California High-Speed Train Project

TECHNICAL MEMORANDUM

Design Criteria
TM 1.1.0

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Revision	Date	Description
0	16 Mar 07	Alignment and Platform Criteria for Conceptual Design

Prepared by PB 100 YEARS

for the California High-Speed Rail Authority

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1.0 GENERAL

1.1 INTRODUCTION

This Design Criteria provides design guidance for the conceptual and preliminary design of the California High Speed Train (CaHST) Project. It is issued for use by the Regional Design Consultants for advancing the design of a high-speed train system that meets design standards for system safety, maintains acceptable passenger comfort, achieves maximum design speed and operating service, provides for efficient maintenance activities, accommodates projected ridership capacity, and promotes design consistency across the program's geographic sections.

The initial release of the Design Criteria is intended to provide the basic design parameters required to define and advance the conceptual and preliminary alignment and transit systems infrastructure for the overall corridor. It is anticipated that this initial release will be expanded, revised as required, and re-issued as the development of the project progresses.

1.2 PROJECT DESCRIPTION

1.2.1 Segment Limits

The project is divided into six geographical segments as defined below:

Bay Area to Central Valley: San Francisco and Oakland termini to the junction with the Sacramento to Fresno segment as will be determined by ongoing program-level environmental study of this segment. The proposed stations to be included in this segment are all stations west of the Sacramento to Fresno segment pursuant ongoing program-level environmental study.

Sacramento to Fresno: Sacramento terminus to the north end of the platforms of the proposed Fresno station and includes the proposed stations in Sacramento, Stockton, Modesto, and Merced.

Fresno to Palmdale: North end of the platforms at Fresno station to north end of the platforms at Palmdale station, including the proposed stations in Fresno and Bakersfield.

Palmdale to Los Angeles: this segment extends from north end of the platforms at Palmdale station to the north end of the platforms at Los Angeles station, including the proposed station in Palmdale.

Los Angeles to Orange County: this segment extends from the north end of the platforms at Los Angeles Station and west end of the Los Angeles River near Redondo Junction to the southern terminus in Irvine, including the proposed stations in Norwalk, Anaheim, and Irvine.

Los Angeles to San Diego via the Inland Empire: this segment extends the west end of the Los Angeles River near Redondo Junction to the Inland Empire, before continuing to the southern terminus in San Diego, including the proposed stations in City of Industry, Ontario Airport, Riverside, Murrieta, Escondido, Universal City, and San Diego.

2.0 PERFORMANCE REQUIREMENTS

2.1 SYSTEM CAPACITY AND RIDERSHIP FORECASTS

To be included in a subsequent release.

2.2 TRIP TRAVEL TIMES

To be included in a subsequent release.

2.3 SERVICE DESCRIPTION

To be included in a subsequent release.

2.4 DESIGN/OPERATING SPEED

2.4.1 Speed Requirements

Maximum Design Speed: 250 mph (403 km/h) where cost effective and environmentally feasible.

Maximum Operating Speed: 220 mph (354 km/h) where horizontal and vertical alignments permit.

In areas with dense urban development, environmental constraints or major physical obstacles, there will need to be departures from the required maximum design speed. Specific sections of the corridor where the maximum design speed cannot be practicably achieved will be identified by the regional design consultants and discussed with the CaHST Program Manager (PM) to establish the alignment criteria that meet the speed flow characteristic required of each section of the HSR system and the parallel alignment and clearance requirements of other operators on that corridor. Should further constraints arise that may require a lower design speed during the process of defining track alignments within the corridor, these must be brought to the attention of the PM for review and approval.

Design will be developed following Imperial unit criteria. Metric criteria is provided for reference.

3.0 INFRASTRUCTURE

3.1 TRACK ALIGNMENT

The high-speed rail technology requires a dual track mainline system to safely support the ridership volumes, frequency of service, scheduling flexibility and delay recovery required for the proposed system.

3.1.1 Survey Control and Base Mapping

NAD 1983, (1991.35) California Coordinate System datum is to be used as the horizontal coordinate values. NAVD 88 Vertical Datum is to be used as the vertical datum.

Base mapping for Conceptual Design drawings can be ortho-corrected aerial photography or available topographic mapping. Vertical control shall be accurate to 3 feet +/- or better.

Base mapping for Preliminary Design drawings shall be topographic mapping. Vertical control shall be accurate to 1 foot +/- or better.

Base mapping for Preliminary Design drawings shall meet Caltrans requirements for survey and photogrammetry.

3.1.2 Stationing

Each segment will be defined by coordinates, alignment and configuration of tracks for agreed end locations and then be stationed within itself by the designer for that segment.

The alignment will be continuously stationed south to north and west to east within the segment, using Imperial units and designated in feet. Station call-outs will be appropriate for the scale of the drawings with station marks annotated at 100-foot increments minimum.

All tracks will be identified using track identification nomenclature. The general track identifiers will be four alphanumeric characters - three letters followed by a number. The letters will indicate the geographic segment and the number of the track centerline. The southbound/eastbound track will be designated “1” and the northbound/westbound track will be designated “2” for the general dual track arrangement. Where additional tracks are required, these tracks will be designated with unique numbers for each additional track. The letter identifier will be as indicated in Table 3.1.2a.

Along the alignment, event points along the “1” track on the plans shall be related to the “2” track and any other tracks by a station and offset.

Figure 3.1.2.a General Track Identification

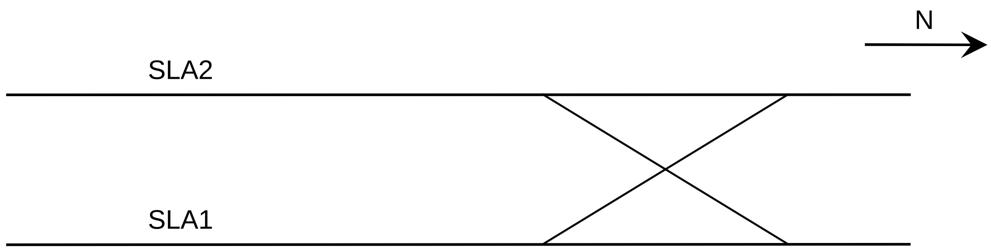

Table 3.1.2a Segment Identifier	Letter Identifier
San Diego to Los Angeles	SLA
Orange County to Los Angeles	OLA
Los Angeles to Palmdale	LAP
Palmdale to Fresno	PFR
Central Valley to Bay Area	CVB
Fresno to Sacramento	FRS

3.1.3 Horizontal Alignment

The horizontal alignment design parameters are based on passenger comfort and limit the lateral force on the passenger. To limit the discomfort caused by excessive lateral force, the track is superelevated. Minimum lengths of tangents and curves are required, and spiral transition curves are applied, to assure a gradual introduction of lateral force.

The steady state lateral forces are limited to 0.05g or 1.6 ft/s^2 (0.5 m/s^2) for the design parameters described in Table 3.1.3a. Table 3.1.3a includes formulae for determining lengths of tangents, curves, and transition curves relative to design speed.

3.1.3.1 Minimum Length of Alignment Elements

Ride quality will benefit from the limitation of the length of any alignment element (such as tangents, spirals, and curves). The minimum element length will be 2.5 seconds of run time for the applicable design speed. In areas where the maximum design speed of 250 mph is applied, this will require the alignment element length to be a minimum of 918 feet.

Table 3.1.3a Horizontal Alignment Criteria	Imperial	Metric
Track gauge	4 feet 8½ inches	1435 millimeters
Track center separation between mainline tracks	16 ft 6 inches	5.0 meters
Track center separation between mainline tracks and sidings	25 feet	7.6 meters
Minimum alignment element length (except grades)	2.5 seconds of running time at design speed	
Desirable maximum horizontal curve radius	TBD	TBD
Minimum horizontal curve radius @ 250 mph, E_u 2.5” @ 220 mph, E_u 2.5”	25,700 ft 20,000 ft	7,850 m @403 km/h 6,100 m @354 km/h
Equilibrium superelevation (E_e)	10 inches	25.4 cm
Maximum actual superelevation (E_a)	7 inches	17.8 centimeters
Maximum unbalanced superelevation (E_u)	3 inches	7.6 centimeters
Spiral length (L_e)	TBD	TBD

E_a = actual superelevation , E_e = equilibrium superelevation, E_u = unbalanced superelevation, L_c = minimum length of circular curve, L_e = spiral length, L_s = minimum length of transition spiral, L_t = minimum tangent length, R = radius, V = velocity

V is in miles per hour (kilometers per hour for metric)
R is in feet (meters for metric)

3.1.3.2 Horizontal Curves
The horizontal curve radius applies at the media line between the two mainline tracks and shall be maintained at as large a value as possible to improve ride quality. See Table 3.1.3a for minimum horizontal curve radii.

3.1.3.3 Superelevation
Superelevation will be applied by raising the outer rail of each track, holding the grade consistent on the lower inside rail of each track. See Table 3.1.4a for superelevation values. Departure from these values requires review with the PM with consideration of required operating speeds and requirements at that location.

3.1.3.4 Horizontal Spirals or Transition Curves
To be included in a subsequent release.

3.1.4 Vertical Alignment

Table 3.1.4a presents recommended maximum gradients for mainlines, secondary tracks and yards, and stations. Also included are formulae for computing radii of vertical curves and minimum curve and tangent lengths.

Table 3.1.4a Vertical Alignment Criteria		Imperial	Metric
Allowable forces in vertical curves (downward)		0.045 g	
Allowable forces in vertical curves (upward)		0.045 g	
Mainline track gradient	Desirable maximum	2.5 %	
	Absolute maximum (not to exceed 17,000 feet)	3.5 %	
Station track gradient	Desirable minimum	0.0%	
	Absolute maximum	0.25%	
Yards and secondary track gradient - desirable Storage and transfer track gradient - desirable		TBD	
Vertical curve radius (R) minimum	Crest	$3.33\ V^2$	
	Sag	$2.22\ V^2$	
Length of vertical curve (LVC)	Desirable	TBD	
	Minimum	2.5 seconds of running time at design speed	
Length of grade between curves	Desirable	2.5 seconds of running time at design speed	
	Minimum	1.5 seconds of running time at design speed	
	Aerial structures (for aesthetics)	1000 feet minimum	305 meters minimum
Lg = length of constant grade, LVC = length of vertical curve, R = vertical curve radius of circular curve, V = velocity V is in miles per hour (kilometers per hour for metric) R is in feet (meters for metric)			

3.1.5 Combined Horizontal and Vertical Curves

Horizontal curves and horizontal transition curves shall not occur simultaneously with vertical curves, without approval from the PM.

3.1.6 Clearance Requirements
Adequate clearances assure the safe passage of trains, access to disabled trains, and safe conditions for maintenance personnel and passenger evacuation. Minimum clearances are listed in Table 3.1.6a and typical sections in Appendix (TBD).

Table 3.1.6a Clearance Requirements	Imperial	Metric
Centerline of track to face of fixed object (horizontal)	14.0 feet	4.27 meters
Top of rail to face of fixed object (minimum vertical)	23.0 feet	7.015 meters
Top of rail to contact wire (maximum vertical)	TBD	TBD
Minimum clearance Horizontal to fixed obstruction	TBD	TBD

3.1.7 Grade Separations
Design, safety and performance targets require that there will be no grade crossings permitted on the dedicated or shared-use high-speed train lines.

3.1.8 Turnouts, Crossovers, and Station Track
3.1.8.1 Turnouts
Switches and Crossovers must meet the requirements of high speed operation.

Diverging speeds shall be designed for a minimum 110 mph.

Speeds must meet the requirements of the mainline design speed and not depend on the speed on the diverging section.

Turnouts will be laid in straight tracks.

Turnouts will be laid in vertical curves with radii > 32,500 feet (crest) and 19,500 feet (sag).

Turnouts will be located outside structures.

Turnout locations would preferably give potential for road access.

Where trains might use two subsequent turnouts, a spacing of at least 100 feet or 2.6V shall be used where V is design speed in mph.

3.1.8.2 Crossovers
For conceptual alignment purposes, crossovers shall generally be located at approximately 20 mile intervals, dependent upon alignment and other constraints.

Crossovers will be provided at one end of each station, beyond the point where station tracks tie into the mainline tracks.

3.1.8.3 Station Track
Stations shall be located on tangent track throughout their length.

3.1.9 Seismic Design Reliability
To be included in a subsequent release.

3.1.10 Tunnels
3.1.10.1 Tunnel Cross Section
For planning purposes, tunnel cross sectional area shall be as listed in Table 3.1.10a. The selected values are subject to confirmation by an aerodynamic analysis of the selected train technology.

Consideration shall be given to reducing the cross-sectional area as appropriate for tunnels that have required maximum operating speeds of less than 220 mph.

Table 3.1.10a Tunnel Cross Section

		Imperial	Metric
Cross section area	Single Track	750 square feet	70 m^2
	Dual Track	1076 square feet	100 m^2
Cross section area based on operating speed of 220 mph (354 km/h)			

3.1.10.2 Tunnel Profile
Low points in sag curves shall be avoided in tunnels, cuts and trench sections.

3.1.10.3 Tunnel Length
Tunnel length shall not exceed six miles (9.66 kilometers).

3.1.10.4 Tunnel Ventilation
Tunnel ventilation shall be provided as necessary to meet National Fire Protection Agency (NFPA) requirements.

3.1.10.5 Tunnel Lining
All tunnels shall be fully lined for structural, water tightness and aerodynamic reasons.

3.1.11 Right-of-Way
3.1.11.1 Access
The right-of-way shall be fully access controlled to avoid intrusion by pedestrians, wildlife and livestock. This requirement applies to both the dedicated and shared use operation alternatives.

Unauthorized vehicles and pedestrians are not permitted to enter the corridor or cross the tracks at grade, which would expose them to a possible collision with a train.

3.1.11.2 ROW Requirements
For dual track alignments, a minimum right-of-way corridor of 50 feet (15.2 meters) shall be provided in congested corridors and where trench, cut-and-cover tunnel or aerial structures are used to create the ROW.

For dual track alignments, a minimum 100-foot (30.4-meter) wide corridor shall be provided in less developed areas to allow for drainage, maintenance needs, etc.

Other factors such as topography, soils, groundwater levels, noise barriers, cut-and-fill slopes, drainage, retaining walls, service roads, utilities, operating speeds, and construction methods will influence the extent of the required right-of-way envelope.

For shared use corridors, right-of-way widths vary depending on the number of tracks required.

Note that the right-of-way widths do not include temporary easements required for construction purposes, and ROW required for stations, storage facilities.

Dual track mainline must be maintained through station areas to allow for run-through or express services. Off-line stopping tracks serving the platforms will be provided at all intermediate stations.

3.2 STATIONS

3.2.1 Platform Configuration

3.2.1.1 Station Passenger Platform

Platforms and circulation areas will be designed to meet the requirements of the Americans with Disabilities Act (ADA)

Platforms shall have a length of 1320 feet to accommodate a sixteen-car train set.

The platform width shall be a minimum of 30 feet wide.

3.2.2 Station Requirements

To be included in a subsequent release.