California High-Speed Train Project

Operations and Maintenance Peer Review

Introductory Material

October 1, 2010

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Introduction / California High-Speed Rail Vision

This document is intended to provide background information on the intended operations of the California high-speed train (CHST) system – to support a Peer Review by international high-speed rail operators. Recognizing that the California system is still at a relatively early stage of the planning process, and that many operational issues remain to be resolved, this document summarizes the state of current thinking within the Program Management Team about how the system will operate once it is built. The primary source of information is a set of Technical Memoranda on operations-related topics, which have been approved by the California High-Speed Rail Authority as the basis for system planning, preliminary design and environmental documentation. Several of these Technical Memoranda are over a year old, and the Program Management Team has continued to evolve and refine the operational, train service and maintenance assumptions that underpin the system design. This document incorporates the data from the approved Technical Memoranda but indicates in the text where assumptions have changed since the Memoranda were originally developed and where alternative policies, operating practices or technical assumptions are being considered.

There are a number of subjects on which advice and feedback from the Peer Reviewers would be valuable, based on their hands-on experience, and greatly appreciated by the Program Management Team. These questions and issues are listed at the back of the document.

Inspired by successes of high-speed train systems around the world, California has for more than 13 years been planning a statewide high-speed rail line that will serve as a backbone and a needed alternative to the state's existing transportation network. It is envisioned as a new system stretching initially from Anaheim/Los Angeles through the Central Valley to San Francisco, and later to Sacramento and San Diego. It will be capable of 220 mph revenue operating speed and a travel time between Los Angeles and San Francisco of 2 hours 40 minutes. It will interconnect with other modes of transportation and provide an alternative, environmentally friendly option to vehicle and air travel. Today, the system is more than a vision; it is a reality California is working toward with the support of the state's voters, labor, environmental, and business advocates, and the strong support of the Governor and the President of the United States.

California's high-speed rail project is a planned transportation backbone whose initial 500 miles will begin in Anaheim/Los Angeles, run through the Central Valley from Bakersfield to Merced, then head northwest into the Bay Area. It will travel up to 220 miles per hour and be able to make its journey from Los Angeles to San Francisco in 2 hours and 40 minutes. Subsequent phases of the high-speed rail system are planned for a southern extension from Los Angeles to San Diego via the Inland Empire and an extension from Merced north to Sacramento.

The project's goal is to increase and maintain California's mobility, which is vital to the State economy's health, as the population grows by a third – from 38 million today to a projected 50 million by 2035.

The project will employ train technologies like those used in other countries with established high-speed train systems (for example: Japan, France, Germany, Great Britain, Spain, Korea and China). That means steel-wheel-on-steel-rail technology, entirely electric power, state-of-the-art safety and signaling systems, and automated train control. This is not new technology – only new to North America. It was introduced in Japan in 1964, France in 1981, and in many other countries within the past two decades.

The system will interface with and complement other modes of transportation – commercial airports, mass transit, the state's highway network, as well as bike paths and foot traffic. The system will be capable of many patterns of service and will compete – as it has in other countries – with air and automobile travel over medium distances.

The California high-speed train will operate primarily on exclusive (dedicated) track with portions of the route shared with other existing passenger rail operations. The route (alignment) will be constructed at-grade, in an open trench, in a tunnel, or on an elevated guideway, depending on the terrain, physical constraints, environmental impacts and community input along sections of the line. Extensive portions of the system will lie within, or adjacent to, existing rail or highway right-of-way (rather than new alignment) to reduce potential environmental impacts and minimize land acquisition.

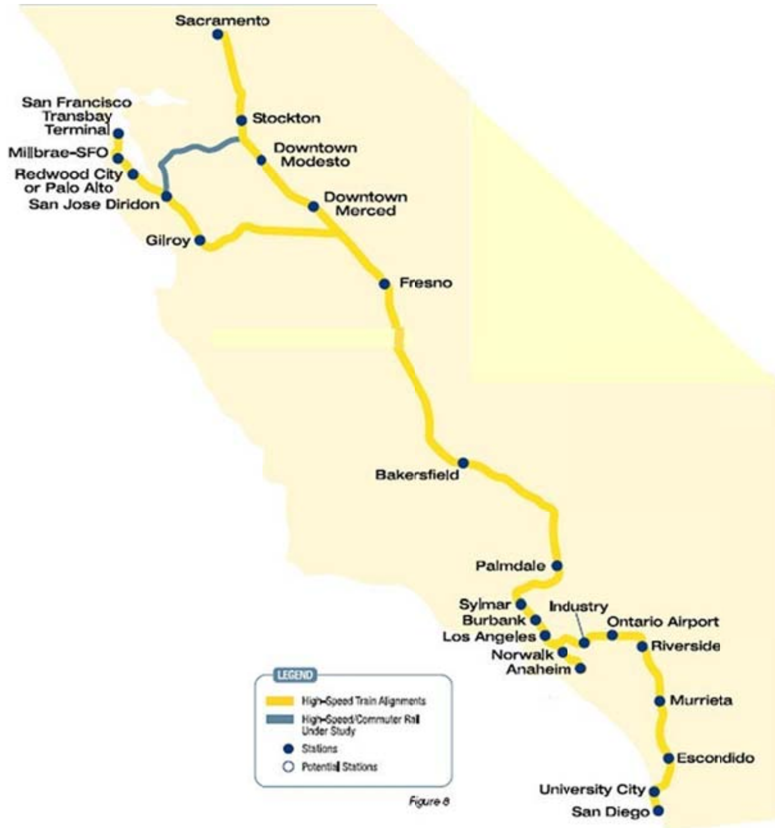
Network Overview

Phase 1 Network

Phase 1 will implement high-speed train service between San Francisco and Anaheim, via the Peninsula corridor, Pacheco Pass, Central Valley and Antelope Valley. In San Francisco, high speed trains will operate at two terminal stations: the new Transbay Terminal and a reconstructed high-speed terminal at the existing Caltrain commuter station at 4th and King Streets. Other major stations along the route include the San Jose Diridon Station and Los Angeles Union Station. The southern terminus of the high-speed line will be at the planned ARTIC regional transportation center in Anaheim.

Figure 1 – Phase 1 High-Speed Train Network

Figure 2 – Full Build High-Speed Train Network



Full Build Network

The full build-out of the California high-speed train network ultimately will include four branches off of a main spine running through the Central Valley and serving Los Angeles Union Station. In addition to the San Francisco and Anaheim branches implemented in the initial phase of development, the Full Build network will provide high-speed train service to the northern portion of the Central Valley and the state capital at Sacramento, as well to Riverside and San Diego via the Inland Empire and Interstate 15 corridors.

Implementation Phasing

The Phase 1 network will be developed over an extended period of time. Several significant interim steps will occur prior to the opening of the full Phase 1 system. A portion of the new dedicated high-speed track will be built early on and used for testing and commissioning of the high-speed trainsets as they are received from the manufacturer. In addition, early revenue service over a portion of the Phase 1 network is planned, once sufficient numbers of trainsets have been commissioned and are ready for service. Alternatives for the extent and location(s) of interim revenue service currently are being evaluated. Service and operations planning for these interim stages has not yet been undertaken in detail.

The Phase 1 network will be designed to be operable as a permanent, stand-alone system. The branch extensions to Sacramento and/or San Diego could be added to the network at any point following completion of the Phase 1 system.

Service Plans

Rail operations and service plans have been developed to serve several purposes:

- Confirm the level of service assumptions (travel times and service frequencies between station pairs) used to develop the estimates of system ridership and revenue
- Validate the operational feasibility of the desired level of service at a conceptual level
- Identify operable patterns of train service, particularly the general requirements for non-stop or limited-stop trains to pass slower trains that need to make a greater number of stops along the route (i.e., the locations and frequencies of occurrence of these "overtakes" at various times of day)
- Provide a basis for estimating the number of required train sets and overall rolling stock fleet requirements for the full build-out
- Provide a basis for estimating platform track and storage track capacity to support operations at the end terminal stations
- Provide a basis for sizing train storage and maintenance facilities throughout the HST network
- Provide a basis for planning passenger-handling operations at HST stations, which can be used to help size and configure station facilities.

The operations and service plans provide a level of service at each station that is generally equivalent to the level of service that has been assumed in the development of the ridership and revenue estimates for the HST system. Weekday ridership demand is assumed to reach peak levels during a three-hour period in the morning and again in the afternoon. Train service density will be greatest during these periods, reverting to a slightly lower level of service during the remainder of the day.

The proposed mix of services offers regular clock face patterns, with each service type leaving (passenger stations) at the same time each hour, with relatively limited exceptions. Slightly more service is assumed during the three hour peak periods in the morning and late afternoon than during off-peak hours, consistent with expected ridership peaking.

Hourly all-stop service is offered on the major routes all day long, to maximize opportunities for a "one seat ride" at regular intervals between most stations on the system. Express service among major cities is offered during the peak periods, when ridership demand is highest. These trains operate non-stop or with few stops and provide the lowest travel times for the heaviest-volume travel markets.

Limited-stop services make up the majority of trains operating on the network and offer a compromise of a relatively fast run time along with connectivity among various groups of intermediate stations along the line. A variety of limited-stop patterns is provided, in order to provide a balanced level of service at all of the intermediate stations. The service plan provides at least four limited trains per hour in each direction, all day long, on the main route between San Francisco and Los Angeles. Each intermediate station in the Bay Area, Central Valley between Fresno and Bakersfield, Palmdale in the High Desert, and Sylmar and Burbank in the San Fernando Valley are served by at least two limited trains every hour – offering at least two reasonably fast trains an hour to San Francisco and Los Angeles. Selected limited stop trains are extended south of Los Angeles as appropriate to serve projected demand.

Every station on the HST network is served by at least two trains per hour all day long, and at least three trains per hour during the morning and afternoon peak periods. Stations, which are estimated to have the largest ridership demand, are served by more trains than intermediate stations with lower estimated ridership.

The service plan attempts to provide direct train service between all pairs of stations at least once per hour. During off-peak hours, certain routes may not be served directly. At these times of day, some passengers would need to transfer from one train to another at an intermediate station, such as Los Angeles Union Station, to reach their final destination. Generally, both the Full-Build and Phase 1 Operations and Service Plans offer a full spectrum of direct service options and minimize the need for passengers to transfer.

The on-board travel time between stations varies, depending on the number of intermediate station stops (which is different for each train type) and the time of day (some trains have additional time built into their peak schedules to allow them to be "overtaken" by express or limited-stop trains while en route).

When the full California HST network is built out, train service will be offered on multiple routes between various origin and destination terminals. The Full-Build Service Plan for 2035 includes service on the following routes, categorized according to the terminals and major stations served:

Table 1 – High-Speed Rail Routes

Route	Description	Phase 1	Full Build
A	San Francisco—Los Angeles—San Diego	✗	✓
B	San Francisco—Los Angeles—Orange County	✓ Anaheim	✓ Anaheim or Irvine*
C	San Francisco— Merced—Sacramento	✓ Merced	✓ Sacramento
D	Sacramento— Merced—Los Angeles—San Diego	✗	✓ Sacramento
E	Sacramento—Merced—Los Angeles—Orange County	✓ Merced & Anaheim	✓ Sacramento & Anaheim or Irvine*
F	Los Angeles—San Diego	✗	✓
G	Los Angeles—Orange County	✗	✓
H	San Francisco—Los Angeles	✓	✗

* The Full Build Service Plan was developed in early 2009, at which time potential extension of the high-speed network to Irvine was being considered. At the present time, the southern terminus for high-speed train service in the Los Angeles-to-Orange County corridor is assumed to be Anaheim.

When the full California HST network is built out, train service will be offered on multiple routes between various origin and destination terminals. Most stations and segments of the network are served by more than one route. Trains also are categorized according to the type of service offered, particularly with respect to the number of intermediate stations served. Three basic service types are offered:

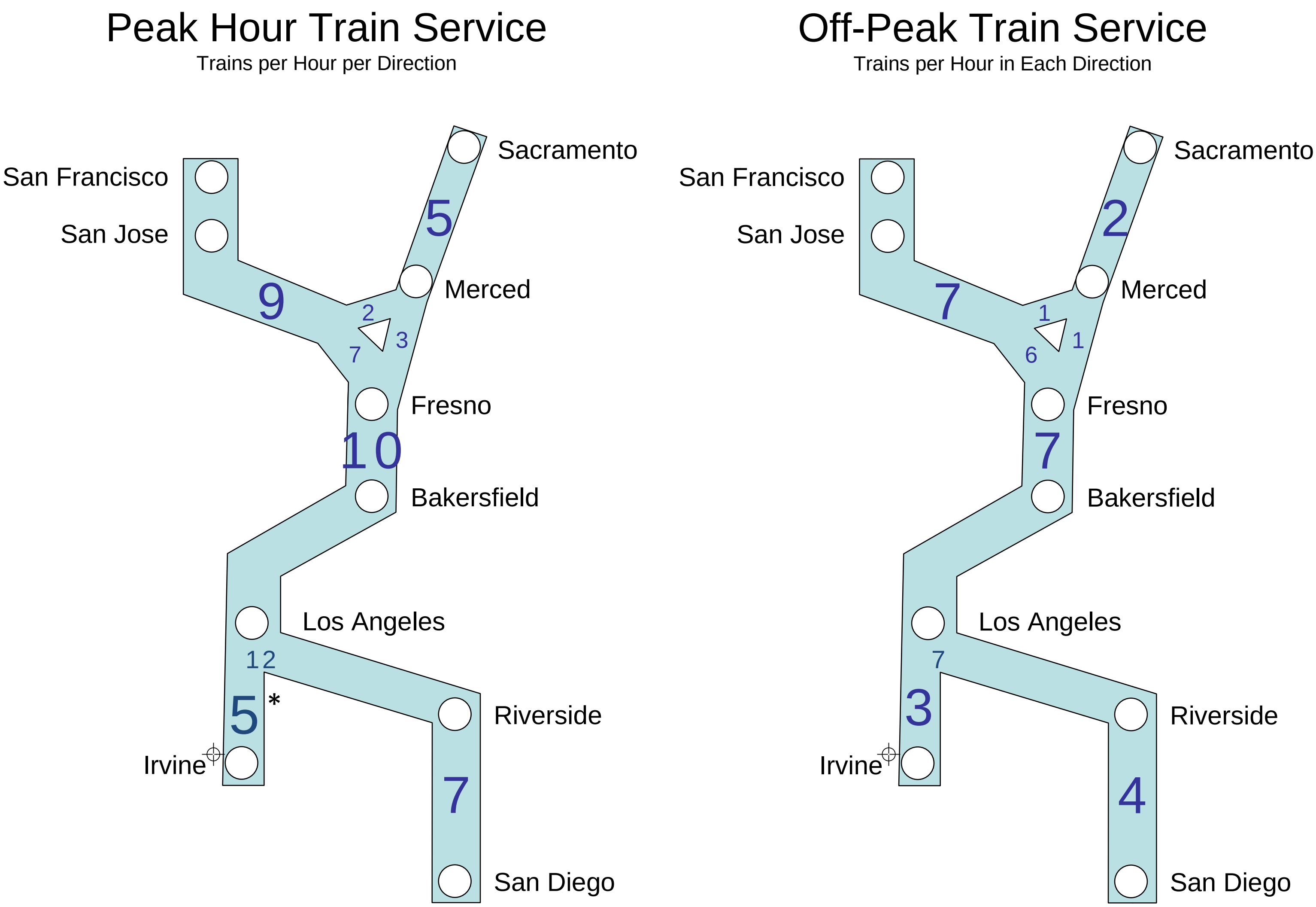
- Express service – serves major stations only and skips most intermediate stops, offers fast trip times between major stations; includes a non-stop service between San Francisco and Los Angeles that operates hourly during morning and afternoon peak periods with a run time of two hours and forty minutes
- Limited-stop service – skips selected stops along a route, offers some of the trip time benefits of express-style service to intermediate stations as well as the major terminals
- All-stop service – "local" trains that make all stops along a particular route segment; ensures direct service among all stations on the network.

These service plans provide a useful initial estimate of the level of service that matches projected long-range demand on the HST system. As the HST project studies continue to progress, and as both the operating plan and the ridership estimates are refined, it will be possible to make informed benefit and cost tradeoffs to develop the most appropriate mix of limited, express and all-stop services, which will affect the trip times between stations and the frequency of service offered at each station for each route.

Full Build Network - 2035

Figure 3 presents the level of train service along various portions of the HST network that is estimated to be required to deliver the appropriate array of choices of train stopping patterns to riders at all stations and satisfy the projected weekday ridership demand in 2035. Weekday ridership demand is assumed to reach peak levels during a three-hour period in the morning and again in the afternoon. Train service density will be greatest during these periods, reverting to a slightly lower level of service during the remainder of the day.

FIGURE 3 – FULL-BUILD SERVICE PLAN – 2035, PEAK HOUR AND OFF-PEAK TRAIN MOVEMENT DENSITY



* The Full Build Service Plan Technical Memorandum assumed dedicated high-speed tracks between Los Angeles and Anaheim. A "Shared-Use" alternative is under active consideration, which would limit the number of high-speed trains in the Los Angeles-to-Anaheim segment to three per hour in each direction.

⌖ The Full Build Service Plan technical memorandum provides for potential extension of the high-speed network from Anaheim to Irvine. At the present time, the southern terminus for high-speed train service in the Los Angeles-to-Orange County corridor is assumed to be Anaheim.

The portion of the network with the greatest density of train traffic will be the short stretch south of Los Angeles Union Station, between Los Angeles and Redondo Junction, where the operations and service plan calls for as many as twelve high-speed trains per hour in each direction during the morning and afternoon peak hours – equivalent to an average headway of five minutes. The main line through the Central Valley has ten trains per hour in each direction during the peaks, and seven trains per hour at other times.

The level of service during the business travel peaks at San Francisco, along the Peninsula Corridor and across Pacheco Pass is nine trains per hour in each direction. The corresponding level of service on the northern section of the Central Valley Line, between Merced and Sacramento, is five trains per hour per direction – with two of these trains operating towards San Francisco and the other three trains operating towards Los Angeles. During off-peak periods, the base level of service provides six trains per hour between San Francisco and Los Angeles (with four of these trains extended to San Diego and two trains extended to Orange County). One train per hour is operated between Sacramento and San Francisco, and between Sacramento and San Diego via Los Angeles.

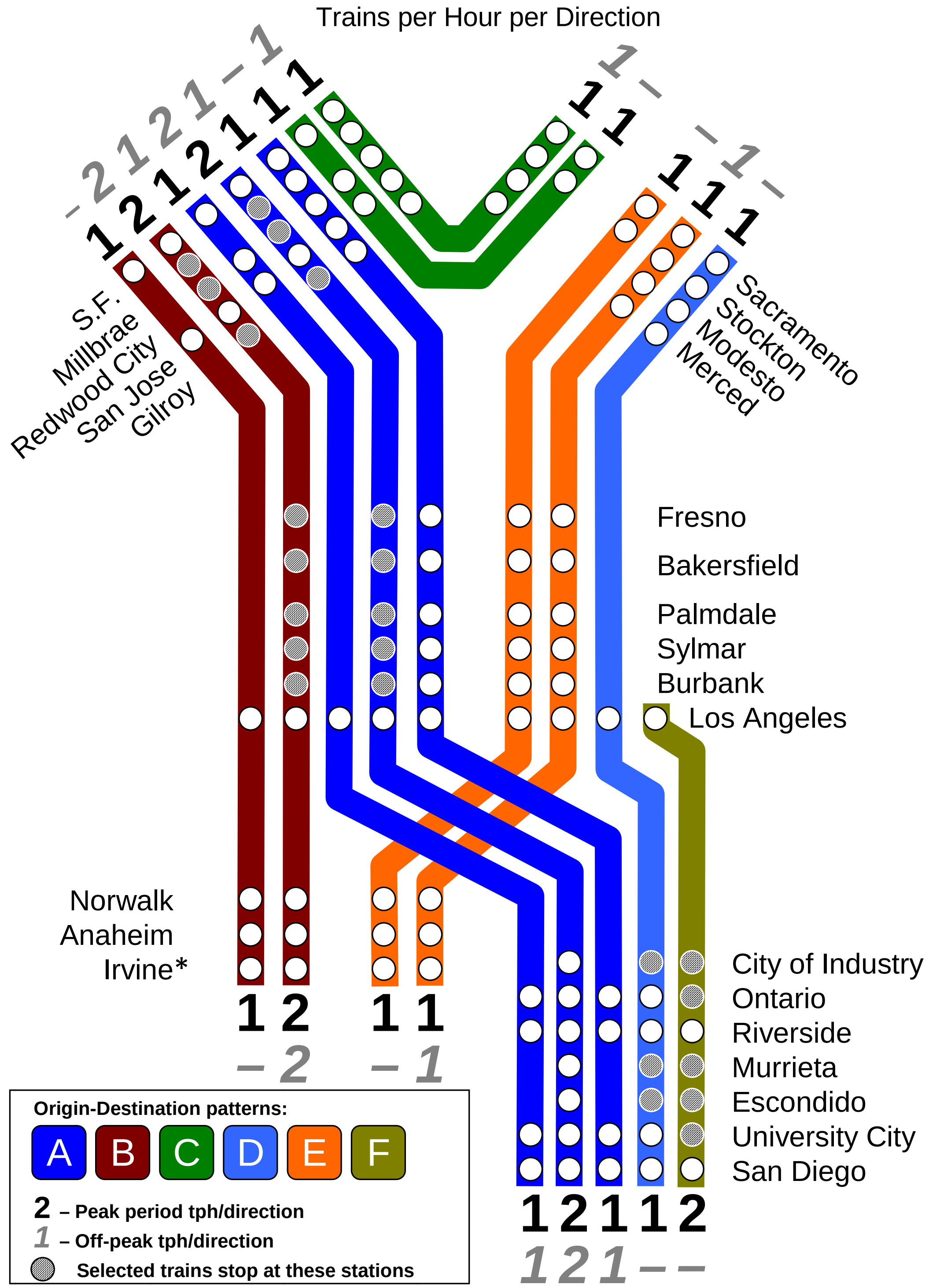
The operations and service plan provides up to seven trains per hour in each direction along the route between Los Angeles and San Diego and up to five trains per hour per direction between Los Angeles and Orange County (Anaheim) during the peak hours. A shared use alternative for the segment between Los Angeles and Anaheim would limit the number of high-speed trains in this segment to no more than three per hour in each direction. The base level of off-peak service is four trains per hour on the San Diego leg and three trains per hour on the Orange County leg.

Figure 4 provides an illustration of the types of service and the number of trains of each type operated on each of the HST routes during a typical peak hour and off-peak hour in the year 2035.

The graphic in Figure 4 shows the variations in the types of trains and stopping patterns that will be available to HST riders, but it generalizes the limited-stop patterns for the sake of presentation clarity. The actual mix of stopping patterns in a typical weekday peak hour and off-peak hour is represented in Table 2 which also identifies the number of trains per hour that would stop at each HST station.

Table 2 also shows the 14 stopping patterns that are provided in the northbound direction during the morning peak hour and the eight stopping patterns that are provided in each direction during mid-day off-peak hours. In both cases, each pattern is operated by one train per hour, with the patterns repeating each hour. A more detailed summary of stopping patterns and service levels at various times of day and in both directions of travel is presented in the Full Build Operations and Service Plan technical memorandum.

FIGURE 4 – FULL-BUILD SERVICE PLAN – 2035, BASIC TRAIN STOPPING PATTERNS



* The Full Build Service Plan was developed in early 2009, at which time potential extension of the high-speed network to Irvine was being considered. At the present time, the southern terminus for high-speed train service in the Los Angeles-to-Orange County corridor is assumed to be Anaheim. Note: The Origin-Destination patterns, A through F, correspond to the Route column A through F, shown in Table 2 on the following page.

TABLE 2 – FULL-BUILD SERVICE PLAN – 2035, TRAIN STOPPING PATTERNS – TYPICAL PEAK AND OFF-PEAK HOURS

FULL-BUILD SERVICE PLAN **TRAIN STOPPING PATTERNS**

Typical Peak Hour (AM Peak Northbound)

Route	Service Type	Stopping Pattern ID	SFT (S.F.-Transbay)	SFO (Millbrae)	RWC (Redwood City)	SJO (San Jose)	GLY (Gilroy)	SAC (Sacramento)	STN (Stockton)	MOD (Modesto)	MCD (Merced)	FNO (Fresno)	BFD (Bakersfield)	PMD (Palmdale)	SYL (Sylmar)	BUR (Burbank)	LAU (Los Angeles Union)	NSF (Norwalk)	ANA (Anaheim)	IRV (Irvine)	COI (City of Industry)	ONT (Ontario)	RIV (Riverside)	MUR (Murrieta)	ESC (Escondido)	UNI (University City)	SAN (San Diego)
A	Bay Area-L.A. Basin Limited Express	1	●		●	●	●										●					●	●			●	●
A	Bay Area-L.A.-San Diego Limited	7	●	●	●	●						●	●		●		●				●	●	●	●	●	●	●
A	Bay Area-L.A.-San Diego Limited	29	●		●	●	●							●	●		●				●	●	●	●	●	●	●
A	Bay Area-Los Angeles All-Stop	4	●	●	●	●	●					●	●	●	●	●	●					●	●			●	●
B	Bay Area-Los Angeles Express	2	●			●											●	●	●	●							
B	Bay Area-L.A.-Orange County Limited	18a	●	●		●	●					●		●		●	●	●	●	●							
B	Bay Area-L.A.-Orange County Limited	21a	●		●	●	●						●	●	●	●	●	●	●	●							
C	Sacramento-S.F. All-Stop	14	●	●	●	●	●	●	●	●	●																
C	Sacramento-S.F. Limited	39	●		●	●		●	●																		
D	Sacramento-L.A.-San Diego Limited	35						●	●	●	●						●					●	●			●	●
E	Sacramento-L.A.-Orange County All-Stop	15						●	●	●	●	●	●	●	●	●	●	●	●	●							
E	Sacramento-L.A.-Orange County Limited	25						●	●			●		●	●		●	●	●	●							
F	Los Angeles-San Diego All-Stop	41															●				●	●	●	●	●	●	●
F	Los Angeles-San Diego Express	42															●						●				●
	Number of trains stopping at station		9	4	7	9	6	5	5	3	3	5	4	6	6	4	12	5	5	5	3	6	7	3	3	6	7

Off-Peak Hour

Route	Service Type	Stopping Pattern ID	SFT (S.F.-Transbay)	SFO (Millbrae)	RWC (Redwood City)	SJO (San Jose)	GLY (Gilroy)	SAC (Sacramento)	STN (Stockton)	MOD (Modesto)	MCD (Merced)	FNO (Fresno)	BFD (Bakersfield)	PMD (Palmdale)	SYL (Sylmar)	BUR (Burbank)	LAU (Los Angeles Union)	NSF (Norwalk)	ANA (Anaheim)	IRV (Irvine)	COI (City of Industry)	ONT (Ontario)	RIV (Riverside)	MUR (Murrieta)	ESC (Escondido)	UNI (University City)	SAN (San Diego)
A	Bay Area-L.A. Basin Limited Express	1	●		●	●	●										●					●	●			●	●
A	Bay Area-L.A.-San Diego Limited	26	●	●	●	●	●					●	●				●				●	●	●	●	●	●	●
A	Bay Area-L.A.-San Diego Limited	27	●		●	●	●							●	●	●	●				●	●	●	●	●	●	●
A	Bay Area-Los Angeles All-Stop	4	●	●	●	●	●					●	●	●	●	●	●					●	●			●	●
B	Bay Area-L.A.-Orange County Limited	16	●	●	●	●	●					●	●				●	●	●	●							
B	Bay Area-L.A.-Orange County Limited	17	●		●	●	●							●	●	●	●	●	●	●							
C	Sacramento-S.F. All-Stop	14	●	●	●	●	●	●	●	●	●																
E	Sacramento-L.A.-Orange County All-Stop	15						●	●	●	●	●	●	●	●	●	●	●	●	●							
	Number of trains stopping at station		7	4	7	7	7	2	2	2	2	4	4	4	4	4	7	3	3	3	2	4	4	2	2	4	4

Note (1): The Full Build Service Plan, developed in early 2009, allowed for possible extension of high-speed service in Orange County to Irvine, which is not currently being considered. The current service plan includes a peak period non-stop train service between San Francisco and Los Angeles; the plan depicted above (Pattern #2) shows an intermediate stop at San Jose. Also, current plans call for splitting the high-speed services at San Francisco between the two terminals at Transbay and 4th and King.

Note (2): The "Route" column on the left of the Table showing the letters A through F, corresponds to the Origin-Destination patterns, A through F shown in Figure 4 on the preceding page.

The proposed mix of services offers regular clock face patterns, with each service type leaving at the same time each hour, with relatively limited exceptions. Slightly more service is assumed during the three hour peak periods in the morning and late afternoon than during off-peak hours, consistent with expected ridership peaking.

All-stop service is offered on three routes (San Francisco-San Diego, San Francisco-Sacramento and Sacramento-Anaheim) all day long. Express service is offered during the peak periods, with one intermediate stop, between San Francisco and Los Angeles and between San Diego and Los Angeles.

The limited-stop services make up the majority of trains operating on the network and offer a compromise of a relatively fast run time along with connectivity among various groups of intermediate stations along the line. A variety of limited-stop patterns is provided, in order to provide a balanced level of service at all of the intermediate stations. The service plan provides four limited trains per hour in each direction, all day long, between San Francisco and Los Angeles. Two of these trains continue to San Diego, and the other two trains continue to Orange County (Anaheim and Irvine). Each intermediate station in the Bay Area, Central Valley between Fresno and Bakersfield, Palmdale in the High Desert, and Sylmar and Burbank in the San Fernando Valley is served by at least two limited trains every hour – offering at least two reasonably fast trains an hour to San Francisco and Los Angeles, and one or two limited-stop trains each hour to San Diego and to Orange County. An all-stop service provides one additional train per hour between San Francisco and San Diego.

The longer-distance intercity markets in the Bay Area-Los Angeles-San Diego corridor are served by a "limited express" service that operates once per hour, all day long. Clock face "on the hour" departures are envisioned southbound from San Francisco and northbound from Los Angeles. This train makes several stops in the Bay Area and between Los Angeles and San Diego, but it operates as a non-stop express between Gilroy and Los Angeles.

Sacramento and the northern Central Valley would be served by all-stop trains once an hour to San Francisco and Los Angeles-Anaheim, supplemented during the morning and afternoon peak periods by one limited stop train per hour to San Francisco and two limited stop trains per hour to Los Angeles (one of which continues to San Diego, with the other continuing to Irvine).

Every station on the HST network is served by at least two trains per hour during the off- peak service periods, and at least three trains per hour during the morning and afternoon peak periods. Stations, which are estimated to have the largest ridership demand, are served by more trains than intermediate stations with lower estimated ridership.

The service plan attempts to provide direct train service between all pairs of stations at least once per hour. During off-peak hours, certain routes are not served directly (e.g., Sacramento-San Diego). At these times of day, some passengers would need to transfer from one train to another at an intermediate station, such as Los Angeles Union Station, to reach their final destination. Generally, the Full-Build Service Plan offers a full spectrum of direct service options and minimizes the need for passengers to transfer.

The on-board travel time between stations varies, depending on the number of intermediate station stops (which is different for each train type) and the time of day (some trains have additional time built into their peak schedules to allow them to be "overtaken" by express or limited-stop trains while en route). The estimated minimum or "optimal/fastest" scheduled trip times between selected city pair stations is presented in Table 3, based on the mix of train types and stopping patterns included in the full build-out service plan. For comparison purposes, typical station-to-station trip times also are shown for peak period all-stop service. The latter trip times are longer, due to the higher number of intermediate stops and additional holding time associated with scheduled overtakes. These scheduled trip time estimates will be refined and in some cases improved in the current, ongoing operations and service planning process.

TABLE 3 – FULL-BUILD SERVICE PLAN – 2035, SCHEDULED TRIP TIMES BETWEEN SELECTED STATIONS

FASTEST TRIP TIMES

		San Francisco - Transbay SFT	San Jose SJC	Sacramento SAC	Fresno FNO	Los Angeles Union Station LAU	Anaheim ANA	Irvine IRV	Riverside RIV	San Diego SAN
SFT	San Francisco-Transbay	--	**0:30**	2:05	1:26	**2:40**	**3:04**	**3:16**	**3:34**	**4:29**
SJC	San Jose	**0:30**	--	1:30	0:55	**2:11**	**2:35**	**2:47**	**3:00**	**3:54**
SAC	Sacramento	2:05	1:30	--	1:06	**2:38**	3:18	3:30	**3:00**	**4:02**
FNO	Fresno	1:26	0:55	1:06	--	1:34	1:58	2:10	**2:18**	**3:19**
LAU	Los Angeles Union Station	**2:40**	**2:11**	**2:38**	1:34	--	0:22	0:34	**0:34**	**1:25**
ANA	Anaheim	**3:04**	**2:35**	3:18	1:58	0:22	--	0:11	--	--
IRV	Irvine	**3:16**	**3:34**	3:30	2:10	0:34	0:11	--	--	--
RIV	Riverside	**3:34**	**3:00**	**3:00**	**2:18**	**0:34**	--	--	--	**0:50**
SAN	San Diego	**4:29**	**3:54**	**4:02**	**3:19**	**1:25**	--	--	**0:50**	--

TYPICAL PEAK PERIOD TRIP TIMES FOR ALL-STOP SERVICE

		San Francisco - Transbay SFT	San Jose SJC	Sacramento SAC	Fresno FNO	Los Angeles Union Station LAU	Anaheim ANA	Irvine IRV	Riverside RIV	San Diego SAN
SFT	San Francisco-Transbay	--	0:38	2:24	1:36	3:27	3:37	3:49	4:07	5:02
SJC	San Jose	0:38	--	1:44	0:55	2:46	3:03	3:14	3:27	4:24
SAC	Sacramento	2:24	1:44	--	1:15	3:06	3:29	3:41	--	--
FNO	Fresno	1:36	0:55	1:15	--	1:48	2:12	2:24	2:29	3:31
LAU	Los Angeles Union Station	3:27	2:46	3:06	1:48	--	0:21	0:34	0:42	1:44
ANA	Anaheim	3:37	3:03	3:29	2:12	0:21	--	0:10	--	--
IRV	Irvine	3:49	4:07	3:41	2:24	0:34	0:10	--	--	--
RIV	Riverside	4:07	3:27	--	2:29	0:42	--	--	--	1:00
SAN	San Diego	5:02	4:24	--	3:31	1:44	--	--	1:00	--

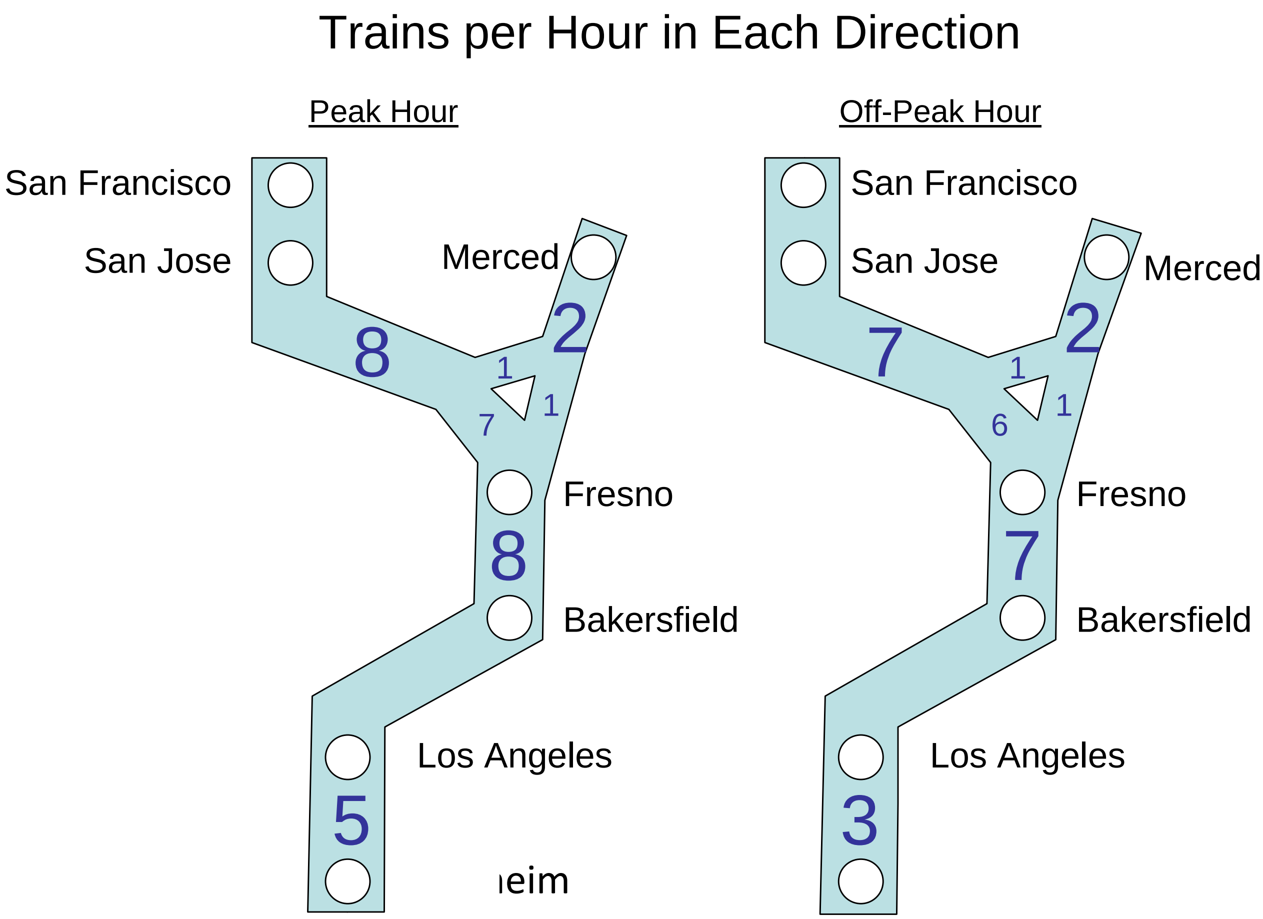
Notes:
Times expressed in Hours:Minutes, from departure at first station to arrival at second station.
Times based on train performance calculations, plus schedule recovery time of 3.5 percent (except where noted otherwise).
Times in **boldface** type denote station pairs served by peak period express or limited express trains.
Times include station dwell times. All-stop service times include allowance for overtakes where necessary.
[1] Time for peak express service based on schedule recovery time of 1.0 percent (Schedule Pattern 2).

Table 3 (above) displays estimated timetable schedule travel times between selected city pairs. For example, when reading the first row of the first table, the numbers shown represent the trip time between: San Francisco and San Jose (30 minutes); San Francisco and Fresno (1 hour, 26 minutes); and San Francisco and Los Angeles (2 hours, 40 minutes). As the HST project studies continue to progress, and as both the operating plan and the ridership estimates are refined, it will be possible to make informed benefit and cost tradeoffs to develop the most appropriate mix of limited, express and all-stop services, which will affect the trip times between stations and the frequency of service offered at each station for each route.

Phase 1 Network - 2035

Figure 5 presents the level of train service along the Phase 1 HST network that is estimated to be required to deliver the appropriate array of choices of train stopping patterns to riders at all stations and satisfy the projected weekday ridership demand on the Phase 1 network in 2035.

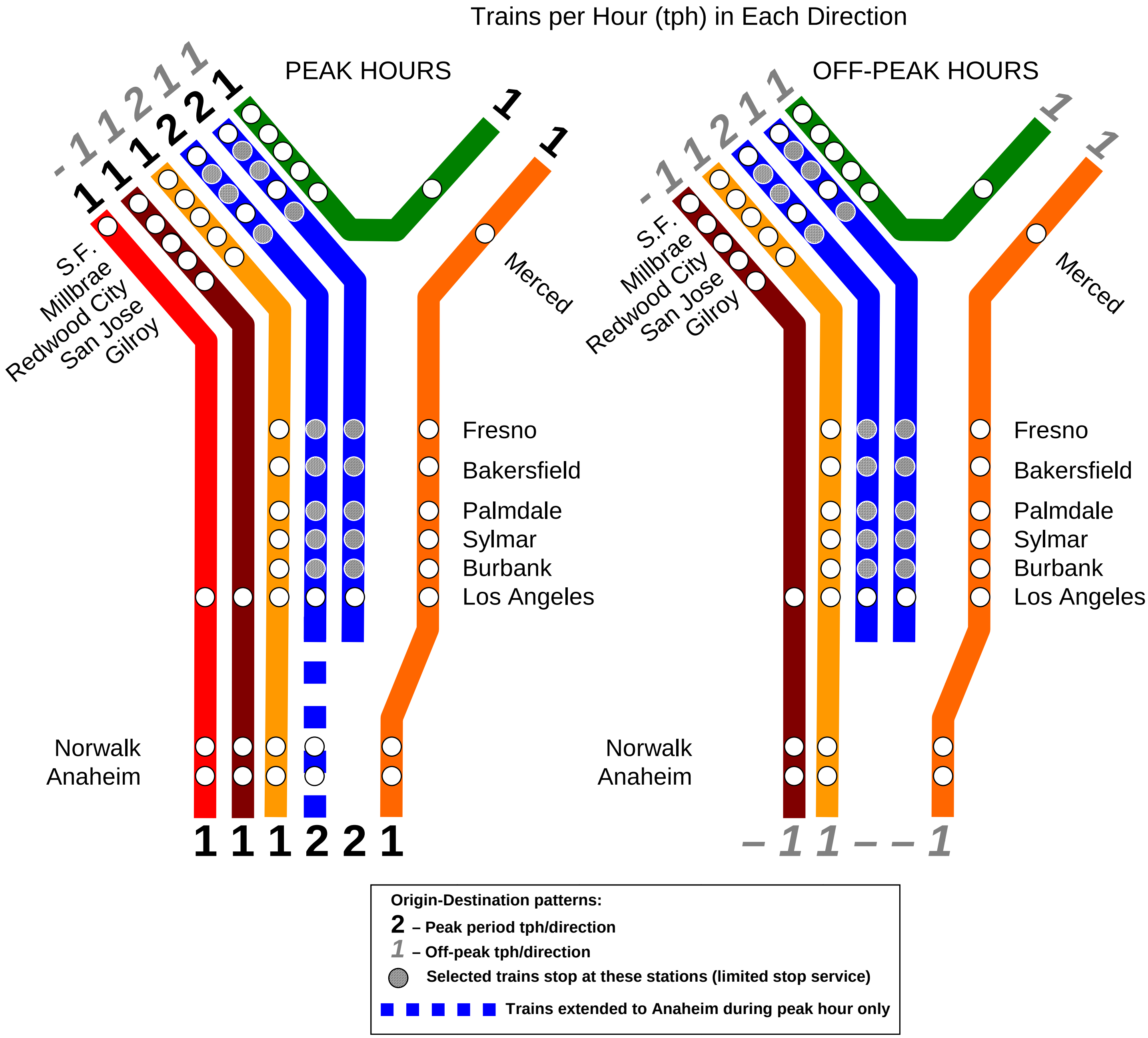
FIGURE 5 – PHASE 1 SERVICE PLAN – 2035, PEAK HOUR AND OFF-PEAK TRAIN MOVEMENT DENSITY



In Phase 1, the portion of the network with the greatest density of train traffic will be the main line between San Francisco and Los Angeles, with eight high-speed trains per hour in each direction during the morning and afternoon peak hours – equivalent to an average headway of 7.5 minutes. The density of traffic in the Phase 1 plan is slightly less than for the Full Build plan.

Phase 1 train service includes trains operating over a subset of the routes listed previously for the Full Build network. Most stations and segments of the network are served by more than one route. Figure 6 (on the following page) provides an illustration of the types of service and the number of trains of each type operated on each of the HST routes during a typical peak hour and off-peak hour in the year 2035.

Figure 6 – Phase 1 Service Plan – 2035, Basic Train Stopping Patterns



The graphic in the preceding figure shows the variations in the types of trains and stopping patterns that will be available to HST riders, but it generalizes the limited-stop patterns for the sake of presentation clarity. The actual mix of stopping patterns in a typical weekday peak hour and off-peak hour is provided in the Phase 1 Service Plan technical memorandum.

Non-stop express service is offered during the peak periods, with one intermediate stop, between San Francisco and Los Angeles/Anaheim. This service provides three trains in each direction in the morning peak, and three trains in each direction again in the afternoon peak.

As in the Full Build case, limited-stop services make up the majority of trains operating on the network. The Phase 1 Operations and Service Plan provides four limited trains per hour in each direction, all day long, between San Francisco and Los Angeles. During the morning and afternoon peak periods, two of these trains in each direction are extended to Anaheim to provide sufficient seating capacity to accommodate peak hour demand.

The longer-distance intercity markets in the Bay Area-Los Angeles-Orange County corridor are served by a "limited express" service that operates once per hour, all day long. Clock face "on the hour" departures are envisioned southbound from San Francisco and northbound from Los Angeles. This train makes several stops at each end of the trip (in the Bay Area on the north end and within the Los Angeles basin on the south side of Los Angeles), but it operates as a non-stop express between Gilroy and Los Angeles, bypassing stations along the entire Central Valley and providing relatively fast trip times among multiple Bay Area and Los Angeles area station pairs.

All-stop service is offered on three routes (San Francisco-Anaheim, San Francisco-Merced and Merced-Anaheim) all day long. Merced and the northern Central Valley would be served by all-stop trains once an hour to San Francisco and Los Angeles/Anaheim.

The Phase 1 Service Plan requires very few passengers to change trains while en route. Direct service generally is provided at least once per hour between all pairs of stations on the Phase 1 network.

The on-board travel time between stations varies, depending on the number of intermediate station stops and any requirements for scheduled "overtakes" of slower stopping trains by faster nonstop trains.

The "Express" train type makes no intermediate stops between San Francisco and Los Angeles during the weekday peak periods and therefore provides the fastest run time between these points (two hours-forty minutes), based on the assumption of one percent recovery time[1]. At the other end of the spectrum are "All Stop" trains that serve every station along the line and therefore take significantly longer to make a run between San Francisco and the Los Angeles basin.

Passenger Station Operations

The Full Build service plan (horizon year 2035) encompasses 25 passenger stations, including 20 intermediate stations and five terminal stations. The current Phase 1 service plan (expected to be operational prior to 2020), provides 11 intermediate and four terminal stations. Los Angeles Union Station is listed as an intermediate station but will serve both roles – as an intermediate station for some trains and a terminal station for other trains.

Station platforms are assumed to have a length of 1380 feet (420 m). In accordance with CFR regulations that require that platform design meet the requirements of the Americans with Disabilities Act (ADA) Accessibility Guidelines, the CHSTP platforms will be designed to allow for level boarding.

Intermediate Stations and Siding Tracks

Acknowledging the complexity of the operating plan and to provide the opportunity for overtakes, all the intermediate stations in the exclusive, dedicated sections of the high speed system incorporate siding tracks for stopping trains and are spaced about 50 miles apart in rural areas and approximately 15 miles apart in metropolitan areas, with overall average spacing about 30 miles.

The high speed rail station in Los Angeles is both a terminal station and intermediate station in Phase 1 and the Full build out. This station has a special layout that incorporates features of both an intermediate and terminal station.

The typical intermediate station will have the configuration shown in Figures 7 and 8, with siding tracks on the outside flanked by side platforms. The platforms will be high-level, tangent and will cover the full length of a

[1] The introduction of the non-stop express train between San Francisco and Los Angeles represents a slight change from the Phase 1 Operations and Service Plan referenced in the accompanying technical memorandum (November, 2008), which assumed that the peak period express train would make one intermediate stop between San Francisco and Los Angeles – at San Jose.

400 meter train, permitting level boarding through all train doors. In the shared use corridor south of Los Angeles and in the four-track corridor between San Jose and San Francisco, station track and platform configurations will need to be developed that allow for stations to be used by both high-speed trains and conventional intercity and/or commuter trains. These configurations will likely be different from that shown in the figure below. Alternative configurations, and their operational characteristics, advantages and disadvantages, will be evaluated in the course of preparing more detailed operating and service plans during the next several months.

FIGURE 7
INTERMEDIATE STATION – TYPICAL CONFIGURATION

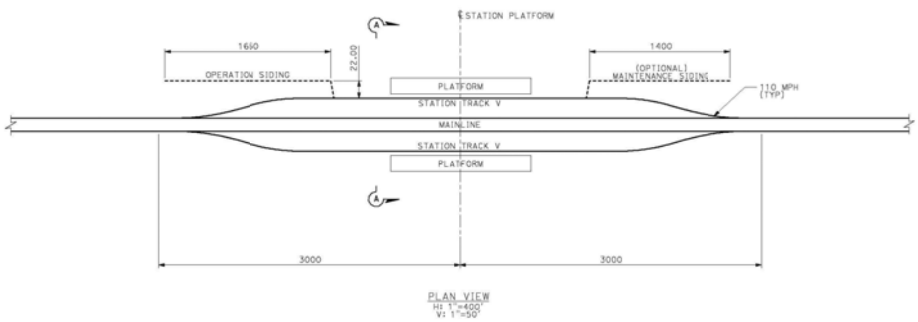
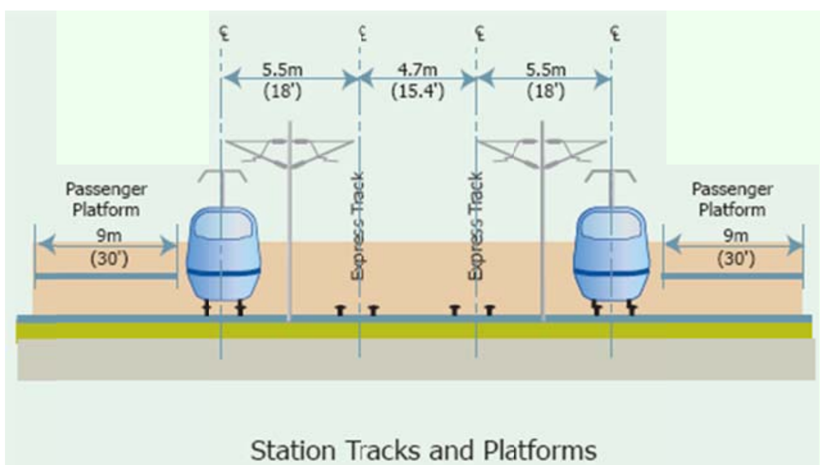


FIGURE 8
INTERMEDIATE STATION – TYPICAL CROSS-SECTION

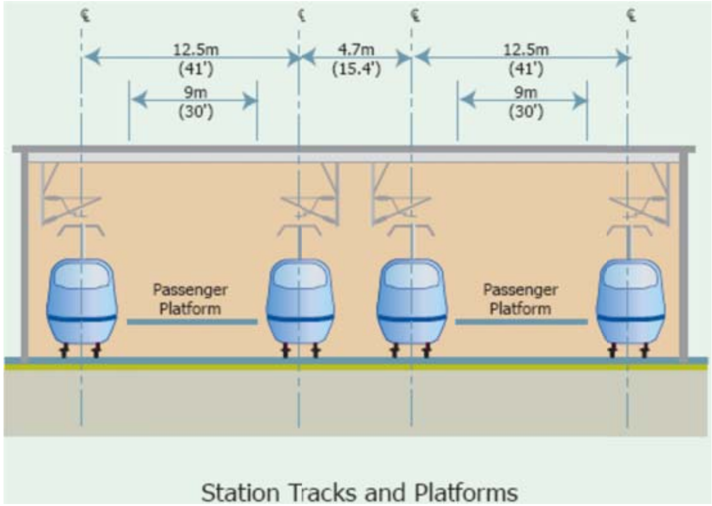


Terminal Stations

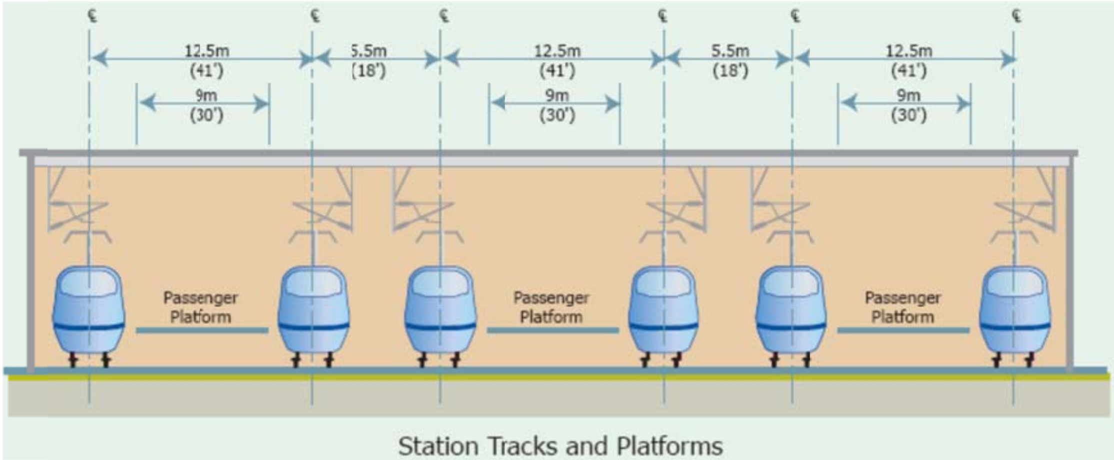
Three stations are identified as terminal stations in Phase 1: San Francisco, Anaheim, and Merced with Los Angeles serving as both a terminal and intermediate (run-through to Anaheim) station. In the Full Build network configuration, San Diego becomes the southern terminus of the inland branch from Los Angeles. Merced will become an intermediate station as the Central Valley line is extended to the north, and Sacramento will be the terminal station on this branch of the network. Terminal stations are envisioned to have island platforms serving tracks on both sides and be able to accommodate train cleaning, restocking with on board food service, mandatory train inspection and as-needed maintenance and repair of trainset components – along with the alighting and boarding of passengers. The track and platform configurations at terminal stations vary based on the level of projected train service, local physical constraints, and requirements for other (non-HST) train services that would be located adjacent to the facilities for CHST. Figure 9 shows typical configurations for a four-track and six-track terminal.

FIGURE 9
TERMINAL STATION – TYPICAL 4-TRACK AND 6-TRACK CROSS-SECTIONS

Four-Track Terminal with Two Island Platforms



Six Track Terminal with Three Island Platforms



Passenger Boarding

There are a few different ways in which passenger boarding could be managed at CHST terminal stations. The CHST project has not yet reached a conclusion on the preferred methods for passenger-handling system-wide, and there will be a strong desire on the part of the CHST sponsors and operator for consistency in the methods of passenger handling across the entire system. Passenger-handling requirements affect the design and configuration of the physical facilities used for passenger-processing, waiting and queuing and horizontal and vertical circulation.

The potential variations in passenger-handling procedures and required facilities encompass the following:

- Advance staging of boarding passengers
  - Retain all boarding passengers at concourse level until cleaning/servicing is substantially complete and the train is ready for boarding
  - Permit boarding passengers to descend to platform level as soon as the load of detraining passengers has cleared the platform (passengers and service personnel and equipment would occupy the platform level simultaneously)
- Number and location of boarding concourse points
  - Board from a single concourse location
  - Board from dual locations
  - Board from multiple locations spread along a mezzanine or longitudinal concourse situated above or below the platform level, with multiple vertical circulation connections to the platforms
- Reserved seat policy
  - Open seating, where passengers select the car that they will board
  - Reserved seating (similar to most European and Asian high-speed rail systems), where passengers are assigned to a seat in a particular car, and where the time required to board the train can be minimized by pre-positioning passengers either on the platform or at concourse level close to where their seat will be located.

The above options have differing implications in terms of required facilities, the configuration of concourse and vertical circulation elements, and the station operating costs associated with managing the boarding process.

<u>Train Cleaning and Servicing</u>

At terminal stations, train servicing will be done using the passenger platforms. Due to space constraints at the proposed terminal sites, dedicated service platforms are not envisioned. To maximize the efficiency of servicing operations, maximize passenger safety and achieve predictable layover times, normal operating procedures will plan for providing temporal separation between the passenger unloading and loading processes and train servicing activities at the terminal platforms.

In order to attract and keep a dedicated passenger base it is extremely important to establish and maintain a cleanliness standard aboard the train consists. This service is accomplished by means of several layers of cleaning techniques implemented at selected times in a service day.

- Normal (Lay-up) Cleaning – This service is performed upon passage through a Level 1/2 maintenance site and is generally done when a train is laid up for a sufficient time to receive a thorough interior cleaning of the passenger areas to include seats and bathrooms. It is usually scheduled daily and is completed prior to a train entering revenue service in the morning. All trash is removed, seats and floors cleaned, and bathrooms sanitized.
- Soft (Pick-up) Cleaning – When a train set turns in a terminal station or on a storage track with insufficient opportunity for a full normal cleaning, this service is performed to return the interior to a condition that is appealing and satisfactory.

Servicing of toilets is envisioned to occur in the overnight layup, maintenance facilities and not planned to be done in any of the terminals during the turnaround time window.

Train Layover Times at Terminal

All CHST trains will change directions at terminal stations, by virtue of their configuration as a stub-ended terminal. Three types of train movements will occur in terminal stations

1. Revenue to Non-Revenue: Revenue trains (with passengers) arrive, with the equipment turning and going to the rail yard for storage or servicing, without passengers
2. Non-Revenue to Revenue: Trains enter the terminal from the rail yard (without passengers), departing passengers board (the train), and the train departs as a revenue train (with passengers)
3. Revenue to Revenue: Revenue trains (with passengers) arrive, the train will lay over at the platform while it is inspected, cleaned and restocked with bathroom and food service supplies, departing passengers board (the train), and the train departs as a revenue train (with passengers).

Estimating the time required to carry out the various terminal turnaround train servicing and passenger processing functions, and identifying which functions can proceed in parallel with each other and which depend upon the prior completion of other activities, enables the defining of a "critical path" of activities that governs the minimum time required between the arrival of an inbound train and the subsequent departure of the outbound train. The functional and timing relationships are presented diagrammatically in Figure 10 on the following page, which provides a graphic illustration that arrays the required sequence of steps that must be followed for four basic processes that occur during the turnaround layover period:

1. Passenger alighting and boarding
2. Re-stocking of food and beverage service items
3. Coach cleaning and re-stocking of bathroom supplies
4. Train safety system pre-departure preparation

In addition, minor equipment repairs that can be accomplished during the layover period will be addressed.

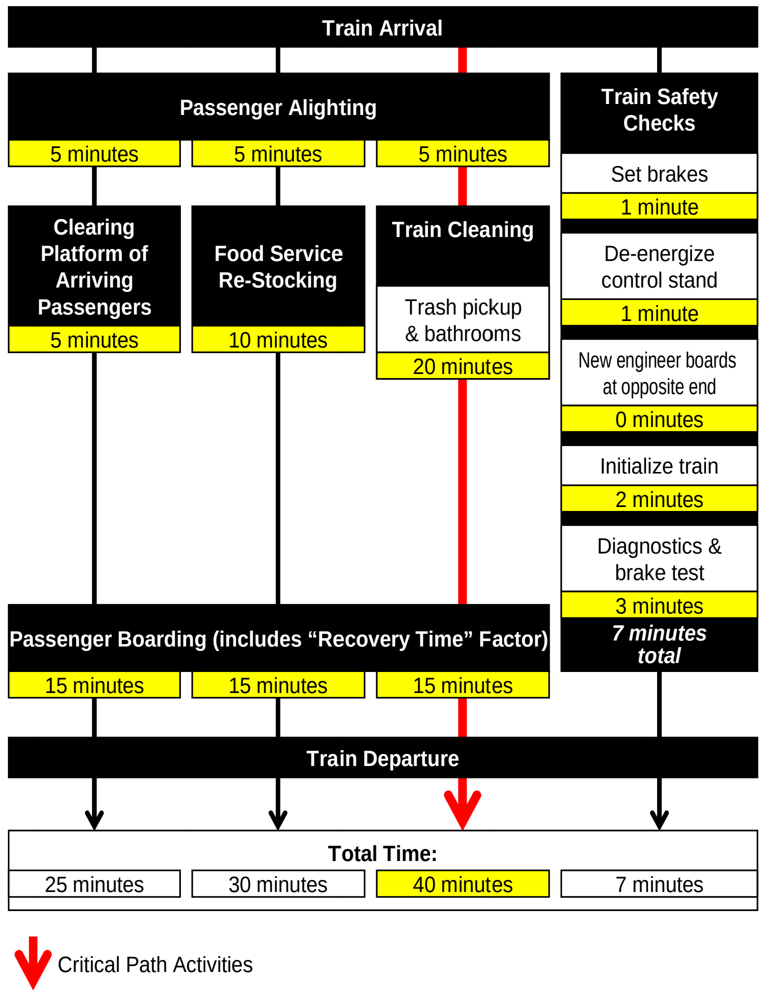
Facilities will need to be provided at the terminals to support the food service provisioning (commissary), coach cleaning and railroad mechanical department (equipment maintenance and repair). These facilities will need to be located in proximity to the CHST platforms, to minimize the time required to access a train when it arrives at the terminal. Direct service elevator access is required between these facilities and the CHST platforms, separate from the elevators and access points used by passengers.

The diagram in Figure 10 presents the time estimated for each function and identifies activities that depend upon the prior completion of other activities. One can see that the train cleaning function requires the longest duration of time to complete – when compared with food service provisioning and train safety testing. Therefore, train cleaning is on the critical path that drives minimum turnaround time. The critical path activities for train turnaround at terminal stations are, in sequential order:

1. Passenger alighting
2. Train cleaning
3. Passenger boarding.

FIGURE 10
CRITICAL PATH ACTIVITIES FOR CHST TERMINAL LAYOVER AND TURNAROUND TIME

(Revenue Train-to-Revenue Train)



The scheduled terminal station turnaround time for CHST is composed of four primary "critical path" factors: Passenger alighting, interior cleaning, passenger boarding, and a "Recovery Time Factor". The following table summarizes CHST assumptions for the minimum exception and minimum standard scheduled turnaround times (based on a 400 meter train).

TABLE 4 –
TIME REQUIRED FOR TERMINAL LAYOVER ACTIVITIES
(CHSTP PLANNING ASSUMPTIONS, REVENUE TRAIN TO REVENUE TRAIN)

Critical Path Activity	Minimum Exception	Minimum Standard
Passenger Alighting	5 minutes	5 minutes
Cleaning, Restocking, Servicing & Provisioning	(2) 10 minutes	(1) 20 minutes
Passenger Boarding "Window" (includes up to 10 min "Recovery Time" Factor)	15 minutes	15 minutes
Total Scheduled Turnaround Time Assumption	30 minutes	40 minutes

(1) 400 m train requires coach cleaning staff of 16.
(2) 400 m train requires coach cleaning staff of 31.

Note: Train safety system preparations can be accommodated within time windows available for alighting, cleaning and boarding.

Providing a scheduled 15-minute "window" for passenger boarding would permit train cleaning and servicing functions to be concluded prior to the start of the boarding process and minimizes the time spent queuing by departing passengers while also providing for a necessary allowance of up to ten minutes of "recovery time" for trains arriving later than scheduled in the timetable.

TABLE 5 –
MINIMUM SCHEDULED TERMINAL LAYOVER TIMES
(CHSTP PLANNING ASSUMPTIONS, REVENUE TRAIN TO REVENUE TRAIN)

Code	Station	Phase 1	Full Build	Minimum Scheduled Layover Time (minutes)
SFT	San Francisco – Transbay	✓	✓	30
SF4	San Francisco – 4th and King	✓	✓	40
SAC	Sacramento		✓	40
MCD	Merced	✓		40
LAU	Los Angeles - Union Station	✓	✓	40
ANA	Anaheim	✓	✓	40
SAN	San Diego		✓	40

Rolling Stock Storage and Maintenance

Fleet Requirements

A "baseline" total of sixty five (65), 200 meter trainsets were estimated to operate the 260 daily trains scheduled in the Phase 1 revenue service plan. An additional twenty-nine (29), 200m sets are required to "fill out" the 400m trainsets that serve the peak periods (and all-day express services).

A total of 107 train sets are estimated to be required to operate the 339 daily trains scheduled for the Full Build revenue service plan. Each train set comprises a base configuration, 200 meters in length and seating approximately 500 passengers. Some of these train sets will be doubled in length to accommodate peak passenger loadings up to 1,000 passengers per train. An additional eighty-five 200 meter units are required to "fill out" the 400 meter trainsets that serve the peak periods (and all-day limited express services), as shown in Table 6. The determination of requirements for 200 meter versus 400 meter train lengths was based on estimated train-specific passenger loadings on the various routes during the peak, peak shoulder and off-peak hours and will be refined as the ridership estimates are updated.

TABLE 6 – FULL BUILD SERVICE PLAN – REVENUE TRAIN SETS REQUIRED AT EACH TERMINAL TO START WEEKDAY MORNING TRAIN SERVICE

Terminal	200 meter Sets	400 meter Sets	Total
San Francisco – Transbay & 4th & King Terminals	6	24	30
Sacramento	3	14	17
Merced	--	3	3
Los Angeles Union Station	2	16	18
Orange County (Anaheim)	9	8	17
San Diego	2	20	22
Merced			
Total	22	85	107

The Full-Build Operations and Service Plan described in this document requires 107 revenue train sets. The estimated proportion of 200 meter and 400 meter sets is indicated in Table 7, along with an allowance for spare train sets, resulting in an overall fleet requirement for 212 total 200-meter units. The allowance of 10 percent spares is the mid range of spare ratios for U.S. and international intercity and high-speed rail fleets. A lower spare ratio could be justifiable if an aggressive preventive maintenance program is adopted, which invests in the facilities, spare parts inventories and labor force needed to progressively replace train set components on a regular schedule before component failure occurs or life expectancy is reached. Conversely, a decision in favor of a more traditional maintenance philosophy that undertakes more limited periodic inspections and relies more on reactive repair and replacement of components as they wear out, would tend to increase the required spare ratio – as would the desire for spare ready equipment sets to ensure a very high level of equipment availability. The fleet requirement numbers will be modified as the operating plan, demand projections, and maintenance plans are refined.

TABLE 7 – FULL BUILD – HIGH-SPEED TRAIN FLEET REQUIREMENTS

	Train Sets	200 meter Equivalent Units
200 meter Revenue Train Sets	22	22
400 meter Revenue Train Sets	85	170
Subtotal	107	192
Spare Equipment (Assume 10 percent)		20
Total		212

Train Storage and Maintenance Facilities

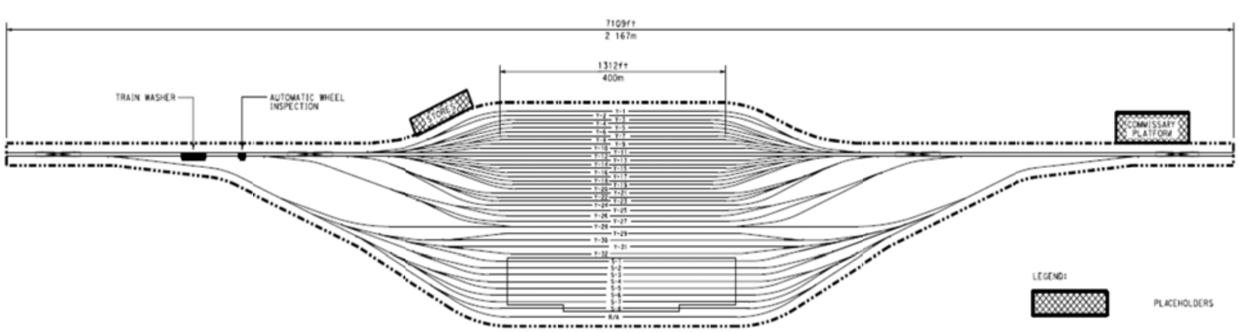
Train storage yard facilities will be located as close as physically possible to the terminal stations.

Generally, the terminal stations are in heavily urbanized areas that do not have land available immediately adjacent to the terminal for new train storage yards. As a result, trains that are entering or leaving service at a terminal station will have to operate as non-revenue or "deadhead" train movements to and from the storage yards.

The overnight layup facilities are the basic facility at each of the terminal locations that provide overnight storage for the trainsets and daily inspections and cleaning. The terminals in San Diego, Anaheim and Sacramento will be limited to overnight layup facilities. One periodic inspection facility is located in northern California (San Francisco), one in southern California (Los Angeles), and one heavy maintenance facility in the center of the statewide system to provide all of the overhauls and component refurbishment. An example of a typical concept configuration for an overnight storage, layup facility equipped with a shop to perform periodic inspections is shown below in Figure 11.

FIGURE 11

EXAMPLE: TYPICAL CONCEPT CONFIGURATION – OVERNIGHT-STORAGE YARD WITH SHOP



The storage capacity of each facility is based on the number of trains estimated in the Phase 1 and Full Build-Out Operations and Service Plans and is summarized in Table 8 below.

TABLE 8 – STORAGE / LAYUP TRACK REQUIREMENTS

Phase 1 Network

Location	200 m Sets	400 m Sets	Total Sets	200 m Equivalents	400 m-long Tracks
San Francisco	14	13	27	40	20
Sacramento					
Merced	5	1	6	7	4
Los Angeles	13	2	15	17	9
Anaheim	4	13	17	30	15
San Diego					
Total	36	29	65	94	48

Full Build Network

Location	200 m Sets	400 m Sets	Total Sets	200 m Equivalents	400 m-long Tracks
San Francisco	6 -12	18 - 24	30	48 - 54	24 - 27
Sacramento	3 – 6	9 - 14	15 - 17	24 - 31	12 - 16
Merced	0	0 - 3	0 - 3	0 - 6	0 - 3
Los Angeles	2 - 2	11 - 16	18 – 19	30 - 34	15 - 17
Anaheim/Irvine	8 - 9	8 – 9	17	26 - 25	13
San Diego	2 – 8	11 - 20	19 - 22	30 - 42	15 - 21
Total	22 - 42	58 - 85	100 - 107	158 - 192	79 - 97

Note: this table shows a range of values, depending upon the level of future ridership and the specific Service Plan that is operated.

Rolling stock maintenance program

Consistent with international standards, the California high-speed train system is planned to provide five different levels of train maintenance activity:

- Level 1 – In Service Monitoring: daily testing and diagnostics of certain safety sensitive apparatus on the train in addition to automatic on-board and on-ground monitoring devices.
- Level 2 – Examinations in Service: inspections, tests, verifications and "quick" replacement of certain components on the train. Examples include inspection and maintenance tasks associated with the train's running gear, bogies, underbody elements and pantographs.
- Level 3 – Periodic Inspections: part of a planned preventive maintenance program requiring specialized equipment and facilities. Examples include: a) examination of interior fittings and all parts of the train in the immediate environment of the passengers, b) in depth inspection of axles and underbody components, critical to train safety by identifying and repairing any condition in the running gear and connecting components, c) wheel condition diagnostics and re-profiling (wheel truing).
- Level 4 – Overhauls (HMF only): part of the planned life cycle maintenance program requiring a specialized heavy maintenance shop with specific heavy duty equipment. Activities include the complete overhaul of train components replaced during Level I, II and III. In addition, a full complement of heavy

maintenance is completed on each trainset every 7 to 10 years (30 days per trainset) as well as mid-life overhauls which are performed on each trainset every 15 to 20 years (45 days per trainset).

- Level 5 – Rolling Stock Modifications & Accident Repair (HMF only): Activities to support installation of a major modification to the design of the trainset for purposes of improving safety, reliability and passenger comfort. In addition, this category includes repair to a trainset which has "suffered" significant damage.

The frequency with which these maintenance procedures are performed varies by level. To minimize cost, maximize flexibility and to address all of the levels of maintenance and inspections, these maintenance functions will be undertaken at a relatively small number of facilities spread across the CHST network. The locations at which maintenance will occur can be broken into three groups:

- Overnight Layup Facility – Provides Levels 1 and 2 maintenance and inspections
- Periodic Inspection Facility – Provides Levels 1 to 3 maintenance and inspections
- Heavy Maintenance Facility – Provides Levels 1 to 5 maintenance and inspection, including overhauls and component refurbishment.

Facility site location criteria

It is important that each of these facilities be located immediately adjacent to the HST System main line tracks and connected directly to these (main line tracks) with a 110 mph turnout and two connecting tracks (i.e. "double track") of approximately 3,696 feet on both ends of each facility. The connecting tracks will transition to become the slow speed (15 mph) lead tracks within each facility.

In addition to proximity and connectivity to the HST System main line tracks, the site of the Terminal Storage Maintenance Facilities (TSMF) should be such that the distance between the TSMF and the Terminal Stations is minimized. The preferred distance is up to 1.5 miles, the desirable distance is from 1.5 to 3.0 miles and the exception is further than 3.0 miles. Terminal Storage Maintenance Facilities are required for the terminus stations or end points of the system at San Francisco, Los Angeles, Anaheim and Merced for Phase 1 with additional TSMF at San Diego and Sacramento for the Full Build-Out. In addition, consideration is being given to a possible combined TSMF for Los Angeles and Anaheim.

The desirable site for the Heavy Maintenance Facility is that it be located centrally on the HST System between Merced and Bakersfield. Being central is important. Merced-Bakersfield is the "Central Part" of the system, is part of the trunk line (Anaheim-SF), and has the ability to include a high-speed test track (no other part of the system meets these criteria). The required length of this test track is based upon current high-speed train manufacturers' recommendations for testing and commissioning which includes a protocol for sustained running for ten minutes up to 250 mph. Train operations at these speeds require a tangent (straight) alignment for the aforementioned speeds of approximately 80 to 105 miles.

It was determined that it is critical for the HMF to be activated prior to delivery of new train-sets for purposes of (potential) assembly and to have all of the functional requirements of the facility available during the required testing, acceptance and commissioning of the fleet. The testing procedures require that each train achieve a test speed greater than the in-revenue-service operating speed; for the CHSTP that speed range is between 223 mph (minimum) and 242 mph (recommended/preferred) and that this speed be sustained for a duration of ten minutes for each test run. Consequently, in order to provide track infrastructure capable of meeting these requirements, the maximum operating track speed must be 223 mph / 242 mph and the length of the "test track" must be between 80 miles (for 223 mph scenario) and 105 miles (for 242 mph scenario).

Estimated spatial requirements

Based on a conceptual rendering of these facilities they require the following land parcel "footprints" range (depending on the shape of the land parcel), inclusive of buildings, outdoor service areas, storage, roadways and parking:

- Merced to Bakersfield Heavy Maintenance Facility Concept, 154 Acres
- Los Angeles Storage Yard and Maintenance Facility Concept, 62 to 83 Acres
- San Francisco Storage Yard and Maintenance Facility Concept, 90 to108 Acres
- Anaheim Yard and Maintenance Facility Concept, 52 to 74 Acres
- Sacramento Yard and Maintenance Facility Concept, 54 to 76 Acres
- San Diego Yard and Maintenance Facility Concept, 70 to 93 Acres
- Los Angeles / Anaheim (combined TSMF) Yard and Maintenance Facility Concept, 88 to105 Acres

Commissioning of rolling stock

In addition to the in service maintenance regimen, the HMF is assumed to be used during the pre-revenue service period for the assembly, testing, acceptance, and commissioning of the HST System new rolling stock fleet. Implementation of the testing, acceptance and commissioning activity would also require a main line test track between 80 and 105 miles in length connected directly to the HMF. The HMF would also be used for decommissioning or retirement of equipment from the system to make way for the next generation of rolling stock.

Maintenance of Way

Maintenance of Way Functions

The Maintenance of Way (MOW) function is responsible to maintain the infrastructure in a state of good repair and insure that the physical plant complies with regulatory (FRA, CPUC etc.) guidelines and standards (as may be applicable). The disciplines encompassed in MOW include Track (for inspection and maintenance of the track and its components), Electric Traction (for inspections maintenance of the Overhead Catenary and Traction power system), Signal & Communications (for inspections and maintenance of signals, train control systems and the communications network) and Bridges & Structures (for inspection and maintenance of bridges, aerial structures and tunnels).

Maintenance of Way Facility Locations and Configurations

Adequate space will be required to "park" on-track right-of-way maintenance equipment, store maintenance of way material inventory and replacement parts, and support a "headquarters" and staging area for HST System "sub-division" maintenance personnel. Although the detailed Maintenance of Way plan has not yet been developed, the locations that support an effective Maintenance of Way program strategy are envisioned to be located near Gilroy, Merced, Visalia, Bakersfield, and Palmdale for Phase I, with Stockton, City of Industry and Temecula added later for the Full System Build-Out. The selection of right-of-way maintenance facilities will be based on servicing a track distance of 75 miles in each direction from the site of the Maintenance of Way Base for a total coverage of 150 miles. This is to accommodate the time for equipment traveling at 60 mph to reach locations along the alignment needing maintenance during the five hour non-revenue period.

The site for each MOWF must be located immediately adjacent to the main line trunk of the HST System and be connected to the main line with a standard turnout. Also required is effective connectivity to the highway road net-work and access to utilities including water, gas, electricity, sewer and communications.

Based on a conceptual rendering, a typical MOWF would require a land parcel "footprint" of between approximately 24 to 26 acres each, inclusive of roadways and parking.

Train Dispatching and Control

Operations Control Center

A provision for a train operations control center has been assumed within the HMF "compound", on a second level of the HMF building. Space for employee parking, pedestrian access/egress and appropriate bathroom and lunchroom facilities has been included. However, the operations control center can be located at any place along the system. Utilizing the second level of the HMF building will allow space for the operations control center without increasing the foot print of the HMF building or the additional cost of a separate building

Communications with HST Stations

CHST trains will be dispatched and controlled from a central control facility remote from the individual stations and terminals. A direct communications link will exist between the central control facility and the Terminal Operations Center or CHST Passenger Services office at each CHST station and terminal, to enable station staff of the CHST System Operator (and the Terminal Operator, at facilities where the terminal is managed by a third party) to monitor the status of train operations on the rail network and respond to any unusual conditions that may arise.

Manpower Estimates for Operations and Maintenance Activities

Order of magnitude staffing estimates were developed for rolling stock (Maintenance of Equipment), infrastructure (Maintenance of Way), and Operations. These estimates are presented in the following sections and accompanying tables.

Maintenance of Equipment

The Phase 1 operations plan consists of 260 revenue trains per weekday and is represented by a combination of 200 and 400 meter trainsets. Converting the 400 meter trainsets into the 200 meter equivalents and adding 10% of spare equipment, yields an estimated total of 107 trainsets (200 meter equivalents). The Full Build-Out operation plan consists of 339 revenue trains and is represented by 212 trainsets (200 meter equivalents), including a 10% spare ratio. The staffing estimate for the Phase 1 and Full Build networks is summarized in Table 9 below:

TABLE 9 –
REQUIRED MANPOWER STAFFING – MAINTENANCE OF EQUIPMENT

Phase 1 Network

Function	Baseline	Upper Range
Car Inspectors/Cleaners (Level1 & 2)	728	834
Inspection (Level 3)	688	794
Heavy Maintenance* (Level 4& 5)	561	645
G&A, Mgmt	198	228
Total	2175	2501

* Assumes Level 4 Heavy Maintenance activities (component rebuilds etc.) for Phase 1 but no Heavy Overhaul until Full Build-Out

Full Build Network

Function	Baseline	Upper Range
Car Inspectors/Cleaners (Level1 & 2)	1695	1945
Inspection (Level 3)	1252	1440
Heavy Maintenance* (Level 4& 5)	1645	1895
G&A, Mgmt	460	528
Total	5052	5808

Maintenance of Way and Infrastructure

Maintenance of Way & Infrastructure order of magnitude staffing estimates are presented in the table below, for the Phase 1 and Full Build networks.

TABLE 10 – REQUIRED MANPOWER STAFFING – MAINTENANCE OF WAY AND INFRASTRUCTURE

Phase 1 Network

Element	Baseline	Upper Range
Track	195	234
Traction Power / OCS	150	180
Signal/Train Control	40	48
Communications	35	42
Bridges & Structures	25	30
Material Control	35	42
System Support	94	113
G&A, Supervision	60	72
Total	634	761

Full Build Network

Element	Baseline	Upper Range
Track	312	375
Traction Power / OCS	240	288
Signal/Train Control	64	77
Communications	56	67
Bridges & Structures	40	48
Material Control	56	67
System Support	154	185
G&A, Supervision	96	115
Total	1018	1222

Train Operations

Phase 1 Assumptions:

- Revenue service applies seven days per week (weekdays, weekends and holidays). Average estimated trip time per revenue train: 3 hours, 20 minutes.

- Typical basic revenue "road" crew is comprised of one engineer, one conductor, and one assistant conductor; total of a three person crew.
- Typical yard crew for layup, maintenance and storage facilities is comprised of one engineer (train operator) and one conductor; total of a two person crew.
- In addition to the typical basic revenue "road" crew, two positions are assigned to each 400 meter revenue train for ticket/ fare verification/collection and general on-board services.
- One Special Services (S.S.) attendant is assigned to each 200 meter train; two S.S. attendants assigned to a 400 meter train.
- Based on the estimated average trip time per revenue train, a "crew" is assumed to be "on duty" for one roundtrip (revenue) per day, approximating an eight-hour work day and providing adequate "protection" to comply with the Code of Federal Regulations-- Hours of Service requirements.
- All operational train movement positions are included under the heading "Dispatcher".

Full Build-Out Assumptions:

- Revenue service applies seven days per week (weekdays, weekends and holidays).
- Average estimated revenue train trip time: 4 hours, 10 minutes.
- Typical basic revenue "road" crew is comprised of one engineer, one conductor, and one assistant conductor; total of a three person crew.
- Typical yard crew for layup, storage and maintenance facilities is comprised of one engineer and one conductor; total of a two person crew.
- In addition to the typical basic revenue "road" crew, two positions are assigned to each 400 meter revenue train for ticket/fare verification/collection and general on-board services.
- One Special Services (S.S.) Attendant is assigned to each 200 meter train; two S.S. Attendants assigned to each 400 meter train.
- Based on the estimated average trip time per revenue train, a "crew" is assumed to be "on duty" for one roundtrip (revenue) per day, approximating an eight-hour work day and providing adequate "protection" to comply with the Code of Federal Regulations-Hours of Service requirements .
- All operational train movement positions are included under the heading "Dispatcher".

Transportation Operations order of magnitude staffing estimates for the Phase 1 and Full Build networks are presented in the table below:

TABLE 11 – REQUIRED MANPOWER STAFFING – TRANSPORTATION OPERATIONS

Phase 1 Network

Positions	Baseline	Upper Range
Engineer	263	303
Train crew	688	792
S.S Attendants	311	358
Yardmasters	17	20
Dispatchers	56	65
G&A, Management	130	150
Total	1,465	1,688

Full Build Network

Positions	Baseline	Upper Range
Engineer	386	444
Train crew	1012	1164
S.S Attendants	317	365
Yardmasters	27	31
Dispatchers	66	76
G&A, Management	170	195
Total	1,978	2,275

Project Status

This document is based on the latest published technical memoranda and system and operations planning documents. Most of these documents were prepared in mid-2009 based on analytic work undertaken in the first half of 2009 to support the initiation of section environmental and design work. Operational concepts and estimated ridership levels have evolved since that time. However, the fundamental system assumptions and descriptions remain valid.

Limitations of Analyses Performed to Date

The Full-Build and Phase 1 Service Plans developed in 2009, while contributing to confident approximations at the conceptual level, do not yet represent detailed operating plans for the system, even though the train timetables and string-line diagrams give the impression of a high level of precision. This conceptual plan analysis is based on optimal ideal operations with trains running exactly on schedule. It does not analyze any randomization, delays or perturbations to the normal schedule and does not address the time required to recover from track blockages or the impacts of delay conditions on the network.

The analyses to date have been based on a relatively simplistic set of assumptions about practical headways. The hypothetical train schedules published as appendices to the Service Plan technical memoranda were developed on the basis of allowing at least a three minute separation between trains. The complexity of train stopping patterns, the mix of non-stop and stopping trains and the varying line speeds along the high-speed corridors require a more sophisticated analysis of the capacity of the signaling and train control system to handle trains at close headways. This analysis is underway during the 4th Quarter of 2010 and will result in a more precise Service Plan and definition of potential train schedules. In the meantime, the schedules that accompany the Service Plan technical memoranda serve as useful placeholders for the quantity and type of high-speed train service that is desired and envisioned for the California system.

The Full-Build and Phase 1 Service Plans recognize the need for non-revenue or "deadhead" train movements between terminal stations and the train storage and maintenance facilities; however, these non-revenue train movements have not yet been analyzed in detail.

A full detailed operating plan supported by dynamic computer simulation modeling of train movements throughout the system will be developed in a subsequent task later in the project, at which time "investment grade" analysis will allow development and Authority approval of a realistic proposed timetable that can be proven to operate reliably.

Scope of Analyses to be Undertaken in the 4th Quarter of 2010

The scope of the next phase of operations and service planning, and ridership forecasting analysis will provide significant input for the CHSTP 2010 Business Plan and is intended to improve upon the precision and accuracy with which the operations of the CHST system are modeled and analyzed. The following tasks will be undertaken in the service planning realm:

- Simpler operating patterns – offering greater reliability and more closely matching projected travel demand patterns
- Updated train performance calculations and speed profiles, based on preliminary alignment engineering to date
- More precise modeling of overtake operations at intermediate stations
  - Detailed analysis of intermediate station overtakes
- More precise adherence to practical operating headway limitations
  - Detailed estimation of practical headways based on current project signal system planning parameters
- Analysis of intermediate station dwell times and factors affecting dwell time variability
- Analysis of appropriate schedule pad and recovery time factors
- More precise analysis of terminal operations, including:
  - Layover operations, including passenger alighting and boarding and train mechanical inspection, cleaning and servicing
  - Passenger-handling procedures affecting the time required for passenger alighting and boarding
  - Make-up and break-up of 400 meter trainsets at terminal platforms, in order to accomplish consist management objectives (matching train capacity to ridership demand)
  - Non-revenue train movements to and from storage and maintenance facilities
- Investigate alternative station and storage yard locations and analyze their effect on the service plan and overall system operations
- Incorporate allowances for maintenance of way activities; maintenance (time) "windows"
- Development of comprehensive service and operating plans for all rail services that potentially share tracks with CHST trains over a portion of their run, including:

    - Caltrain service between San Jose and San Francisco
    - Amtrak Pacific Surfliner and Metrolink commuter service between Los Angeles and Anaheim.
- More precise allocation of business and commuter travel between CHST and parallel rail services
- Full dispatch dynamic computer simulation of the CHST Phase 1 network, including analysis of schedule perturbation scenarios.

In addition, the Operations and Maintenance Team will be conducting a series of internal workshop sessions to address issues related to train operations, equipment maintenance, infrastructure maintenance, and passenger-handling at stations. Workshop topics will include the following:

1. Operational reliability and delay/failure recovery – objectives, performance metrics, analytic tools and methods, appropriate assumptions for system planning and infrastructure planning
2. Schedule pad / recovery time – requirements for reliable operations, policy, analytic tools and methods, modification of TPC outputs to reflect scheduled times instead of pure TPC times, differences for highest-priority non-stop train versus other trains, appropriate assumptions for system planning
3. Overtake and Upstream/Downstream Headway Analysis (described above)
4. Factors affecting dwell times at intermediate stations
    a. Trainset characteristics
        i. Trainset passenger-carrying capacity: 500 passengers, smaller number, or use a range
        ii. Number of doors
        iii. Specific provisions for wheelchairs, bicycles and passenger luggage (locations on the train and internal configuration as it affects passenger alighting and boarding)
        iv. Variations among rolling stock types
    b. Service policies
        i. Seat reservation policy (assigned seat, assigned car/open seating within car, reserved seat with open seating)
        ii. Classes of service (single class or separate first class)
        iii. Ticket media
        iv. Train crewing assumptions
        v. Ticket checking – on board, on platform, or in station
        vi. Personal luggage handling – provision for porters (red caps) and/or smarte cartes
    c. Passenger-processing assumptions
        i. Platform queuing configurations
    d. Contingency operations – delay mitigation
5. Factors affecting terminal turnaround operations and scheduled layover times
    a. Train inspection and brake testing
    b. Cleaning
    c. Food service provisioning
    d. Differences for 200 meter and 400 meter trainsets

e. Consist management

f. On-board train crew utilization

6. Factors affecting station operations

   a. Security – access control, screening, separation of CHST passengers from other passengers

   b. Fare collection – barrier-free versus fare control arrays at stations; proof-of-payment versus 100% check; location at which fares are checked

   c. Baggage-handling – checked versus passenger-carried; baggage assistance from either porters (red caps) or via carts – current assumption is there will be no provision for checked baggage.

   d. Bicycles

   e. Ticketing

   f. Train information dissemination; customer communications

   g. Terminal operations and facilities requirements as distinct from those at intermediate stations

   h. Integration with / separation from other rail operators (passengers and station operating/support functions)

   i. Contingency plans; Emergency Action Plans

7. Factors affecting infrastructure maintenance

   a. Inspection and maintenance activities performed during a 5 hour overnight “window” when the system is shut down for train operations; productivity of the workforce.

   b. Inspection and maintenance plan methodologies; scheduling with and without tracks out of service

   c. Utilization of high performance high speed rail system maintenance equipment and machinery

   d. Deployment of resources; staff, material and equipment

Operational Assumptions

The following key assumptions underlie the concept level Operations and Service Plans and conceptual Equipment and Infrastructure Maintenance Plans. The CHSTP Program Management Team would appreciate confirmation from the International Peer Reviewers that these are appropriate assumptions to make for purposes of high-speed rail system planning, based on their experience with the operation of such systems worldwide.

1. The HST system is assumed to operate on dedicated tracks, independent of any other passenger or freight rail services, except in the following locations:
    a. Peninsula Corridor – approach tracks leading to the two terminals at Transbay and 4th and King Streets (shared between CHST and Caltrain commuter trains)
    b. LOSSAN Corridor – between the south side of Los Angeles Union Station and Anaheim (shared by CHST, Amtrak intercity corridor trains and Metrolink commuter trains)
2. Train sets are assumed to comprise units of 200 meters (m) in length, either singly (200 m train with 500 passengers) or operating as pairs (400 m train with 1,000 passengers).
3. The schedule features "clock face" service patterns and regular intervals between trains (headways), which can be easily remembered and is markedly customer friendly.
4. The schedule features service patterns that repeat every hour, as opposed to patterns that differ somewhat from hour-to-hour providing for more simplified operations – this makes the service more regular and predictable and reduces the number of different types of overtakes required.
5. Express trains are given the highest priority in terms of their schedule paths; limited stop trains and those that travel a longer distance along the network have the next highest priority, and all-stop local trains generally have the lowest priority and, therefore, the highest incidence of overtakes.
6. The service plan assumes that all mainline junctions where branches of the HST network join together (e.g., the junctions south of Merced, in the Redondo Junction vicinity south of Los Angeles Union Station, and at the approach to the two San Francisco terminals) are fully grade separated, avoiding the need for head-on opposing train movements at the junctions.
7. Both the Phase 1 and Full-Build Service Plans address projected conditions on a typical busy weekday in the year 2035. Estimated passenger loads were calculated for a peak day (busier than average month and busier than average day of the week, at approximately the 90th percentile level). Explicit service plans for weekends and holidays were not prepared.
8. Equipment cycles - Trains arriving at a terminal station are assumed to lay over at the platform for a certain period of time, for passenger alighting train servicing/inspection and passenger boarding, then depart in the opposite direction as the next available departing revenue train. This analysis generally adhered to the minimum terminal layover times presented in Table 2. In certain cases, shorter layover times were assumed in order to keep the number of trainsets to a reasonable minimum and to avoid inordinately long layovers, which would occupy terminal station or yard tracks for extended periods of time. Except during the late evening time period, train sets are generally available at the San Francisco and Anaheim terminals to provide "protection" for short connections from potentially delayed trains. These additional equipment sets would be culled from the 400 meter local and limited trains operating during the morning peak period that continue during the mid-day period as 200 meter trains. The train turns at the endpoint terminals are balanced during the mid-day and late evening off-peak hours. During the peaks, additional directional service is offered, so a relatively small number of trains are designated for mid-day yard storage in lieu of making a revenue turn.
9. Daily equipment utilization – Most trainsets are able to make 3-4 (single, one-way) trips between the Bay area and Los Angeles basin over the course of a service day. Selected trains (one per hour each way) operate to and from Merced. At Merced, these trains then turn for the next available train operating towards the alternate terminal (i.e., a San Francisco-Merced train will lay over at Merced and turn for a Merced-Anaheim train).

Questions and Issues

The following issues remain of concern to the Operations and Maintenance Planning Team and will be the subject of more detailed study and analysis during the next several months (4th Quarter of 2010). The CHSTP Program Management Team would appreciate and benefit from feedback from the International Peer Reviewers on these and other subjects.

Service Plan

1. Density of train service and variety of stopping patterns – The CHST operating and service plans are based on a high level of utilization of the two-track high-speed rail line. The high volume of trains is required based on estimated ridership demand, along with the customer service objective of operating a robust mix of express, limited-stop and multi-stop trains to serve point-to-point ridership demand in the most effective manner. Creating a train schedule and operating procedures that allow reliable day-to-day operation of a dense high-speed rail line is a challenge. The current planning assumptions, cited below, will be tested by means of detailed computer simulations:

    a. Nominal capacity of 12 trains per hour per direction (based on uniform stopping patterns and operations at a nominal practical headway of five minutes)

    b. Peak operations at up to 10 trains per hour per direction, with variable stopping patterns, and with some express or non-stop trains overtaking stopping trains at intermediate stations

2. The operating and service plans for Phase 1 and the Full Build network provide for a mix of various types of train service and a variety of station stopping patterns:

    a. Express service

    b. Limited-stop service

    c. All-stop service (with up to two scheduled overtakes per train between San Jose and Los Angeles)

    The density of train service, particularly during the weekday morning and afternoon peak periods, will require the express trains to pass (or "overtake") the all-stop trains and some limited-stop trains as they make station stops *en route*. Similarly, some limited-stop trains will need to overtake the all-stop trains. These overtakes will need to be carefully scheduled – and operated with discipline and precision by the train dispatchers, train crews and station personnel – in order for the required density of overall service to be delivered and high reliability performance to be maintained.

3. Schedule recovery time or pad – Train running times were obtained from computer-simulated train performance calculations, with an additional time factor added to these times. This added time, sometimes referred to as "schedule pad" or "recovery time" accounts for operator performance, external conditions and minor delays, which result in minimal day-to-day fluctuations in train performance – the additional time factor assumed in this analysis is common in passenger train scheduling, permits trains to recover from time lost due to minor causes, and provides an allowance for the system to maintain a high degree of overall on-time performance when operations are normal. The additional time factored into this service plan assumes a recovery time of three and one-half percent for most trains. However, certain "premium" services, such as express trains during peak periods were assumed to operate with a recovery time allowance of as little as one percent.

4. Practical headways for train scheduling purposes – The minimum spacing between trains following each other past a given point (commonly referred to as headway or frequency of service) was assumed to be three minutes for the development of the Operations and Service Plans. These practical headways actually will vary, depending upon whether trains are stopping or operating non-stop, the maximum line speed through intermediate station locations, whether or not overtaking occurs at intermediate stations, and the design attributes of the signal and train control system.

5. Train overtakes are arranged to utilize station (siding) tracks for express trains to pass local trains making a station stop, while maintaining consistency and reliability in the service stopping patterns. The siding tracks are assumed to be sufficiently long to enable diverging and merging movements from and to the mainline tracks to be made at high speed, with the bulk of deceleration and acceleration for stopping trains occurring on the sidings and not on the mainline tracks. This allows for relatively close spacing of trains approaching overtake locations, reduces delays associated with overtakes, and maximizes overall system capacity and train scheduling flexibility. More work is needed to define the practical upstream and downstream headways for overtake operations at stations. These practical headways are assumed to vary, depending upon the maximum line speed at the station. More information on the location, frequency, capacity impacts and other characteristics of overtaking operations on international high-speed rail systems would be valued.
6. Storage yard facilities generally will not be located immediately adjacent to the terminal stations, due to property availability constraints. Reliable operations will be easier to maintain if these storage and maintenance facilities can be located in proximity to the terminal stations, thereby minimizing the quantity of deadhead train-miles that must be operated over the main line tracks. Future operations analyses and computer simulations will be developed to measure the extent to which deadhead train movements are required, or can be permitted, over the main line to reach storage yard facilities – for various yard location alternatives.
7. Overall viability of shared operations – What are the requirements for a successful operation with shared use of tracks by both high-speed trains and commuter trains? What are the equipment compatibility requirements (trainset performance including maximum speed, acceleration and braking, and car dimensions including door/platform height)? Also, what issues exist with respect to shared operations with electrified high-speed rail equipment and commuter or conventional intercity passenger trains hauled by diesel locomotives?
8. Current system planning is being conducted assuming the allocation of HST trains and Caltrain commuter trains between two different terminal facilities in San Francisco: Transbay, and the existing Caltrain station at 4th and King Streets. Train operations at the San Francisco end of the network will be complex, linking the two terminal stations, each with mixed HST and commuter traffic, with the San Francisco-area storage and maintenance yard, as well as the four-track main line that has high-speed trains on two dedicated tracks and commuter trains on the other two tracks. Detailed operating plans for the San Francisco terminal area, based on network simulations, currently are being developed.
9. HST service is assumed to be operated during the period between approximately 5:00 AM and 12:00 Midnight. Given the length of the Full-Build HST network, the service plan includes a few trains that operate outside of this window to ensure balanced service across the entire network. How are competing interests reconciled between the demand late-night passenger trains and the desire to have longer overnight windows for maintenance of way activities?
10. Service tapering at the start and end of the service day, reflecting the relatively lower level of demand during the very early morning and late evening hours – Two equipment cycles begin in the 5:00 AM hour at Merced rather than Sacramento, providing the first train in the morning to both San Francisco and Los Angeles. Similarly, an early morning train is assumed to start from Bakersfield and operate north to San Francisco. Overnight storage of these three trainsets is assumed to be provided at the planned maintenance facility near Merced. The Bakersfield train would operate as a non-revenue or "deadhead" train between Merced and Bakersfield. To balance the daily equipment cycles, the last three trains out in the late evening would run Los Angeles-Merced, San Francisco-Merced and San Francisco-Bakersfield, with these three trains ending up at the Merced maintenance facility for overnight storage. In addition to providing early morning and late night service to intermediate stations on the HST network, these trains can be used by the HST system operator to cycle different train sets on a daily basis to and from the major maintenance facility at Merced, where heavy scheduled maintenance, repair and overhaul will be performed on the HST fleet on a periodic, rotating basis.

11. The Operations and Service Plans for the Phase 1 and Full Build networks include passenger train movements that are balanced across the entire network throughout the day, providing service in both the early morning (by 6:00 AM) and night-time (around midnight) hours. This provides a full array of train choices to passengers and provides an estimate of daily trainset mileage that is at the high end of expected values, though it tends to minimize the amount of time available overnight for maintenance of way activities that require track outages. As more detailed operating and service plans are developed, and as maintenance of way requirements become better know, the passenger train service patterns at the beginning and end of the day will need to be optimized, making tradeoffs between customer service demands and the costs associated with right-of-way and equipment maintenance.
12. The analysis assumed intermediate station dwell times of 1.25 to 1.50 minutes and minimum terminal layover (turnaround) times of 30 to 40 minutes, as described previously. Terminal layover time is defined to be the time between the scheduled arrival of a train set at a terminal and the scheduled departure of the same train set in the opposite direction of service. During layover, sufficient time must be allocated for passenger unloading, train servicing and light maintenance activities such as interior cleaning, inspection and brake testing, provisioning and re-stocking of food service supplies, and passenger boarding. The minimum times provided in Table 3 were used as a guideline; the service plan assumes slightly faster (turnaround) times in a limited number of individual cases where necessary to maintain the smooth flow of trains at a terminal.
13. Estimated fleet requirements are based on the assumption that the HST operator implements a consist management plan to set train lengths based on ridership and adjusts trainset lengths at the terminal stations as necessary to efficiently deploy equipment. Train sets are assumed to be modular, comprised of either one or two 200 meter long units. Trainsets that must be 400 meters long to handle peak period passenger loads but which require only one 200 meter unit for off-peak operations are assumed to be able to trim or add units while stationed at the terminal platform during the layover period. The detailed operations of the terminal areas, incorporating these equipment manipulations as well as non-revenue or "deadhead" moves to and from train storage yards, has not yet been modeled or analyzed in detail.
14. Train crew size – operating personnel (engineers and conductors – single job classification with all staff fully trained and qualified for all train operations positions); number of On-Board Services staff

<u>Station Operations and Passenger-Handling</u>

15. Ticketing and Fare Collection – CHST passengers are expected to obtain tickets for their trip in one of three ways: staffed ticket windows at the station, ticket vending machines at the station, and off-site prior to the trip (e.g., e-tickets). The trend in U.S. rail and air travel over the past decade has been away from the use of staffed ticket windows, in favor of TVMs and pre-printed e-tickets. This trend is expected to continue, but the customer service objectives of the CHST system call for the staffing of ticket offices and information kiosks to provide personalized service to those passengers who want it. Ticket office facilities are intended to have a modular design that permits flexible allocation of the ticketing and associated queuing spaces among staffed windows and TVMs. At this point in time, clear direction has not yet been established with respect to the type and required performance capabilities of ticket media (i.e., whether or not tickets need to be electronically-readable or possess embedded microchips), and whether or not boarding passes separate from actual tickets will be required.

    The long-range vision for high-speed and regional transportation services in California is that a universal farecard and fare payment system is available to passengers and able to be used on any of the modes and routes serving the stations at which CHST trains operate. Plans for such a system are in the early stages of development at several of the regional transit systems, but full implementation requires substantial challenges to be overcome and remains many years away. To the extent that fare media and fare collection systems can be consolidated and standardized, passengers will be better able to have a "seamless journey" experience. However, as a practical matter, stations will need to be able to operate successfully in the short to medium term with multiple fare collection procedures and systems in place, with each operator able to collect fares in the way best suited to its operations.

Fare collection can occur on-board the vehicle, at the entry to the vehicle, or off-board within the station environment. Public spaces within stations will be designated as either “paid” or “free” areas. Free areas are open to the general public. Paid areas are zones within which all persons are expected to be in possession of a valid ticket or pass. Clear lines of demarcation will exist between free and paid areas. Paid zones can either be controlled by barriers and arrays of fare collection devices such as turnstiles or they can be part of a barrier-free “proof of payment” system where there are no fare control arrays, but people within the paid area can be asked by fare inspectors to produce their ticket or pass and are issued a summons for a fine if they do not have a valid ticket. Station planning is based on barrier-free fare controls, although the facility would be able to accommodate fare control arrays for CHST if the CHST operator were to choose to implement a barrier-type system. CHST passengers would have their tickets checked upon entry to the CHST paid or secure area.

16. Passenger Security Screening and Access Control at Stations – Station security will be commensurate with station security on existing high speed rail networks in the USA, Europe and Asia. Unless otherwise exempted, the CHST System will conform to the current Federal requirements regarding transportation security as developed and implemented. The rail platforms and bus loading bays are considered secure zones, which are able to be cordoned off by security personnel when necessary – with passengers entering the zone subject to either random or comprehensive security screening, depending on the threat condition. The normal mode of operation at CHST stations is assumed to be barrier-free, with access to and from the rail platforms and bus gate areas without the need for security screening. However, the physical configuration of facilities needs to be able to accommodate portable screening equipment, should screening prove to be requirement at some point in time. The same lines of demarcation will be used for both fare collection/control and security screening. Since security screening would not be a normal operating procedure, such screening would be undertaken using portable equipment (magnetometers and baggage screening devices) and portable pedestrian channelization barriers that could be deployed when needed at these screening locations but normally stored at a remote location within the terminal.

17. Baggage-Handling – Most CHST passengers are expected to carry their own baggage to and from the train. The CHST project has not yet made a final decision concerning the handling of checked baggage on CHST trains. At the time of this writing, the CHST system is assumed to not offer checked baggage service, like most of the existing European and Asian high-speed rail systems. Should a determination be made that checked baggage is to be handled on CHST trains, baggage check-in, baggage claim and back-of-house baggage handling facilities would need to be provided at all stations, and the stations would have to be designed accordingly.

    A porter service (red cap) is assumed to be available at major stations to assist passengers with transporting their luggage to and from the trains. Porters would be stationed at the curb frontage of the CHST stations and also on the CHST platforms as trains arrive at the station.

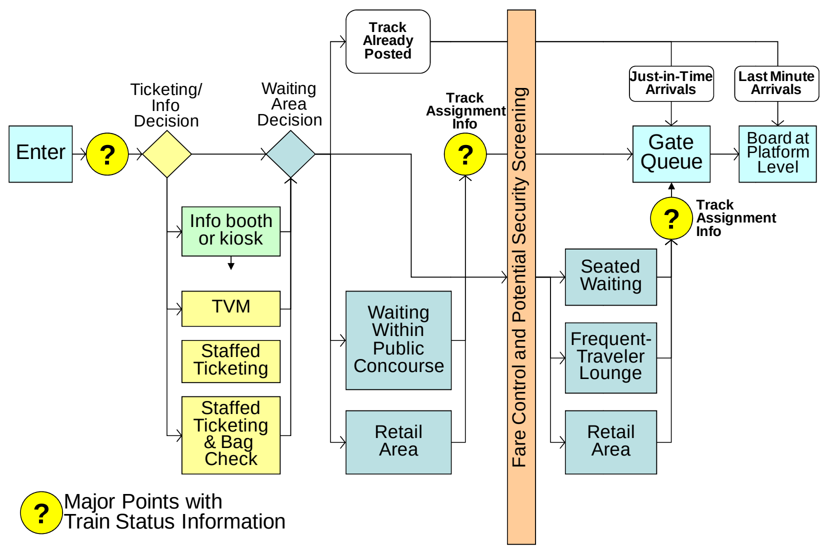
    Luggage trolleys (e.g., Smarte Cartes) are assumed to be prohibited from station platforms, because of the potential safety hazard posed by trolleys falling from the rail platforms onto the tracks. Passengers are assumed to carry their own luggage through stations or retain the services of a porter.

18. Bicycle-Handling – California (particularly the San Francisco Bay Area) has a well-developed bicycle-riding culture and a higher proportion of the population that regularly rides bicycles. The policy with respect to handling bicycles on-board CHST trains has not yet been formally established. Options include prohibiting bicycles, permitting only folding bicycles that can be stored in the regular luggage racks provided throughout the train, or permitting bicycles to be stored in a portion of the front or rear power car, in a zone of the train where passenger seating is not provided. In the latter instance, the number of bicycle storage positions would be limited, so passengers would be expected to reserve bicycle storage space at the time they make their seat reservation.

Regardless of whether/how bicycles are accommodated on-board CHST trains, all CHST stations will have convenient and secure facilities for the storage of bicycles. At major stations, private concessions may operate "bicycle stations" comprising storage racks/lockers and bicycle rental and repair facilities within or adjacent to the station building.

19. Passenger Boarding Process, General – The following diagram depicts the typical passenger boarding process and the way finding and station facility usage decisions that will be made by passengers from the time that they arrive at the station:

CHST Ticketing-Waiting-Boarding Process



20. Passenger Boarding Process, Intermediate Stations – Boarding passengers will wait within the station building up until approximately five or six minutes in advance of the train's scheduled departure time. At this time, passengers will be instructed to proceed to the platform, by means of information posted on variable information signs and announced on the public address system. Assuming a policy of reserved seating in specific cars, passengers will follow signage and proceed to a designated point along the platform adjacent to where the car they will board will stop. When the train arrives at the station, the alighting passengers will be discharged from the train and will walk to the platform exit points. The waiting passengers will than board the train, either carrying their luggage or being assisted by a porter. The car interiors are assumed to be designed to permit relatively rapid boarding, circulation within the car by passengers and stowing of luggage.

21. Passenger Boarding Process – Terminal Stations – The boarding procedure for passengers at terminal stations is expected to be different from that at intermediate stations. The train will occupy the platform track for a longer period of time (for its full layover time) if it is continuing as a revenue train, or for a somewhat shorter period if it is a train that is originating or terminating its revenue service and is connecting to or from a nearby storage yard. Arriving passengers will first alight from the train and proceed to the exits. Once the platform has been substantially cleared of passengers (approximately five minutes from the train's arrival time), train servicing will begin. Cleaning crews will clean the car interiors and rest rooms. Food service personnel will restock the train's food service supplies, equipment maintenance engineers will make any minor repairs or maintenance checks that may be required, the incoming train crew will hand over control of the train to the outgoing crew, and the outgoing crew will perform the required pre-departure safety checks. When these servicing activities have been completed (for which 20 minutes is allotted at all terminals except San Francisco-Transbay, where 10 minutes is programmed), passenger boarding begins. If the incoming train has arrived exactly on time, a total of 15

minutes will be available for boarding. If the incoming train has arrived late, then the boarding time interval would be shortened accordingly.

22. Passenger Access to Platforms – The CHSTP station plans are being developed based on the concept that all station platforms used by CHST passengers will be within a controlled zone where passengers will be expected to have a valid ticket prior to entering the onto the platform.

    Current plans for the CHST system do not call for the provision of separate platforms for train servicing and for use by maintenance personnel at either intermediate or terminal stations. Though such platforms would be desirable to separate passenger flows from maintenance and servicing activities, right-of-way constraints will not permit these additional platforms to be provided at most locations.

23. Access to Platforms Served by High-Speed and Non-High-Speed Trains – At certain station locations, particularly in the shared use corridors south of Los Angeles and north of San Jose, stations may need to be configured in a way that allows tracks and/or platforms to be shared by both CHST and commuter or Amtrak trains and passengers. If the Operating Plan and passenger-handling procedures allow for simultaneous occupancy of platform zones by CHST passengers and the passengers of other railroad operators, then track and platform configurations could be kept relatively simple – such as island platform configurations with HST trains operating on one side of the platform and other trains on the track on the opposite side of the platform (a possible configuration in the Caltrain Corridor), or simple side or island platforms serving tracks where HST and other trains operate one after the other (a possible configuration in the corridor between Los Angeles and Anaheim). On the other hand, if CHST security, fare control and passenger-handling procedures require that platforms be dedicated to the exclusive use of CHST passengers, then more complex track and platform configurations might be required at certain stations to provide the appropriate level of physical separation between CHST and other rail passengers.

    Sharing of platform tracks and platforms by multiple train services becomes significantly more difficult if the trainset types have either different car widths or door heights. Standardizing these rolling stock dimensions is highly desirable for shared operations.

24. Service Access to Platforms – Service access to the CHST platforms, via elevators or ramps, separate from the routes used by passengers is required at terminal stations.

25. Dwell Times at Intermediate Stations are assumed to be in the range of 1.25 to 1.50 minutes. These times are relatively short by international standards and are based on highly-disciplined passenger-handling operations at the station platforms. The current plans assume that boarding passengers are pre-positioned on the platform at or close to the car where their reserved seat is located, prior to the arrival of the train – based on car numbering information displayed on variable message signs along the platform. As a matter of policy, dwell times should be kept as short as possible to minimize running times. However, dwell times need to be sufficiently long to allow sufficient time for alighting and boarding of passengers carrying extensive luggage, to accommodate passengers who are in wheelchairs or otherwise mobility-impaired, and to minimize the potential for trains to be delayed due to excessive station dwells. Dwell times, in part, will be a function of the volume of passengers to be unloaded or loaded at a station. The configuration of door openings, vestibules, aisles and luggage storage racks on the trains will influence the passenger alighting and boarding process and potentially could affect the dwell times at stations. Future refinements of the operating and service plans will test alternative trainset interior and door configurations, alternative passenger-handling procedures and a range of possible alighting/boarding volumes – in order to verify the appropriate dwell times to assume at intermediate stations.

<u>Rolling Stock and Infrastructure Maintenance</u>

26. Spare ratio of 10 percent – The fleet maintenance philosophy, maintenance plan and terminal operating plans, which drive the number of spare equipment sets needed to allow for periodic and non-scheduled maintenance and repair activities, and to protect reliable operations at the major terminals.

The spare fleet requirement is assumed to be 10 percent of the revenue fleet requirement, which is in the mid range of spare ratios for U.S. and international intercity and high-speed rail fleets. A lower spare ratio could be justifiable if an aggressive preventive maintenance program is adopted, which invests in the facilities, spare parts inventories and labor force needed to progressively replace train set components on a regular schedule before component failure occurs or life expectancy is reached. Conversely, a decision in favor of a more traditional maintenance philosophy that undertakes more limited periodic inspections and relies more on reactive repair and replacement of components as they wear out, would tend to increase the required spare ratio – as would the desire for spare ready equipment sets to ensure a very high level of equipment availability. The fleet requirement numbers will need to be modified as the operating plan, demand projections, and maintenance plan are refined. The figures presented in the Service Plan technical memoranda serve as placeholders for preliminary sizing and planning of HST storage and maintenance facilities.

27. Infrastructure maintenance plan and asset management system – There has become increasing emphasis on rail systems to implement an asset management system as an integral part of the overall infrastructure management philosophy. The physical plant and rail system elements, and their condition, are inventoried and documented in a data base. Routine inspections at specified intervals are then conducted to monitor and update the information associated with the condition of each element of the system, comparing the current inspection results with previous observations and with the required specification (of that particular element of the system i.e. a section of track etc.). This approach provides on-going, real time diagnostics, identifying corrective action when necessary. It provides a snapshot of the condition of the physical plant. In addition, and in the case of the CHSTP, it provides the owner (i.e. California High Speed Rail Authority) of the property, a method of insuring that the assets are being properly maintained. It would be helpful to know what asset management and maintenance philosophy is employed on existing high speed train systems.
28. Maintenance resources may be deployed around the high speed train system during the normal service day to respond to situations such as a malfunction of an element of the physical plant (i.e. a switch or signal) or an equipment breakdown (with a trainset). Although somewhat dependent on the effectiveness of the overall maintenance programs for the infrastructure and rolling stock, these unplanned events can and do occur. In developing the overall maintenance plans (for both infrastructure and rolling stock) consideration is being given to defining the number of staff and how best to locate them around the system in order to respond to these events in an expedient manner and maintain the highest levels of on time performance.
29. Contracting and outsourcing services – provision of "commercial" services in terminals and stations; on-board food and beverage services etc. Are these or any other support services subject to outsourcing on high speed train systems in other countries?

Reference Documents

TM 4.2 – Phase 1 Service Plan

TM 4.3 – High-Speed Train Service Plan Draft – Full Build Network with Links to Sacramento and San Diego

TM 5.1 – Terminal and Heavy Maintenance Facility Guidelines

TM 5.3 – Facilities Requirements Summary