California High-Speed Train Project

TECHNICAL MEMORANDUM

OCS Requirements

TM 3.2.1

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0	13 July 09	Initial Release

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for the California High-Speed Rail Authority

System Level Technical and Integration Reviews

The purpose of the review is to ensure:
- Technical consistency and appropriateness
- Check for integration issues and conflicts

System level reviews are required for all technical memorandums. Technical Leads for each subsystem are responsible for completing the reviews in a timely manner and identifying appropriate senior staff to perform the review. Exemption to the System Level technical and integration review by any Subsystem must be approved by the Engineering Manager.

System Level Technical Reviews by Subsystem:

Systems:	__Not Required__________________	_________ Date
Infrastructure:	*Signed document on file*__________ John Chirco	26 Apr 09 _ Date
Operations:	_Not Required__________________	__________ Date
Maintenance:	__Not Required__________________	__________ Date
Rolling Stock:	*Signed document on file*__________ Frank Banko	__08 May 09 _ Date

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ABSTRACT

The California High Speed Train Project (CHSTP) will provide high-speed train service in the state of California with proposed terminal stations (end-of-line or end-of route) in Sacramento, San Francisco, Fresno, Bakersfield, Los Angeles, Anaheim and San Diego. Intermediate stations will serve locations along the alignment. For much of the alignment, high speed trains will operate along a dedicated track with stations that exclusively serve high speed train operations. There are also two locations (the Lossan and Caltrain corridors) where the proposed California High-Speed Rail (CHSR) line will operate within a shared right-of-way with conventional passenger railroad lines.

The purpose of this technical memorandum is to review standards and best practices to provide criteria for the overhead contact system requirements of the California High Speed Train Project to:

- Provide a general system description and define the general performance requirements of the overhead contact system
- Define the overhead contact system performance requirements for high speed
- Provide a general detailed description of the overhead contact system
- Define the environmental requirements and climatic conditions applicable to the CHSTP overhead contact system
- Define the electrical requirements including the electrical clearances applicable to the overhead contact system
- Define the overhead contact system mechanical requirements
- Define the overhead contact system structural requirements
- Define the grounding and bonding requirements applicable to overhead contact system
- Define the overhead contact system interface requirements in order to ensure that they will be adequately taken into account in the design, procurement, construction and testing processes
- Define the requirements applicable for the execution of the design, construction, testing and commissioning of the overhead contact system.

Development of the design criteria for the Overhead Contact System will include review and assessment of, but not be limited to, the following:

- Existing FRA, State of California General Orders, NESC, IEEE and NFPA guidelines where applicable
- Existing international standards, codes, best practices and guidelines used for existing High Speed Line Systems and applicable for the Overhead Contact System for applicability to the CHSTP.
- Other existing international standards, codes, best practices and guidelines applicable for the Overhead Contact System

The current design practices for high-speed overhead contact system presently in operation throughout the world are considered in the development of the Overhead Contact System for the CHST project.

6.0 DESIGN MANUAL CRITERIA

These design criteria are principally provided to support the environmental review process. Typical OCS arrangements and spacing guidelines are included in Directive Drawings TM 3.2.1-A through E and TM 3.2.1-G through J. The following design criteria are provided as information for consideration during the development of the CHSTP corridor as applicable.

- Electric trains shall be able to go through the OCS phase break arrangement without establishing an electrical continuity between the successive electrical sections which are fed from different phases. This shall be realized at the maximum operating speed and with the train pantographs raised and in contact with overhead catenary, but with the pantograph breaker off.
  - On the CHSTP sections dedicated to very high speed, either a phase break design of at least 1319 feet long, or a shorter phase break separation of less than 466 feet (142 m) constituted by three insulated overlaps can be used. Adequate means shall be provided to allow a train that is stopped within the above phase break arrangements to be restarted; i.e. the neutral section shall be connectable to the adjacent sections by remotely controlled switches/isolators.
  - On shared use corridors where the maximum operation speed is 125 mph, the designs of phase break separation sections for high speed sections can be adopted, but in addition, a third phase break design arrangement of an overall distance less than 27 feet using insulators and having its centre section connected to the current return path / ground may also be adopted.
- For the CHST, there should be only one type of pantograph current collector head used for all trains and carbon strip material is recommended to minimize wear. The pantograph static force shall be adjustable between 9 and 27 pound force (40 and 120 N) and the nominal static force is to be 15.75 (+4.5,-2.25) pound force (70 N + 20 N/-10 N). The CHST pantograph shall be proven for very high speed performance and equipped with a fail safe device that will detect any failures of the contact strips and will trigger the lowering of the pantograph in case of a failure. Also the CHST pantograph shall be equipped with an uplift limiting device (pantograph stop) and with insulated horns.
- The OCS-pantograph current collection at the design stage shall be assessed at the maximum operational speeds, by the determinations of the mean value (Fm), of the standard deviation (σ) of simulated contact forces, of the statistical value $F_m - 3\sigma$, of the contact loss percentage (NQ), and of the vertical movement of the contact point.
- The CHSTP OCS shall preferably consists in a simple auto-tensioned catenary system using a bare bronze or other copper alloy messenger wire supporting a solid pre-sagged copper (or copper alloy) contact wire, by means of copper alloy current carrying dropper, an aerial negative longitudinal feeder and an aerial ground wire connecting each OCS supporting structure.
- The contact wire shall be installed and maintained at a nominal constant and minimum 17'-4.7"(5300 mm) height at support all along the sections dedicated to very high-speed and the height difference at each adjacent structure is to be less than 1/2 in. so as to ensure a constant contact wire height required for satisfactory pantograph current collection at high-speed.
- On shared use corridors where high-speed vehicles operate on tracks shared with American passenger cars, the contact wire height shall generally be set up at a height 18'-8.4"(5700 mm) at support.
- The contact wire height transition between sections dedicated to very high-speed and shared use corridors shall be realized in areas where the speed does not exceed 125 mph. The maximum contact wire gradients and the corresponding maximum gradient changes shall not exceed, according to the maximum speed, the following values:

Maximum speed	Maximum contact wire gradient	Maximum contact wire gradient change
> 125 mph	0	0
125 mph	2/1000	1/1000
100 mph	3.3/1000	1.7/1000
75 mph	4/1000	2/1000
60 mph	6/1000	3/1000
45 mph	8/1000	4/1000
30 mph	13/1000	6.5/1000

- On tangent track (straight track), the contact wire shall be staggered at each location to alternate sides of the pantograph center line. The stagger shall normally be set at ±8 in. On curved track, the staggers shall be calculated on a case by case basis taking into account the track cant, radius track curvature, and wind speed.
- The method of auto-tensioning the messenger and contact wire conductors shall be by balance weight arrangements using tensioning devices. For very high speed, the tensions are to be applied to the contact and messenger wires individually by using separate balance weights, tensioning devices and anchoring positions, while for speeds up to 125 mph in the shared use corridors, the messenger and contact wires will be auto-tensioned using one common balance weight arrangement and a yoke plate.
- The CHSTP Overhead Contact System shall ensure reliable operation under the California specified environmental and climatic conditions and the mechanical tension in each of the contact and messenger wires shall be automatically maintained over a 25°F to 170°F temperature range in above grade sections, while after the first 1300 ft in tunnels, the temperature range for auto-tensioning the conductors shall be 35°F to 155°F.
- For OCS design, the operational wind speed is Vop = 60 mph, and the design wind speed is Vbws = 85 mph. The wind velocity pressure qz shall be calculated by the NESC formula: $q_z = 0.00256\ V^2\ K_z\ G_{RF}\ I\ C_f\ A$ in lb/sq ft (equivalent to $q_z = 0.613\ V^2\ K_z\ G_{RF}\ I\ C_f\ A$ in N/m^2), and the loads due to wind for OCS structural calculations shall be multiplied by the load factors given by table 253-1 of the NESC.
- For pantograph security purposes, the permissible lateral deflection of the contact wire under the action of crosswind shall be ≤ 15 ¾".
- Maximum tension lengths from anchor to anchor shall not exceed 4000 ft in tunnels and in front of power supply stations and 4600 ft in open route.
- The overhead contact system shall be free running under overhead bridges.
- The OCS static and dynamic electrical recommended clearance values to be used for the CHSTP are:

Clearances	For CHST sections dedicated to very high speed		For shared use corridors for speeds up to 125 mph	
	Static (in)	Dynamic (in)	Static (in)	Dynamic (in)
Normal	1'-0.6" (320mm)	8.7" (220mm)	1'-0.6" (320mm)	8.7" (220mm)
Minimum	1'-0.6" (320mm)	8.7" (220mm)	10.6" (270mm)	6.7" (170mm)

- At the maximum operational speed, the dynamic pantograph envelope shall consider twice the value of the estimated or simulated uplift S_0 at the support point, i.e. 9.8" (250 mm) minimum. In very high speed dedicated sections, the design of the OCS cantilever and registration shall consequently allow for a steady arm uplift clearing at least the dynamic pantograph envelope, and thus allow for a minimum uplift of 9.8"(250 mm).
- In shared use corridors where the maximum operational speed is 125 mph, the design of the OCS cantilever and registration shall allow for a steady arm uplift clearing at least the dynamic pantograph envelope for such speed, and thus allow for a minimum uplift of 7.9"(200 mm).
- The above grade sections' OCS structures are to be galvanized Universal Column (U.C.)/H-beams and are to be designed and manufactured to the relevant steel standards.

- The OCS supporting structures shall be calculated in accordance with relevant American standards (NSCE, ASCE, ANSI) and the maximum mast deflection across track, including wind and ice loading, is not to exceed two (2) inches at contact wire level.
- Where the OCS is closely supported in above grade sections, such as at overlaps and turnouts, multiple cantilevers will be attached to a single structure of a heavier section as the applied loads shall not cause twisting of the structure by more than five (5) degrees.
- For multi track areas when independent masts cannot be installed between tracks, portal structures using drop tubes permitting to maintain mechanical independence of the equipment related to individual tracks, are to be designed with respect to overall aesthetics of the complete OCS.
- In tunnels and cut and covers, or for wall fixings, galvanized steel supports shall be fixed using either C-channels or anchor expansion bolts of the undercut type.
- Each and every OCS support location shall be individually numbered for ease of identification on site.
- The overall 2x25kV grounding and bonding protection network for the CHSTP shall consist of OCS aerial ground conductors, connections from these aerial ground conductors to the general buried ground conductor/grounding pillars/impedance bonds connected to the track and connections between all the later and the SSTs, SWSs and PSs grounding bars. In addition, the OCS grounding and bonding system shall safely connect all OCS metallic non live parts and also safely bond overhead bridges.
- The bonding and grounding of the OCS and of other lineside equipment shall ensure, in accordance with IEC 479-1 that the touch potentials are not exceeding:
  - 60 V where accessible to the public under all power supply feeding conditions
  - 650 V for less than 200 ms under short circuit conditions.
- The OCS voltage drop shall be in accordance with IEC 60850 “Supply voltages of traction systems”, whose main voltage criteria are as follow:
  - Operating nominal system voltage: 25.0 kV
  - Highest permanent voltage Umax1: 27.5 kV
  - Highest non-permanent voltage Umax2: 29.0 kV
  - Lowest permanent voltage Umin1: 19.0 kV
  - Lowest non-permanent voltage Umin2: 17.5 kV
- In addition, the maximum short circuit current shall be 12kA for protection measurement purpose and accordingly for specification of the electrical equipment.
- OCS voltage transformers shall be installed on the Overhead Catenary System to monitor the voltage presence of each electrical section and sub-section.
- The dynamic performance capability of the OCS current collection system shall be checked and at least the following data shall be measured:
  - the percentage of arcing, and additionally the contact force,
  - the contact wire uplift at the support as the pantograph passes.