposes:

1. An allowance of 120 seconds additional run time is included for bus/rail interaction in the DSTT.
2. To reflect potential delays due to auto traffic signal system and/or missed traffic signal phases, an allowance of 50 seconds additional run time has been added to Mount Baker to Columbia City and 50 seconds additional run time added to Columbia City and Othello.
3. Station to station run times are based on computer simulations and do not include the added allowances for DSTT joint bus/rail operations or potential delays on MLK
4. For planning purposes, the following times have been assumed:
   Cycle time = 90 minutes based on the following
   37 minutes end to end
   5 minutes terminal layover at Tukwila International Blvd. Station
   11 minutes terminal layover time in the Pine Street tail track (includes 7 minutes actual layover time plus 90 seconds travel time each way Westlake to tail track and back, plus 20 seconds dwell time at Westlake northbound and 20 seconds at Westlake southbound)
5. Travel times and turn round times will be verified in simulated pre-revenue service before final changes are made to the operating plan.

6.5.2 Metro Bus – Dwell and Running times

Bus run times and dwell times are based on empirical data. The 25-second average dwell time experienced today has been reduced by 10 percent to reflect the faster boarding expected with introduction of low-floor coaches. This percentage will be confirmed during testing. Additional dwell time will be necessary for the occasional boarding of passengers on bicycles or in wheelchairs. With low-floor buses, ramps will be deployed in place of wheelchair lifts to assist disabled passengers. Bus ramp deployment and wheelchair securing will extend dwell times. The new hybrid buses have only 2 doors. An analysis using the new buses will be done to better understand the effects of dwells times and ramps vs. lift times and low floor vs. high floor. Run times and dwell times shown in this section will be further updated to reflect revised operating rules, which in turn may require additional modeling. The estimated unimpeded trip times for DSTT are shown in Table 6-8 below.

Table 6-5 One-Way Trip Times From North Tunnel Merge Point and South Merge Point

		Link rail service			Metro bus service		
Station	**Distance (miles)**	**Run (sec)**	**Dwell (sec)**	**Cum (m:s)**	**Run (sec)**	**Dwell (sec)**	**Cum (m:s)**
Convention PL merge *				0:00			0:00
	0.2	90			98		
Westlake			20	1:50		22	2:00
	0.3	62			118		
University Street			20	3:23		22	4:20
	0.4	62			91		
Pioneer Square			20	5:01		22	6:13
	0.3	58			102		
International District / Chinatown			20	5:52		22	8:17
	0.1	47			50 est.		
IDS merge *				6:37			9:07

* The North tunnel merge point occurs between the CPS bus platform and the Westlake Joint use station. The Southern merge point occurs south of IDS station between the I90 entrance and Royal Brougham street.

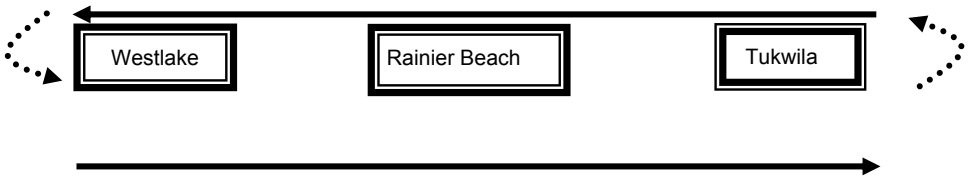
6.6 Pattern of Operation

When the Initial Segment from Westlake to Tukwila Int'l Blvd opens, all trains will operate between those two terminals and stop at every station with using no turnbacks. Once the line has been extended to SeaTac/Airport and ridership capacity has increased, an alternative service pattern may be implemented.

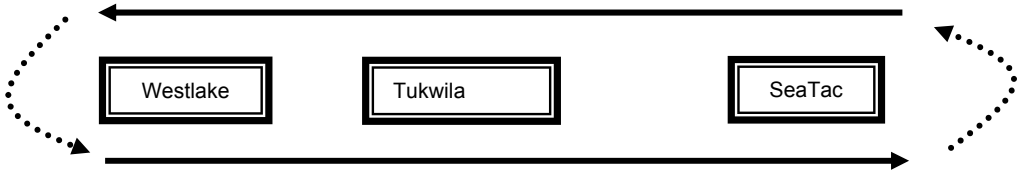
Under the alternate pattern of operation, every other train could turn back in the Rainier Beach pocket track during peak periods allowing for increased capacity between the most heavily traveled stations during the rush hours; the remaining trains may operate to the end of the line. The appropriate service pattern for the rail line will be based on the distribution of riders at stations along the line and the most effective means to tailor the service offered to the required demand. The alternative service scenarios are depicted in Figure 6-1.

Figure 6-1 Alternative Service Scenarios

Initial Operating Scenario: All trains stop at all stations



IS/AL Operating Scenario: All trains stop at all stations



6.7 Service Levels

6.7.1 Link Service levels

Service levels have been established for each part of the day. Weekday service levels are summarized in Table 6-9.

Table 6-6 Weekday Service Levels for IS 2009

Service Period	Time Period	Service Type	Headway (Min)
Early Morning	5:00AM – 6:00AM	Early/Late	15
Morning Peak	6:00AM – 8:30AM	Peak	6
Midday	8:30AM – 3:00PM	Base	10
Afternoon Peak	3:00PM – 6:30PM	Peak	6
Evening	6:30PM – 10:00PM	Base	10
Late Night	10:00PM – 1:00AM	Early/Late	15

6.7.2 Metro Bus Service Levels

King County Metro has preliminarily identified routes as possible routes to operate in the DSTT under joint operating conditions based on the vehicle through put capacity suggested by the joint operation simulation modeling. Average weekday ridership on these routes totaled almost 53,000 daily riders (Metro Route 215 ridership was included, as ST Route 554 has recently replaced that route). Modeling for bus operations was on the basis that buses arrive and depart the staging areas at CPS and IDS at random, and based on forecast 2010 headway. The routes and service levels shown in the table below are for long-range planning purposes only and may be amended due to capacity constraints (either passenger or line) and/or future policy decisions. As of January 2006 King County Metro is in the process of developing a final service plan identifying the routes that will be operating in the DSTT with joint operations. The maximum bus volume would be 120 per hour during PM peak (both directions vs 140 prior to closure of the DSTT).

Table 6-7 Under development: Metro/ST Bus Routes in DSTT Under Joint Operations

			Projected 2010 Hourly Bus Volumes					
			AM Peak Hr		Midday		PM Peak Hr	
Route	Corridor	Serving	NB	SB	NB	SB	NB	SB
41/307	I-5 North	Northgate; SR-522	4	16	4	4	16	4
71/72/73	I-5 North	U District	8	10	6	6	10	8
101	I-5 South	Renton	8	4	4	4	4	8
150	I-5 South	Tukwila; Kent; Auburn	4	4	4	4	4	4
174+	Pacific Hwy	Duwamish; SeaTac; Federal Way	4	4	4	4	4	4
194	I-5 South	SeaTac; Federal Way	4	4	4	4	4	4
255/256	SR-520	Kirkland/Kingsgate/ Overlake	4	8	4	4	8	4
550	I-90	Mercer Island; Bellevue	12	6	4	4	6	12

		Total	**56**	**64**	**42**	**42**	**64**	**56**

6.8 Bus/Train Separation

The OCC controller function and signaling system planned for joint operation are critical to preventing incidents between bus and train and between two trains, by tracking the location of each vehicle and maintaining separation through the use of wayside signals. Train and bus operators will be responsible to adhere to all signal indications. In addition to standard train-train and bus-bus separation, the following train and bus separation rules will apply:

1. A Link train may not enter a station or tunnel bore section until the train or bus ahead has exited that station or tunnel section.
2. A bus may not enter a station or tunnel bore section until the train ahead has exited that station or tunnel bore section.
3. A bus may enter a station or tunnel bore section if following another bus.

Figure 6-2 show where trains and buses will progress into the merge points and through the tunnel under these rules. Figures 6-3 represents operations between the merge points as trains and buses move through the tunnel from station to station; Figure 6-4 depicts operations at CPS/Westlake; and Figure 6-5 depicts train and bus merge operations at IDS. All movements and progression would be controlled by the integrated signal system and under supervision of the OCC.

At the IDS merge points for the I-90 and the E3 bus way there are crossing gates and flashers installed to prevent bus integration against the flow of a train. Current approved design call for flashers only at IDS bus turnback area due to space restrictions. The current installed design also provides for flashers at both the IDS merge locations and CPS. In addition there are two gates located in the IDS area. One gate is at the I-90 ramp and the other gated crossing is at the E-3 bus way. In total there are 6 sets of rail road flashers used to warn bus drivers in the DSTT of approaching trains. These features will be revisited if safety issues arise in the pre–revenue phase of testing between bus and train interface.

Figure 6-2 DSST Bus / Rail Portal and Merge Points)

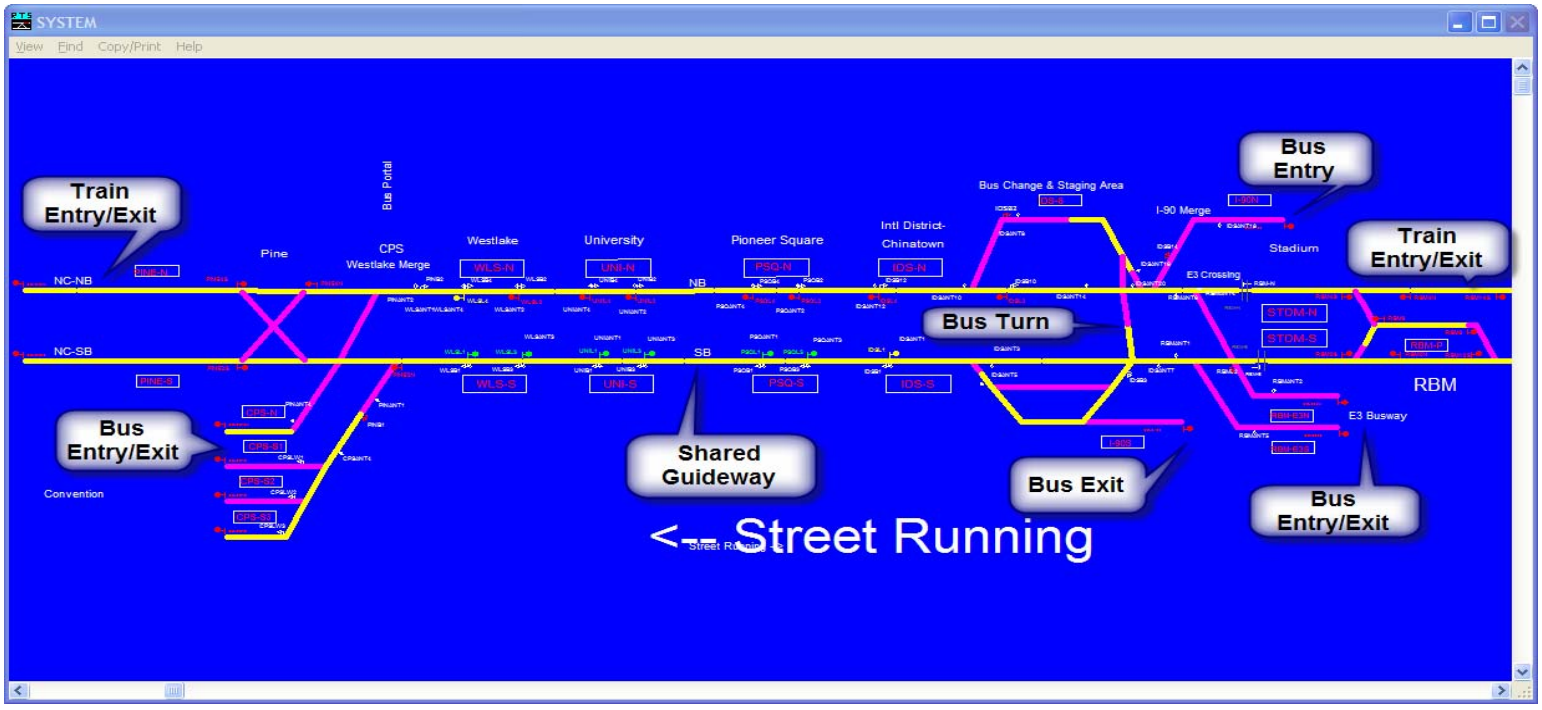


Figure 6-3 Train and Bus Movement Through the Tunnel

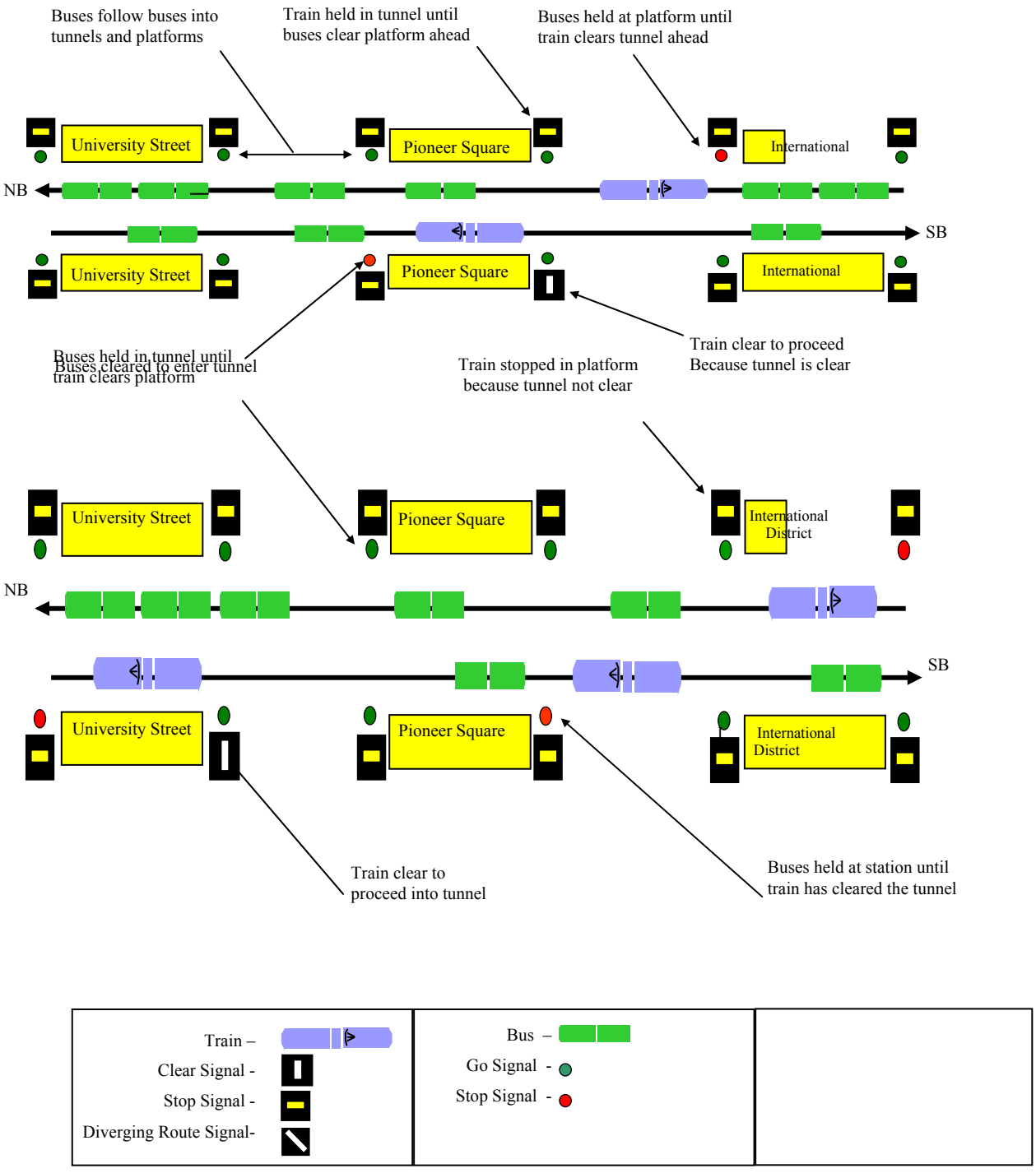


Figure 6-4 Train and Bus Movement at the CPS/Westlake Merge Point

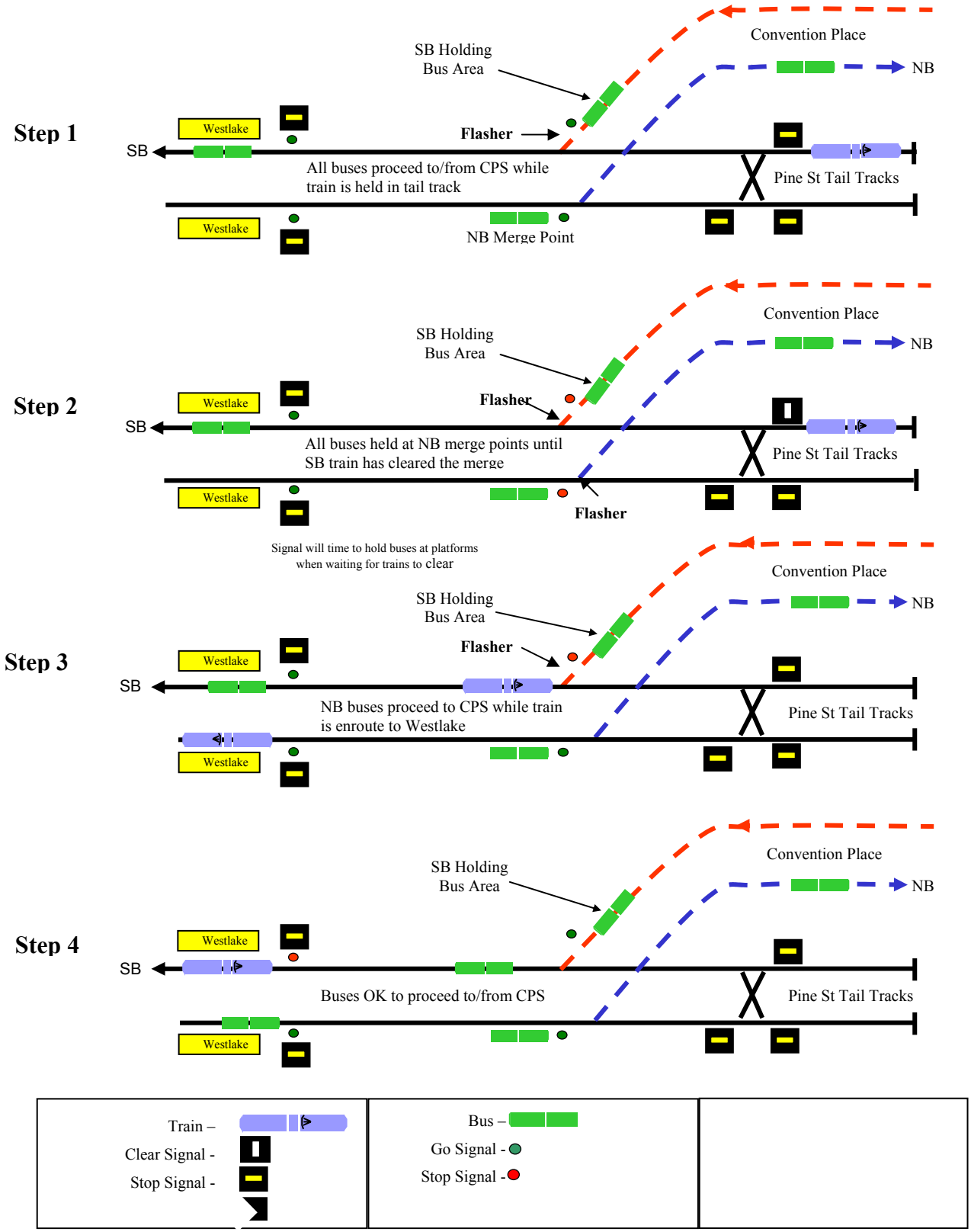
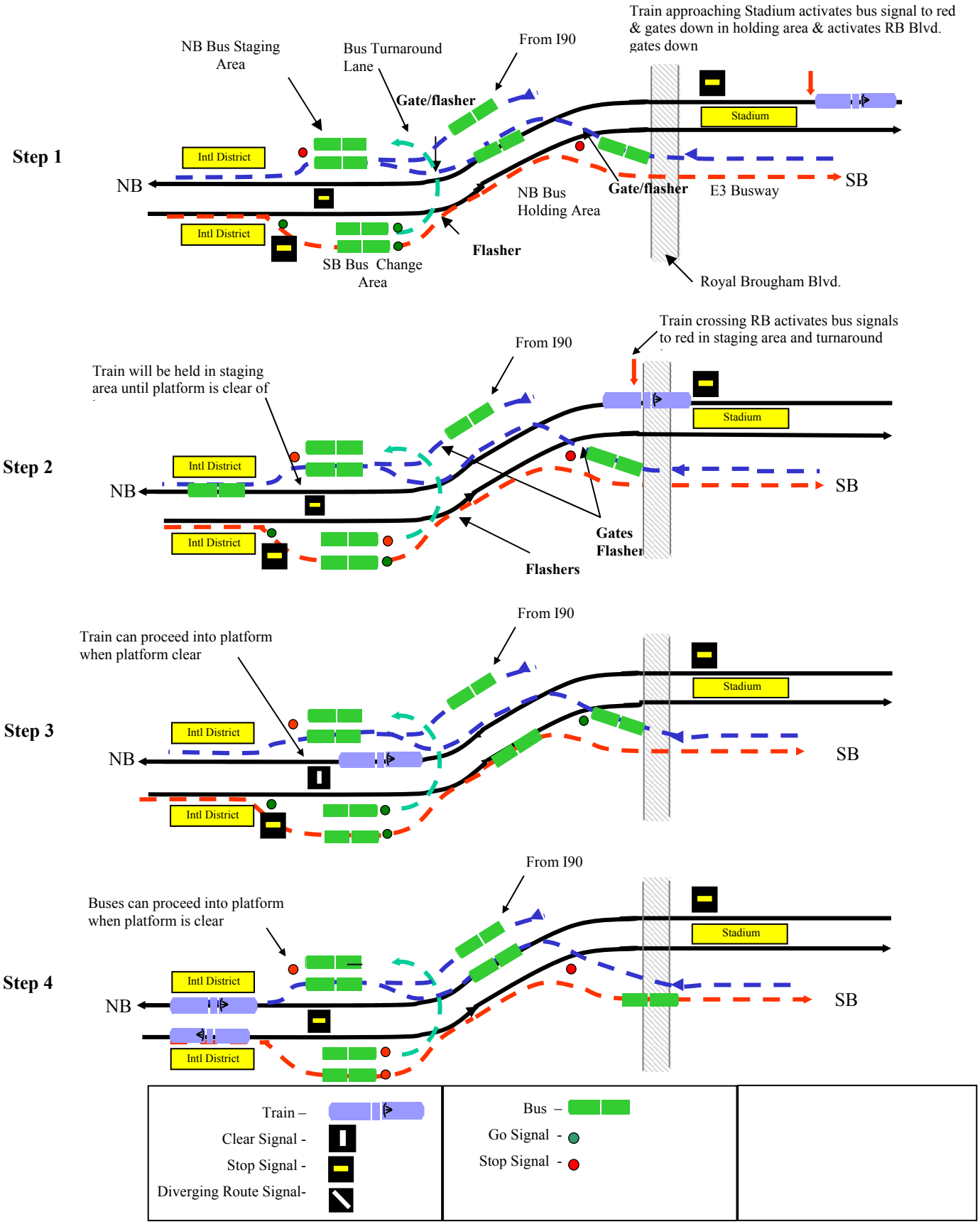


Figure 6-5 Bus /Train Interface IDS



6.9 Fleet Size Requirements

Two-car trains will be sufficient to provide the necessary passenger capacity at the established service frequencies identified in the IS in 2009 and the IS/AL for 2010.

Service frequency and train length determine the number of vehicles required for the 2009 initial IS service. The planned peak hour of six-minute headway requires 26 cars in service during peak periods for year 2009. A 2-car "gap train" and 3 maintenance spares is added to this number to raise the needed fleet size to 31 vehicles. During peak periods, a “gap train” (sometimes called a standby train or “reserve train”) and its operator will be positioned on a siding or pocket track normally near the midpoint of the line, and held in reserve to assume the schedule of a train that has become excessively late or disabled. The figure below shows how service capacity will meet forecast link line loads up to 2016 based on ridership projections. Fleet size for the IS/AL in 2010 is 35 vehicle fleet using 2 car trains for service and 30 cars in peak service, a 2 car gap train, and a 3 car spare ratio. For details, see the 2007 Central Link Rail Fleet Management Plan.

Table 6-8 Peak Vehicle Requirements

Projected Ridership Year	IS	IS /AL
2009	28	
2010		32
2011		32
2012		32
2013		32
2014		32
2015		32

Tables shown in the following pages represent the operational service plans for the IS service in 2009 including Saturday and Sunday service . The IS is projected to start service in July of 2009. Projected service plans for the IS/Al follow with the projected start of service to start early in 2010.

Table 6-9 Service Level and Fleet Size Analysis for IS (Year 2009)

2-Car scenario - No Rainier Beach Turnback

Ridership data for each year are estimated by linear interpolation

Service Pattern	Number of Stations	Route Miles	Travel Times (min) One Way	Terminal Layover	Cycle Time	Headways (mins)	Vehicle Requirements Consist Size	Trains Required	# Revenue Cars	Gap Train	Spare Cars 10.7%	Revenue Service	Total Fleet Size	Ridership Statistics Hourly Ridership Demand	Hourly Seated Capacity	Hourly Vehicle Capacity	Load Factor	Maximum Load Point
Early Late WLS - Tukwila Int'l Blvd (5.00 am - 6.00 am)	12	13.9	34.0	16	84	15	2	6	12			12		313	592	1,096	.53	
Peak Period WLS - Tukwila Int'l Blvd (6.00 am - 8.30 am)	**12**	**13.9**	**34.0**	**16**	**84**	**6**	**2**	**14**	**28**	**0**	**3**	**31**	**31**	**1,250**	**1480**	**2,960**	**.84**	
Base Period WLS - Tukwila Int'l Blvd (8.30 am - 3.00 pm)	12	13.9	34.0	16	84	10	2	9	18			18		625	888	1,644	.70	
Peak Period WLS - Tukwila Int'l Blvd (3.00 pm - 6.30 pm)	**12**	**13.9**	**34.0**	**16**	**84**	**6**	**2**	**14**	**28**	**0**	**3**	**31**	**31**	**1,250**	**1480**	**2,960**	**.84**	Pioneer Sq. to IDS SB
Base Period WLS - Tukwila Int'l Blvd (6.30 pm - 10.00 pm)	12	13.9	34.0	16	84	10	2	9	18			18		625	888	1,644	.70	
Early/Late WLS - Tukwila Int'l Blvd (10.00 pm - 01.00 am)	12	13.9	34.0	16	84	15	2	6	12			12		313	592	1,096	.53	

Saturday

Service Pattern	Number of Stations	Route Miles	Travel Times (min) One Way	Terminal Layover	Round Trip	Headways (mins)	Vehicle Requirements Consist Size	Trains Required	# Revenue Cars	Gap Train	Spare Cars	Revenue Service	Total Fleet Size	Ridership Statistics Hourly Ridership Demand	Hourly Seated Capacity	Hourly Vehicle Capacity	Load Factor	Maximum Load Point
Early Late WLS - Tukwila Int'l Blvd (5.00 am - 8.00 am)	12	13.9	34.0	16	84	15	2	6	12			12		313	592	1,096	0.53	
Base Period WLS - Tukwila Int'l Blvd (8.00 am - 10.00 pm)	12	13.9	34.0	16	84	10	2	9	18			18		625	888	1,644	0.70	
Early/Late WLS - Tukwila Int'l Blvd (10.00 pm - 01.00 am)	12	13.9	34.0	16	84	15	2	6	12			12		313	592	1,096	0.53	

Sunday

Service Pattern	Number of Stations	Route Miles	Travel Times (min) One Way	Terminal Layover	Round Trip	Headways (mins)	Vehicle Requirements Consist Size	Trains Required	# Revenue Cars	Gap Train	Spare Cars	Revenue Service	Total Fleet Size	Ridership Statistics Hourly Ridership Demand	Hourly Seated Capacity	Hourly Vehicle Capacity	Load Factor	Maximum Load Point
Early Late WLS - Tukwila Int'l Blvd (6.00 am - 8.00 am)	12	13.9	34.0	16	84	15	2	6	12			12		206	592	1,096	0.35	
Base WLS - Tukwila Int'l Blvd (8.00 am - 10.00 pm)	12	13.9	34.0	16	84	10	2	9	18			18		413	888	1,644	0.46	
Early Late WLS - Tukwila Int'l Blvd (10.00 pm - 12.00 am)	12	13.9	34.0	16	84	15	2	6	12			12		206	592	1,096	0.35	

Table 6-10 Service Level and Fleet Size Analysis for IS/AI (Year 2010)

Monday - Friday — **2-Car Scenario - No Rainier Beach Turnback** — **Ridership data for each year are estimated by linear interpolation**

Service Pattern	Number of Stations	Route Miles	Travel Times (min) One Way	Terminal Layover	Cycle Time	Headways (mins)	Vehicle Requirements Consist Size	Trains Required	# Revenue Cars	Gap Train	Spare Cars 10.0%	Revenue Service	Total Fleet Size	Ridership Statistics Hourly Ridership Demand	Hourly Seated Capacity	Hourly Vehicle Capacity	Load Factor	Maximum Load Point
Early Late WLS to SeaTac/Airport (5.00 am - 6.00 am)	13	15.32	37.0	16	90	15	2	6	12			12		321	592	1,096	.54	
Peak Period WLS to SeaTac/Airport (6.00 am - 8.30 am)	**13**	**15.32**	**37.0**	**16**	**90**	**6**	**2**	**15**	**30**	**2**	**3**	**35**	**35**	**1,282**	**1480**	**2,960**	**.87**	
Base Period WLS to SeaTac/Airport (8.30 am - 3.00 pm)	13	15.32	37.0	16	90	10	2	9	18			18		641	888	1,644	.72	
Peak Period WLS to SeaTac/Airport (3.00 pm - 6.30 pm)	**13**	**15.32**	**37.0**	**16**	**90**	**6**	**2**	**15**	**30**	**2**	**3**	**35**	**35**	**1,282**	**1480**	**2,960**	**.87**	Pioneer Sq. to IDS SB
Base Period WLS to SeaTac/Airport (6.30 pm - 10.00 pm)	13	15.32	37.0	16	90	10	2	9	18			18		641	888	1,644	.72	
Early/Late WLS to SeaTac/Airport (10.00 pm - 01.00 am)	13	15.32	37.0	16	90	15	2	6	12			12		321	592	1,096	.54	

Saturday

Service Pattern	Number of Stations	Route Miles	Travel Times (min) One Way	Terminal Layover	Round Trip	Headways (mins)	Vehicle Requirements Consist Size	Trains Required	# Revenue Cars	Gap Train	Spare Cars	Revenue Service	Total Fleet Size	Ridership Statistics Hourly Ridership Demand	Hourly Seated Capacity	Hourly Vehicle Capacity	Load Factor	Maximum Load Point
Early Late WLS to SeaTac/Airport (5.00 am - 8.00 am)	13	15.32	37.0	16	90	15	2	6	12			12		321	592	1,096	0.54	
Base Period WLS to SeaTac/Airport (8.00 am - 10.00 pm)	13	15.32	37.0	16	90	10	2	9	18			18		641	888	1,644	0.72	
Early/Late WLS to SeaTac/Airport (10.00 pm - 01.00 am)	13	15.32	37.0	16	90	15	2	6	12			12		321	592	1,096	0.54	

Sunday

Service Pattern	Number of Stations	Route Miles	Travel Times (min) One Way	Terminal Layover	Round Trip	Headways (mins)	Vehicle Requirements Consist Size	Trains Required	# Revenue Cars	Gap Train	Spare Cars	Revenue Service	Total Fleet Size	Ridership Statistics Hourly Ridership Demand	Hourly Seated Capacity	Hourly Vehicle Capacity	Load Factor	Maximum Load Point
Early Late WLS to SeaTac/Airport (6.00 am - 8.00 am)	13	15.32	37.0	16	90	15	2	6	12			12		212	592	1,096	0.36	
Base WLS to SeaTac/Airport (8.00 am - 10.00 pm)	13	15.32	37.0	16	90	10	2	9	18			18		423	888	1,644	0.48	
Early Late WLS to SeaTac/Airport (10.00 pm - 12.00 am)	13	15.32	37.0	16	90	15	2	6	12			12		212	592	1,096	0.36	

6.10 Operating Statistics

Operating statistics for the IS/AL are useful in planning staffing and maintenance requirements, and for estimating operating and maintenance costs. For rail systems, train hours and car miles are the statistics most often used for these purposes. These statistics are presented in the following tables:

Table 6-11 Operating Statistics Initial Segment 2009 (Data extrapolated to a full year)

Day of Week	Days/Yr	Hours of Service	Daily Train Trips	Daily Train Hours	Annual Train Hours	Revenue car miles	Annual Rev Car Miles
Weekday	255	20	272	198	50,490	7,562	1928208
Saturday	52	20	216	162	8,424	6,005	312250
Sunday	58	18	200	150	8,700	5,560	322480
Annual Total	365				67,614		2,562,938

Table 6-12 Operating Statistics Initial Segment/Airport Link (2010)

Day of Week	Days/Yr	Hours of Service	Daily Train Trips	Daily Train Hours	Annual Train Hours	Rev car Miles	Annual Rev Car Miles
Weekday	255	20	278	204	52,020	8,524	2,173632
Saturday	52	20	221	162	8,424	6,765	351,796
Sunday	58	18	205	150	8,700	6,269	363,599
Annual Total	365				69,144		2,889,027

6.11 Future Line Capacity

After the light rail line is extended north and train operations require sole possession of the DSTT, the signal system will enable trains to operate at 2-minute headways. At that time four-car trains will also be able to operate in the DSTT tunnel. Under these circumstances, the line will be capable of carrying nearly 18,000 riders per hour in each direction, as summarized below.

Table 6-13 Maximum design line capacity

Headway	Trains / Hour	Cars / Train	Cars / Hour	Riders / Car	Total Riders per Hour
2 minutes**	30	4	120	148	17,760

** Assumes 74 seated 74 standing for a load factor of 2.0

This volume is likely to be experienced in the central core of the system after several extensions to the Initial Segment. Initial system design is proceeding on the basis that facilities and equipment installed for the IS/AL will be compatible to support future system expansion to support a fleet of 104 vehicles.

7.0 MAINTENANCE

A detailed maintenance plan has been developed and published as a separate Sound Transit document in 2007. King County Metro as the operating agency will be responsible for implementing all required maintenance programs identified in the 2007 plan.

7.1 Scheduled Maintenance on the Right-of-Way

Regular inspection and maintenance activities will be necessary on and along the right-of-way. Activities that require occupancy of a track by maintenance equipment or personnel, or the closure of a track or de-energization of catenary power will normally occur during non-revenue hours. Maintenance activity requiring longer periods of continuous time may involve full or partial closure of track, although this will be a very rare occurrence. Under those circumstances, one of the operating schemes described in failure management strategy operating standard operating procedures will be employed. Prior to the scheduled closure public notice will be given well in advance of any planned alternate service.

7.2 Corrective Maintenance

When equipment failures occur, the OCC will be made aware of the problems by either the SCADA system or by field personnel. OCC will notify the appropriate maintenance section. Maintenance personnel will advise OCC of the necessary actions to repair the problem and the estimated duration. Depending on the nature and severity of the problem, OCC will determine whether the problem can be repaired or deferred until late night or non-revenue hours. If the failure relates to the peak period rush hours, efforts will be made to rectify the problem with a minimum of disruption to service. This may involve allowing trains and buses to operate through the affected area at reduced speed and under controlled conditions. Termination of use of the right of way by either bus or train service will be considered as a last resort and involve one of the scenarios outlined in the failure management SOPs for strategies. The contracted operating agency, King County Metro, is responsible for the development of the SOPs to cover all failure modes.

7.3 Equipment Access

Emergency vehicles and maintenance vehicles can access the right-of-way via the at-grade entrances located along the guideway. In the DSTT access areas are located at IDS and CPS. For other areas of the guideway emergency access points are located off MLK, Tukwila with one more additional area inside the at grade airport section of the guideway. To ensure safety, all vehicles (ST, King County Metro, emergency services) accessing the right of way (ROW) will require prior authorization from OCC.

7.4 Facility Maintenance

A rigorous cleaning, inspection and preventive maintenance schedule is to be followed to ensure that stations remain clean and in a good state of repair. Equipment failures may be identified either by the SCADA system, customers, train operators, field supervisors or bus drivers, or routine inspection by roving supervisors. Failures may also be detected by OCC personnel via SCADA through the CCTV system. . Once identified, a work order report using MMIS system will be prepared and the Facilities Maintenance Department will be notified of the problem. Any failures' that may impact operations will be guided by failure management operating procedures.

8.0 SAFETY AND SECURITY

King County Metro Transit security will have shared responsibility with Sound Transit for system, and public safety and security. Sound Transit's contracted security responsibilities are defined in the KCM and Sound Transit Intergovernmental agreement. King County Metro is charged with developing a WSDOT compliant System Safety Program Plan (SSPP) and a System Security Plan (SSP) that complement the ST SSPP and SSP, an Emergency Plan (that includes an Adverse Weather Plan), and an employee Accident Prevention Plan. Sound Transit will review the plans for adequacy and monitor implementation and performance under the contract by auditing King County Metro compliance against the approved plans. Goals have been set on a number of performance indicators that will be routinely discussed with King County Metro security as part of contract management For the SeaTac/Airport station the Seattle Port Authority Police have advised sound Transit they will maintain jurisdiction for their area.

8.1 Incident Command and Control

In case of incidents during periods of operation, the OCC will have ultimate authority over operations of the service (both rail and bus). Field Supervisors will provide on-site control in coordination with the OCC. An Incident Command and Control structure will be used for all emergencies throughout the entire Light rail system. Training will be provided to all appropriate staff who maybe responsible to provide support to the on scene commander. The local agency having jurisdiction or the country police will have authority at the incident scene when they arrive. Rail supervisors and staff will provide support to the on scene agency in charge.

8.2 Coordination of Rail Safety Issues

Sound Transit and King County Metro safety personnel will be responsible to coordinate activities concerning safety issues for the entire Light rail system. Any conflicting safety standards will be resolved prior to the beginning of revenue operations and safety concerns that arise during pre revenue service will be resolved in a timely manner to the satisfaction of both agencies. Safety training is a responsibility defined in the IGA as that of the contracted operating agency with Sound Transit oversight.

8.3 Emergency Evacuation

Detailed procedures will be jointly developed prior to the beginning of revenue operations. The preferred method of evacuation when required would be the use of a rescue train, for a train-to-train supervised evacuation. All evacuation procedures will follow the guidelines set forth by the Joint Fire Life Safety Committee and the local agency having jurisdiction.

8.4 Emergency Ventilation and Fires

The design of the Beacon Hill and DSTT ventilation systems take into account the potential for a major fire at any location in the tunnels where the train or bus has access. For the DSTT, the preliminary operational assumptions are that there will never be a train and a bus in a tunnel bore at the same time, and there will never be more than one train in the same tunnel bore.

When a fire occurs in a tunnel bore or in a station, nearby fans are activated so that air movement is in a direction that will ensure a safe evacuation route. Airflow will be maintained above the critical value to prevent the back layering of smoke and fumes along the evacuation routes. The general design approach is to ventilate the affected tunnel section in the normal travel direction of the train permitting passenger evacuation. There is a water deluge system in the tunnel bores to supplement the ventilation system.

Airport Link will be an aerial guideway and a small at-grade section so no ventilation is required.

An emergency analysis was performed and focused on determining fan capabilities and operation modes to meet NFPA 130 (2000 edition) requirements. The following minimum design criteria were used for the emergency condition simulations:

- "Worst case" situation was defined for each tunnel ventilation zone.
- One fire incident only was assumed at a time (no multiple, simultaneous events).
- Meet critical velocity for a bus fire with a HRR of 60 million Btu/hr.
- Points of safety or egress are available on either end of the disabled train in the tunnel.
- Smoke leakage to adjacent tunnels is avoided to the extent possible.
- For a train or bus fire in a cut-and-cover station, evacuation will be through the station entrances.
- Air temperature in the evacuation path shall not exceed 140^{o} F.
- Emergency fans can withstand an air temperature of 482^{o} F for one hour.
- The entire fan capacity is required for one tunnel, the dampers to the other tunnel will be simulated closed.

In line with the current practice, emergencies were assumed to occur one at a time, in one tunnel, and in one direction only (no simultaneous fires).

8.5 Training

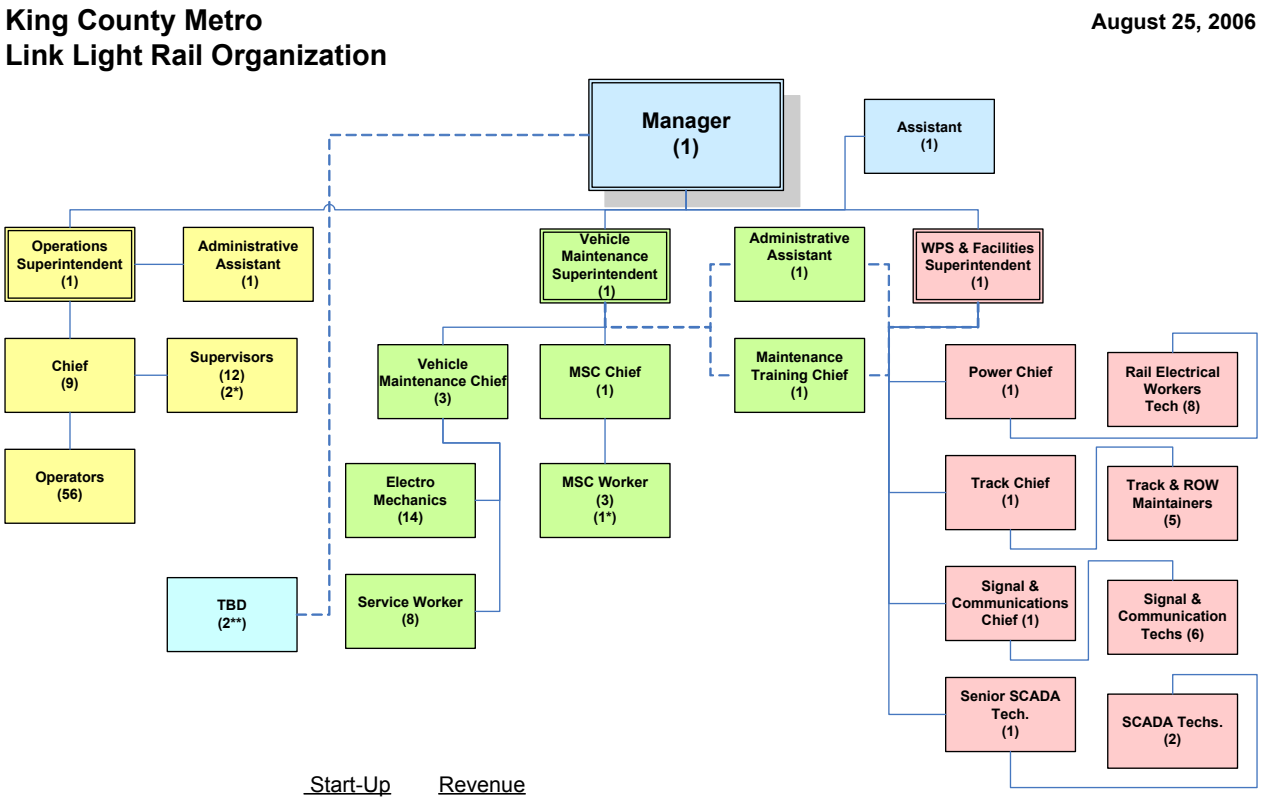
Safety and emergency procedures pertaining to the system will be developed by King County Metro, with coordination of the local agencies that have jurisdiction. Staff from all agencies will receive training prior to start of revenue service. Initial training will be provided for all job categories from the vendor or agency ensuring that a safe operation will be enforced for each job category. All train Operators and OCC staff will be required to be trained and certified annually for the system elements, procedures and equipment that they would be responsible for. All operating staff as a minimum will take rules and SOP training to meet rail industry standards.

9.0 STAFFING

Staff assigned to work in the Light Rail division will be trained to respond to any service related incident during operating hours. Additionally, there will be service supervisory staff assigned to work in the OCC and Field for the entire system. All staff will report incidents to the OCC through the primary use of the radio system with a backup communication system using emergency telephones and passenger telephones. (ETEL/PET)

The detailed staffing plan has been prepared with the concurrence of King County Metro following the Intergovernmental Agreement between Sound Transit and King County Metro. Operating responsibilities for all staff classifications will be defined by King County Metro and Sound Transit under the joint agreement. The staffing plan includes detailed roles and responsibilities of staff assigned to work in the all sections of the system. All Standard Operating Procedures are to be developed jointly between Metro and Sound Transit. Below is a draft flow chart of the staffing plan for the initial segment proposed by King County. All additional staffing needs, to support any extensions will be developed in coordination between King County Metro and Sound Transit. Table 8-1 is a staffing plan submitted and used for the 2006 baseline cost estimate. Final staffing levels are to be finalized by mid 2006.

Figure 9-1 Proposed 2006 King County Metro Staffing Plan



	Start-Up	Revenue
Manager + Admin Assistant	2	2
Operations	79	81
Vehicle Maintenance	32	33
Way, Power, Signals & Facilities	26	26
TBD	0	2
Total	139	144

* These positions will be funded in the operations budget. Hiring will be deferred until sometime after revenue operating day when a need can be demonstrated.

** These two FTE positions will be funded in the operations budget. KCM Light Rail Manager to determine hire dates and positions.

10.0 TESTING AND START-UP

A detailed Testing and Start-up Rail Activation plan has been development identifying the required activities that are needed to take the system into passenger service. The pre-revenue process includes a System Integration Test Plan (SITP) a Rail Activation Plan a System Safety and Security Plan plus a Pre Revenue Operating Plan. The position of Rail Activation Manager is responsible to ensure all activities are coordinated and performed to rail safety and security standards and established operating rules and procedures. The mobilization period is now underway, as construction in some of the civil sections is completed.

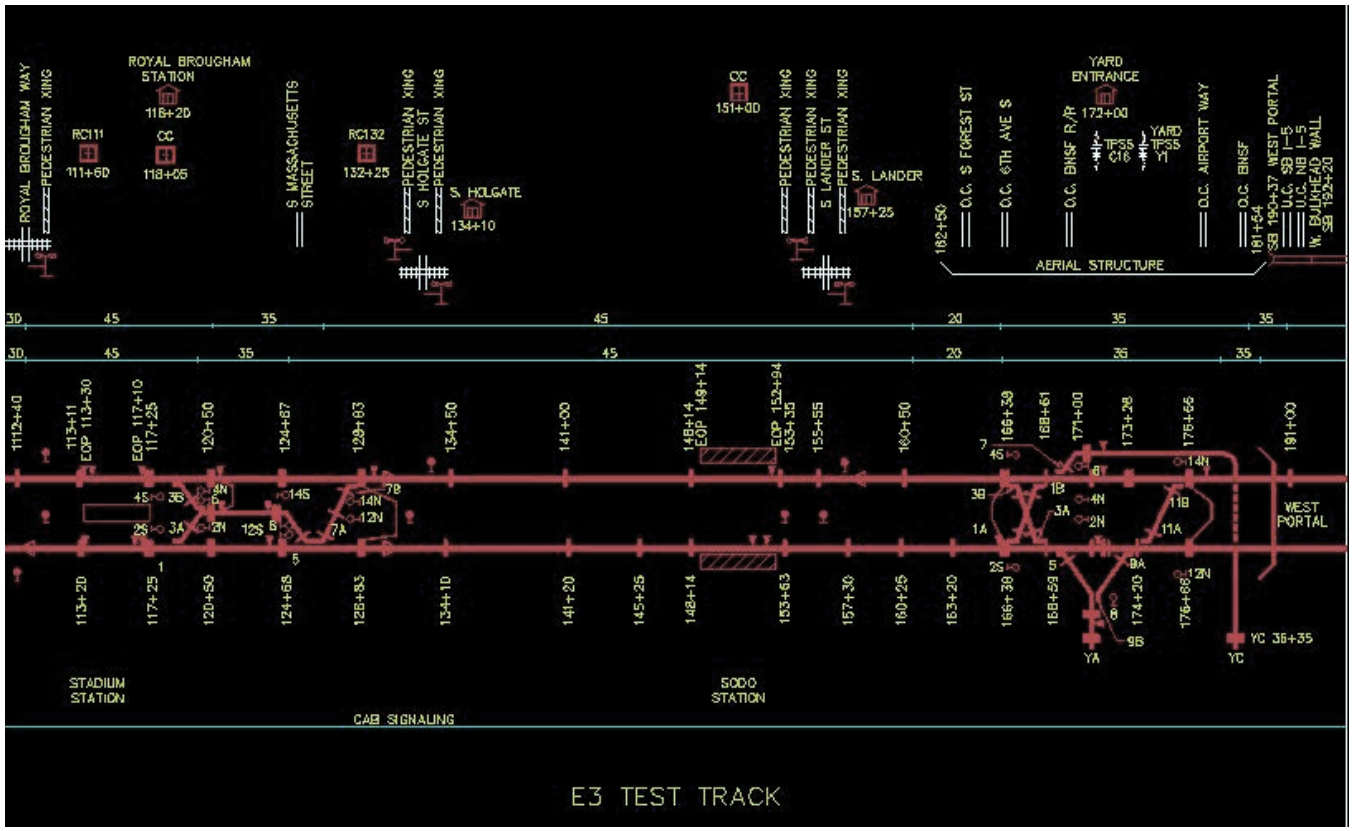
Testing and commissioning of the various support systems used for is well under way. Phase 1 of the project which included the retrofit and closing of the DSTT tunnel has been completed on time. The reopening of the DSTT tunnel for bus service only with the new bus signaling system is in the final completion phase.

The Yard and Test track area have been certified for train service and more then 15 vehicles are now on site and are now in the break in and commissioning phase. Also at this time training for KCMetro tunnel staff on the newly installed DSTT fire life safety equipment is complete. Figure 10-1 is a view of the test track area.

Train interface activities for the DSTT bus tunnel are planned to start in June 2008.

An outline of the integrated testing and startup process is available in the current version of the SIP. Because construction of various line segments will be completed at various time periods in 2008 and 2009, and because the Beacon Hill tunnel section is the last section scheduled to be completed, a full end to end pre-revenue simulation period will start in 2009 and is expected to last 30 to 60 days.

Figure 10-1 2008 Certified Test Track area



11.0 SYSTEM OPERATIONS IN DSTT

This section describes system operations under normal conditions, with trains and buses running according to the established operating rules and schedule. Trains and buses will be operated according to the daily schedule and governed by speed limits, signals, cab signals, operating rules and procedures. Normal operations are not expected to require intervention from the OCC.

11.1 Merge Operations

Trains will arrive at and operate through the DSTT according to a set schedule. The signal system will provide auto signal clearing from the staging areas into the tunnel sections at IDS and CPS with OCC manual override functions available. All E3 buses may go straight through to their station without stopping in the staging area when there is no train at IDS station. In addition to the tunnel segments between CPS and IDS, buses and trains will share right-of-way between the mode change point at IDS and Stadium. Wayside signals will indicate when buses and trains can enter the shared ROW at either end. There are gates protecting the I90 and E3 bus merge point.

Stadium Station to International District Station Points

Following operation along MLK Jr. Way, train operators on northbound trains will make their best time from Mount Baker to Stadium, the merge point for bus and rail service. When a train is detected on approach to Stadium: 1) buses will be held from entering the joint ROW north of the crossing, and 2) trains will slow or stopped to maintain safe braking distance to all occupied zones until the bus vehicle detection system has determined that the shared ROW from the bus staging area into the platform is clear. Once cleared to proceed, the trains will continue into the staging area and into the IDS platform. If the IDS platform is occupied by buses ahead of the train, the train will be held alongside the bus staging area until the buses have left the platform. Any buses still in the staging area when the train arrives will be held until the train has passed. Figure 6-4 shows bus and rail interface at the Royal Brougham/IDS merge points.

Pine Street Tail Track/Westlake Merge Points

Southbound trains departing the Pine Street tail tracks will be dispatched according to schedule. The layover time at the north terminal will provide sufficient recovery time to minimize the likelihood of a delayed departure. Buses in both directions will need to be held at the merge/crossing point between CPS and WLS while southbound Link trains are dispatched from the Pine Street tail tracks. These southbound trains will cross the northbound bus way to CPS, before merging with the southbound bus way. Northbound trains entering the Pine Street tail tracks will not be moving in conflict with buses. Figure 6-3 shows bus and rail interface at the merge point north of Westlake.

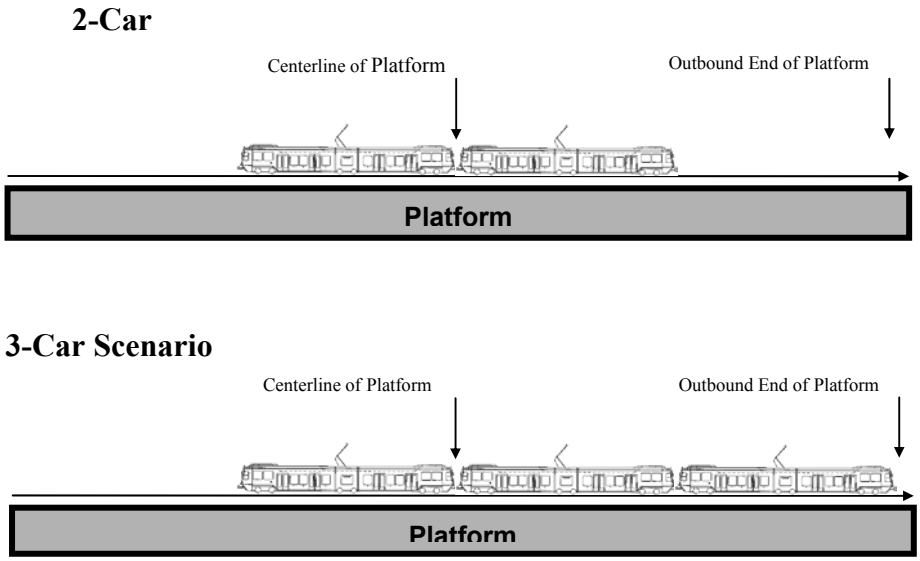
Bus Turn Round at International District

At the IDS mode change point, buses that are turning around to prepare for a northbound run will need to cross the Link tracks. As with the merges, track crossings will be governed by wayside signals. Buses will not move into this turn-back location until they are ready to proceed and will be allowed by the signal system to make this movement up to 45 seconds prior to the arrival of a train in the staging area.

11.2 Train Tunnel Operations

Trains will stop at a designated location on the platform, based on to the number of cars in the train. Two-car trains will stop 95 feet from the forward end of the platform, while three- and four-car trains will pull to the forward end. (See Figure 11-1.) This will consistently place doors at specific locations for ease of loading by passengers who are in wheelchairs or who are sight-impaired.

Figure 11-1 Train/ Bus Stopping Locations at Stations



The train operator will open the doors, observe via cab-mounted CCTV as patrons alight and board, and close the doors when safe to do so. Audible warning and visual indication will be given before doors close. When the doors are closed and the train receives a signal indicating clearance to depart, it will depart the station platform at the permitted speed. The low-floor design and special suspension system of the Link LRVs will provide for the quick and unassisted boarding of passengers in wheelchairs, within the 20-to 30 second dwell time built into the train schedule. Wheelchair passengers will be provided designated areas near each door vestibule for riding. These areas will have flip-up seats that provide a clear space for the wheelchairs. Passengers with bicycles will also board directly onto the LRVs at IDS southbound or alight at IDS northbound. Bicycle storage racks are provided in each LRV. A policy to allow a test period for bicycles boarding in the DSTT is being explored.

Inbound buses (buses completing their trip in downtown Seattle) will pull as far forward at the platform as possible or will fill any available position in a group of coaches if operating within a group. Outbound buses (buses beginning their trip in downtown Seattle) will load and unload passengers at the head of their assigned bay. As at present, the forward bay on the northbound platform (Bay A) is for bus routes destined north on I-5, while the rear bay (Bay B) is for buses heading east on SR520. The forward bay on the southbound platform (Bay C) is for bus routes heading south on I-5. The rear bay on that platform (Bay D) is for boarding buses destined east on I-90. There is room for up to three articulated buses to queue at each bay (although the third bus is required by

policy to stop again at the front position to board passengers). The use of the radio tag identification equipment and variable message signs will enable the provision of real-time bus information at the platforms.

The bus operator will be responsible to observe all bus wayside signals in the tunnel and following speed limits and minimum bus separation requirements. The operator will open and close the doors on the coach. If passengers in wheelchairs wish to board a bus, the driver will extend the boarding ramp at the front door if needed to close the gap between platform and door. Dwell times for boarding wheelchairs are expected to be shorter than at present due to the low-floor design of the new tunnel bus fleet; the boarding ramp will deploy much more quickly than the wheelchair lift on the current Breda buses. Passengers with bicycles will continue to be accommodated on buses only at CPS and IDS. Bicycles will be placed in a rack in the front of the bus.

The four DSTT stations have a northbound and southbound lane/track as well as an additional lane in the middle. King County Metro currently uses the middle lane as a passing lane, allowing buses to pass delayed buses in front.

Under joint operation, buses will be allowed to pass other buses at tunnel stations only when authorized by OCC and ensuring it is safe to do using line-of-sight rules. Buses will be allowed to pass delayed trains only when authorized by OCC under operating rules..

12.0 ABNORMAL SYSTEM OPERATION

The Light rail system line is designed to ensure that if facility and systems components fail, service can continue, consistent with operational safety. This section provides a discussion of operation under abnormal conditions. Before the start of revenue service a comprehensive Failure Management Plan and Standard Operating Procedures will be developed by King County Metro and trained to all operating staff to ensure failures and the operational responses to various failure conditions are coordinated.

12.1 Causes of Abnormal Operation

Events may occasionally occur during operations that disrupt scheduled service to an extent that requires implementation of service management techniques. When emergencies of a more serious nature occur, coordinated responses by several departments within the Metro operating groups and, under certain circumstances, emergency service external to either King County Metro or Sound Transit are required. Some examples of causes resulting in abnormal operations include:

a) Track out of service due to blockage or for repair

b) Disabled train in station or between stations

c) Disabled bus in station or between stations

d) Loss of traction power or station power

e) Loss of wayside signals

f) Accident involving personal injury or loss of life

g) Fire on train, bus or in tunnel

h) Security breach or civil disturbance

i) Major seismic event (earthquake) or other natural disaster.

12.2 Failure Reporting

Train operators, bus operators, maintenance personnel, security, and other personnel in a position to observe operations will report incidents and emergencies to the OCC as soon as an event or condition is detected. The OCC will direct and coordinate system response working with the on-site transit service supervisors, and relying on detailed procedures that will be prepared by King County Metro and drilled prior to system start-up. (Incident reporting will be the responsibility of the OCC controller as a standard operating procedure.) The OCC will advise King County Metro and ST Customer Service of activities that may impact bus and/or rail operations.

12.3 Failure Management Strategies

Operating strategies will be used to adjust service up to partial closure of the guideway. For Link, these actions include terminating train service at a station or operating a bus shuttle service around the problem, and operating trains in both directions using a single track (single-tracking). For bus service, operating strategies include schedule adjustment, use of diesel propulsion in the tunnel, run-around of blockages in the stations using the bypass lanes, reverse operations, routing terminating bus service to the surface streets and lastly, rerouting bus service.

In a single-track operation, trains will be held at an interlocking at each end of the single-track segment (for the DSTT, these interlockings are at WLS and Stadium and will be released to proceed first in one direction and then in the other. Each train will clear the interlocking at the exit end of the single-track segment before the next train can be authorized to enter the single-track segment. Under certain circumstances, more than one train may be operated in one direction before trains in the opposite direction are routed through. When single tracking of trains is considered not desirable, trains may be terminated prior to arrival at a station. Turn back operation strategies will depend on the location and variables of each incident. Detailed operating procedures will be developed by King County Metro prior to initiation of operations.

12.4 Public Information

Information will be disseminated about temporary service disruptions, delays and changes. Announcements will be both oral (through the public address system) and visual (using the VMS). The OCC will make announcements at stations. Local news services will be notified of any extended delays, and King County Metro and Sound Transit will post notices on their web sites.

Table 12-1 General Response to Abnormal Operations

Condition	Train	Bus for DSTT only
One track out of service due to blockage or for repair (Blockage may result from disabled vehicle, wayside equipment failure, personal injury/accident or scheduled maintenance)	• Single tracking of service using the unaffected track. • Train service terminated before blockage with bus shuttle service.	• Reverse run of buses through affected section. • Surface operation of terminating buses. • Some buses terminate at portals with transfer to trains and other buses. • Surface operation of all bus service, as a last resort.
Disabled train in station or between stations	• Another train will push or pull the disabled train to a pocket track or the yard.	•
Disabled bus in station or between stations	• Service suspended in the affected tunnel until cleared. • Trains turned back prior to entering area. • Single track around area.	• Another bus pushes disabled coach. • Tow truck tows disabled coach.
Loss of traction power	• Train service suspended in affected area; trains turned back prior to entering area. • Use a bus bridge shuttle.	•
Loss of train signals	• Train run with line-of-sight mode and radio authorization. • Some trains may be turned prior to entering affected area.	• Bus operations continue with supervisory control and authorization.
Fire at one facility or on vehicle in tunnel	• Service suspended until cleared by the Fire Department.	• Buses rerouted to surface during period of disruption.
Major seismic event	• Service in is suspended until safety is confirmed by inspection.	• Buses rerouted to surface until tunnel safety is confirmed by inspection.

An analysis and Standard Operating Procedures will be developed by the operating agency, King County Metro, to determine the optimum service to be operated by rail under various failure conditions.

13.0 Sound Transit's Oversight of King County Metro Link Operations

The intergovernmental agreement between Sound Transit and King County Metro defines the scope of work of responsibilities that each agency will provide. King County Metro is contracted to be the operating entity until the year 2015.

13.1 Performance Standards

Sound Transit in concurrence with King County Metro will audit various functions defined in the Inter Governmental Agreement (IGA). The IGA is the base line contract that is to be used for setting the standard of performance to be implemented by King County Metro. An example of one of the described functions is the performance standards exhibit of the IGA. The following table identifies the performance standards agreed to in the IGA by Sound Transit and the operating agency, King County Metro.

Sound Transit's Transportation Services department is responsible for all operational audit functions described in the IGA. Sound Transit will ensure that King County Metro meets all the requirements needed for meeting 49 CFR Part 659

King County Metro shall demonstrate that it is achieving the specified requirements in the Agreement by achieving the following performance standards (in a calendar month reporting period unless otherwise noted).

Table 13-1 Performance Standards

Performance Area	Performance Standard	Goal
On-time Performance	Percent of scheduled train trips completed within 3 minutes of scheduled terminal arrival time	≥98.5%
	Cancelled or incomplete trips	≤10
System Availability	Percent of time (during revenue service hours) that elevators and escalators (including DSTT) are available for patron use	≥95%
System Cleanliness	Completed LRV interior cleanings daily (%)	100%
	Completed LRV exterior cleaning 2 times per week	100%
Employee Injury/Illness on the job	Employee Injury/Illness Rate	≤1.00
Train Accidents	Number of accidents per 1,000,000 revenue miles	≤6
Employee Sick Leave	Number of days of sick leave per employee per year	≤8.0
Incidents/Accidents	All events not related to train accidents per million revenue miles (passengers and employees)	<6
Station Cleanliness	Completed daily station cleaning as defined in the Maintenance Matrix	100%