California High-Speed Rail Authority

RFP No.: HSR 14-32

Request for Proposals for Design-Build Services for Construction Package 4

Book III, Part A.1
Design Criteria Manual Changes

Table 1-2: Design Life

Infrastructure	Design Life
Track and Civil Works, including: • Site, earthwork, line layout, storm drainage • Concrete slab with the exception of: • Track, including rails, ties/clips and ballast • Roadway, pavement, parking facilities • Switches and Turnouts	 100 years 50 years 40 years 30 years
Structures, including: • Underground structures • Above-ground facilities, including bridges, aerial structures, passenger stations, ventilation buildings • Retaining Walls • Components of the grounding, bonding, and lightning protection system embedded within concrete structures with the exception of: • Support Facilities • Movement Expansion joints, bearings	 100 years 50 years 50 years
Mechanical, Electrical, Plumbing, Ventilation and Fire Protection Systems	30 years
Systems	
Traction Power Systems, including: • Traction power supply system (TPS) • Overhead contact system (OCS) support structures and conducts, with the exception of the contact wire, the life of which is dependent upon the number of pantograph passes. • Grounding, bonding, and lightning protection system	 50 years
Train Control and Communications System, including: • ATC systems • Yard signal systems and their subsystems • Equipment and supporting cabling • Supervisory Control and Data Acquisition • Communications wired and wireless data transport systems • Communications administrative, control and timing systems • Communications safety, security and fire detection systems • Communications copper and fiber optic cable infrastructure and associated equipment	 30 years
Other technology-based systems: • Equipment and non-safety critical, microcontrollers, computers, software and similar commercial off-the-shelf (COTS) equipment	 10 years

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Minimum segment lengths shall apply to horizontal and vertical alignment segments. Where alignment segments overlap, each change in alignment shall be treated as a separate alignment element for the purpose of calculating minimum segment lengths. Where there is a vertical curve within a horizontal curve, the parts of the horizontal curve outside of the vertical curve shall be treated as separate segments when calculating segment lengths. The segment length requirement shall govern only where other design considerations for the various alignment elements do not require longer segment lengths. See Section 4.6, Combined Horizontal and Vertical Curves for further information. The segment length requirement will govern only where other design considerations for the individual alignment elements do not require longer segment lengths.

Minimum segment lengths for various design speeds are presented in Table 4-1. Additional values, for design speeds not shown, can be obtained from the formula provided in this section, rounded up to the nearest integer.

Table 4-1: Minimum Segment Lengths at Various Speeds

Design Speed (miles per hour)	Minimum Segment Lengths (in feet) for times of		
	2.4 seconds	1.8 seconds	1.0 seconds
250	880	660	367
220	774	581	323
200	704	528	293
175	616	462	257
150	528	396	220
125	440	330	183
110	387	290	161
90	317	238	132

4.4.3 Minimum Radii

The minimum allowed curve radius shall be derived from the following formula:

$$R = 4V^2_{max} / (Ea + Eu)$$

Where:

R = Radius (feet)

V_{max} = Maximum design speed (miles per hour)

Ea = Actual superelevation (inches) Ea_{max}= 6 inches

Eu = Unbalanced superelevation (inches) Eu_{max}= 3 inches

reliable operations. The limits of the HST operating envelope is defined as the area from the outer face of the Overhead Contact System (OCS) pole foundations in width and from top of the OCS poles to the trackbed supporting the HST tracks in height. In locations where the HST operating envelope is located within an open trench, on retained fill, or on an aerial structure, the limit of operating envelope shall be extended to the outer face of retaining walls, trench walls, abutments and piers of aerial structures.

6.3.1 Protection Against Intrusion of Conventional Trains

Passenger and freight trains that operate in shared corridors or adjacent to the HST system shall be prevented from entering into the HST operating infrastructure by lateral separation or by a physical barrier (e.g., earth berms, ditches, or reinforced concrete walls) when lateral separation between railway systems is insufficient.

6.3.1.1 Protection Measures without Physical Barriers

The preferred protection is to locate HST operating infrastructure at a sufficient distance from passenger and freight (conventional) railroad systems to avoid intrusion. A lateral distance of 102 feet or greater measured between the closest HST track centerline (TCL) to conventional railroad right-of-way does not require a physical barrier for intrusion protection. Alternatively, when the HST alignment is on embankment and its trackbed is 10 feet or higher than the freight/conventional railroad top of rail, use of a physical barrier for intrusion protection of HST operating infrastructure is not required. Additionally, separation requirements of conventional railroad owners and operators shall be considered in establishing required separation.

6.3.1.2 Protection Measures with Physical Barriers

When lateral separation between the closest HST TCL to conventional railroad right-of-way is less than 102 feet, or separation requirements of conventional railroad owners and operators, physical barriers shall be installed. The intrusion protection shall be designed to mitigate the risk of a train derailment from adjacent conventional railroad intruding into the HST operating envelope. For train collision loads, refer to the *Structures* chapter. For grounding and bonding of reinforced concrete barrier refer to the *Overhead Contact System and Traction Power Return System*, and *Grounding and Bonding Requirements* chapters. The intrusion protection is achieved by the following measures:

- HST Guideway At or Below Grade
  - Use of a minimum 10-foot-high berm, or 10-foot-deep ditch, or a 5-foot-deep ditch and a 5-foot-high berm combination, as an intrusion protection measure when HST guideway is at-grade. Refer to Standard and Directive Drawings for typical sections of various intrusion protection measures.
  - Use of a minimum 10-foot-high reinforced concrete barrier as an intrusion protection measure when HST guideway is at or below grade, or if required by conventional railroad owners and operators. Refer to Standard and Directive Drawings for placement of the wall within HST right-of-way.

- When there is a concrete barrier as an intrusion protection between a conventional railroad and the HST and there is an aerial structure pier between HST and the railroad, the concrete barrier shall transition to protect the pier. Refer to AREMA Pier Protection requirements. The minimum height of the barrier protecting the pier shall be 10 feet. The transition of the concrete barrier from inside HST right-of-way to the pier shall be at 3:1 slope or flatter.
- Sufficient separation between the physical intrusion protection and the HST right-of-way shall be provided to allow maintenance of the intrusion protection barrier. This separation shall not be less than 5 feet.
- Refer to Standard and Directive Drawings for typical sections of various intrusion protection measures.

- HST Guideway supported on retaining walls
  - When HST guideway is supported on MSE retaining walls, intrusion protection measures shall be identical to intrusion protection for HST guideway at-grade.
  - When HST guideway is supported on cast-in-place retaining walls, the wall shall be designed for train collision loads, refer to the *Structures* chapter.

- HST Elevated Guideway
  - Where the side clearance from the closest conventional rail TCL is less than 25 feet to the face of a HST structure, such as a pier or a retaining wall (with the exception of a trench wall), a 6-foot high reinforced concrete barrier shall be constructed at a minimum distance of 1 foot from the face of the HST supporting structure. Where the side clearance is 12 feet or less, the height of the reinforced concrete barrier shall be 12 feet. The reinforced concrete barriers shall be designed to protect HST supporting structures from a direct impact by a derailed conventional railroad locomotive.
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These guidelines are for physical separation and do not include right-of-way considerations that may require additional separation. Additionally, separation requirements of freight railroad owners and operators shall be considered in establishing required separation.

6.3.2 Protection Against Intrusion of Roadway Vehicles

Protection against highway/roadway vehicles from intruding into the HST operating infrastructure shall be provided through sufficient lateral separation between state highway systems or local roadways and the HST system, or the installation of barriers. For highway vehicle collision loads, refer to the *Structures* chapter.

6.3.2.1 Protection Against Intrusion of Roadway Vehicles into the HST Operating Infrastructure

For state highway systems, protection against errant roadway vehicles from intruding into HST operating infrastructure shall be provided. Caltrans requires protection for errant roadway vehicles when HST fixed objects are located within the highway Clear Recovery Zone (CRZ).

Caltrans Highway Design Manual establishes 52 feet as the CRZ for the high-speed rail project. Therefore, when a high-speed rail corridor is constructed longitudinal to a freeway, expressway, or a conventional highway with posted speeds over 40 mph, the nearest fixed object or feature associated with the operation of the rail facility shall be located at a minimum of 52 feet horizontally from the planned ultimate edge of the traveled way. When the HST alignment is not longitudinal to a Caltrans freeway, expressway, or highway, the standard Caltrans 30 feet requirement for CRZ shall apply.

If these clearances cannot be provided, a design exception shall be obtained from Caltrans and the Authority along with appropriate roadside protection mitigation measures, such as installation of a metal beam guard rail or concrete barrier.

For protection of HST operating infrastructure, appropriate required type of roadside protection shall be site specific, based on site specific hazard analysis, and shall consider factors such as traffic volumes, speed, highway geometry, side slopes, accident history, and others. For instance, in locations where high volumes of cargo and tanker trucks are present with high probability of intrusion into HST operating infrastructure, a more stringent intrusion protection is required and shall be provided, such as a concrete wall up to 7.5-foot high meeting design force requirements specified for AASHTO TL-6 with a Caltrans type 60D barrier or metal beam guard rail installed for protection. However in most cases, a 56-inch high concrete barrier meeting design force requirements specified for AASHTO TL-5 is required to protect HST operating infrastructure from intrusion by errant vehicles.

For local roadways, protection against adjacent roadway vehicles from intruding into HST operating infrastructure shall be provided based on site specific hazard analysis and per the requirements of the local jurisdictions.

For both the state highway system and local roadway systems, the intrusion protection shall be designed to mitigate the risk of errant vehicles from an adjacent roadway intruding into the HST operating infrastructure. Refer to Standard and Directive Drawings for various conditions where intrusion protection measures are required along the HST alignment.

6.3.2.2 Protection Against Intrusion of Roadway Vehicles over the HST Operating Infrastructure

Protection against intrusion of roadway vehicles on grade separated structures onto the HST operating infrastructure below the structure shall be provided. The overhead structure shall be designed to include vehicular railing with sufficient strength to withstand collision loads defined in the *Structures* chapter. The vehicular railing shall extend to the nearest intersection or 100 feet beyond the end of the overhead structure with appropriate taper to redirect vehicles that may travel down the roadway embankment and into the Authority's right-of-way. In conjunction with keeping the roadway vehicle from intruding into the HST operating infrastructure, a protective screening and barrier shall be provided to prevent contact with the OCS, to prevent pedestrians from falling onto, and to reduce the risk of objects being dropped onto the HST operating infrastructure. Refer to the *Overhead Contact System and Traction Power*

7.8.1.1 Fences

Fencing shall be installed during construction as a means of protecting Authority properties. If temporary fencing is installed, it shall be replaced by permanent fencing prior to completion of construction.

Permanent fencing to be used is as follows:

- Access Restriction (AR) Fencing
- Access Deterring (AD) Fencing
- Station Area (SA) Fencing

Refer to the *Stations* chapter for Architectural and Station Area fencing within the station site areas, including transitions to AR and AD fencing, and pedestrian and vehicle gates on station site.

A. Access Restriction Fencing

AR fencing is permanent fencing used to deny access to the HST trackway and to protect the Authority's property.

AR fences shall meet the following minimum material and height requirements.

Unless otherwise specified, fencing shall extend from ground level to a minimum height of 8 feet. AR fence shall be welded wire mesh as indicated in *Standard and Directive Drawings*. In high security areas, the AR fence fabric shall be expanded metal mesh as indicated in *Standard and Directive Drawings*. The locations of high security shall be determined through a Site-Specific Hazard Analysis.

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Fence posts shall be cast into concrete footings, set into concrete retaining walls or set in rigid traffic barriers.

AR fences shall be located inside the Authority's right-of-way within a distance of 1 foot from the right-of-way line.

Combinations of walls or barriers with welded wire fabric or expanded metal mesh with a total height of 8 feet measured from the highest ground surface adjacent to the wall or barrier may be used as AR fencing.

B. Access Deterring Fencing

AD fencing is permanent fencing used to deter access and/or prevent from passing through to areas that do not require a high degree of security. AD Fencing is primarily within Authority's right-of-way. AD fences may also be used in areas where the risk of trespassing is low, such as storage area inside a wayside facility. AD fencing shall be 6 feet high, consisting of 6 feet of

welded wire mesh. Fence posts shall be cast into concrete footings, set into concrete retaining walls or set in rigid traffic barriers.

C. Grounding of Fencing

Permanent fencing shall be bonded and grounded to prevent electric shock from induced voltage. Refer to the *Grounding and Bonding Requirements* chapter for additional details on the requirements for grounding of fences.

D. Vegetation Control along Fences

Vegetation along fenced areas of Authority property shall be controlled to assure that no large trees or shrubs provide access over the fence by people or animals. Fencing and trees, including branches, shall be kept apart a minimum of 5 feet. Refer to the *Overhead Contact System and Traction Power Return System* chapter for vegetation clearance to electrical lines within the Authority right-of-way. Future growth of vegetation shall be considered when planning new landscaped areas.

7.8.1.2 Walls

Walls may be used to prevent intrusion by vehicles into Authority property. When appropriate, walls may be used in combination with fences at the following locations:

- Where there is vertical separation from trackway
- Where there is close proximity between the HST trackway and an adjacent transportation facility

Refer to the *Rolling Stock and Vehicle Intrusion Protection* chapter for vehicular intrusion protection.

7.8.1.3 Traffic Barriers

Traffic barriers may be required where the Authority right-of-way abuts public and private roads and highways and at highway overpasses where there is a potential of vehicles accidentally entering the Authority right-of-way. Traffic barriers used to protect HST trackway shall comply with the requirements of the *Rolling Stock and Vehicle Intrusion Protection* chapter and Caltrans Standards:

A. Traffic Barriers Types

Traffic Barriers shall be either rigid or semi-flexible depending on the location as indicated herein. Refer to *Caltrans Standard Plans* for installation and construction details. Refer to the *Rolling Stock and Vehicle Intrusion Protection* chapter and *Standard and Directive Drawings* for barrier types and clearance requirements between Authority and Caltrans facilities.

- Rigid Traffic Barrier –Refer to the *Rolling Stock and Vehicle Intrusion Protection* chapter for types of rigid traffic barriers. When rigid traffic barriers are placed at Authority right-of-way, the barrier shall be used in conjunction with AR fences to prevent intrusion into HST trackway from adjacent roadways.

- Semi-flexible Traffic Barrier – Shall be used along service roads located within Authority right-of-way except when such roads are located in close proximity to any track in which the placement of barriers may compromise the trackway clearance envelope. Semi-flexible barriers shall be placed at the outside of curve as required by safety considerations, to delineate the roadway and maintain vehicles within the trackway. Semi-flexible traffic barriers shall be Caltrans Metal Beam Guard Railing of the appropriate type for the local condition. Design and installation details for Metal Beam Guard Railing are found in *Caltrans Standard Plans*.

7.8.1.4 Fencing and Traffic Barriers in combination

AR fencing shall be located a minimum of 3 feet from the back side of a semi-flexible traffic barrier.

If 3 feet separation cannot be achieved, a rigid traffic barrier shall be used and fence height shall be increased by a height equal to the height of the barrier.

If AR or AD fencing is installed on top of a rigid barrier the combined height of fence and barrier shall not be less than 8 feet.

7.8.1.5 Gates

Gates with locking devices shall be provided along fenced areas to allow access to authorized personnel, emergency vehicles, and maintenance equipment.

Gates shall be constructed of the same material and height as adjacent fence and shall not decrease the level of security provided by the fences.

Gates shall be either swinging or sliding type. Sliding gates shall be utilized where swinging gates foul the walkway or vehicle envelope when opened. For gate details, refer to *Standard and Directive Drawings*.

Gate locations along fencing within freeway right-of-way shall require Caltrans approval.

Gate locations shall be coordinated with (i.e., placed adjacent to or near) the location of Authority wayside facilities requiring access from outside Authority right-of-way.

At aerial sections, access to the trackway shall be made from stations or emergency stairs or by mobile ladder equipment from roadways adjacent to the trackway. If no adjacent or crossing roadways exist, construction of access roads is required. Gates shall be provided at emergency stairs landing along aerial structures at intervals of 2.5 miles nominal on either side of the trackway (not on both).

For gate placement at communications, train control, and traction power facilities refer to *Standard and Directive Drawings*.

Gates shall be bonded and grounded to prevent electric shock from induced voltage. Refer to the *Grounding and Bonding Requirements* chapter for additional details on the requirements for grounding of gates.

A. TYPES OF GATES

- Walking Gates

Gates for personnel and equipment access (walking gates) shall have a minimum width of 4 feet.

For Traction Power Facilities, walking gates shall be 6 feet wide.

- Driving Gates

Gates for vehicular access (driving gates) shall have a minimum width of 12 feet.

Gates along right-of-way fencing may require approval by the local fire protection authority having jurisdiction. For emergency responders vehicular access minimum gate width shall be 20 feet.

Driving swinging gates shall be a pair and shall be hinged from the inside. Provision shall be made for swinging gates to swing not less than 90 degrees away from Authority facilities.

Driving gates shall be provided in conjunction with either access roads or at locations where existing roads make it practicable for emergency vehicles to get to the trackway.

Along at-grade trackway, driving gates shall be located at 2.5 mile nominal intervals on either right-of-way side. When possible, access gates shall be staggered.

Driving gates shall be provided at traction power facilities. Minimum gate width shall be 20 feet.

Trackside access driving gates shall be provided at Authority facility locations. If this cannot be provided due to site constraints, an alternative method of providing vehicular access to the trackside from the Authority facility shall be submitted to the Authority for review and concurrence.

Table 7-3: Access Control - Gates

Type of HST Trackway	Nominal Gate Spacing Interval
At-Grade, Unretained Fill, and Unretained Cut	2.5 miles
Aerial	2.5 miles
Retained Fill (Embankment) or Retained Cut	2.5 miles

7.8.1.6 Fence Signage

Fencing shall be provided with signs warning of hazards from operations, high voltage electrical installations, and any other relevant hazards, at any location where the public may reasonably be expected to approach the right-of-way.

Signs bearing the words "Danger", "High Voltage Lines" and "Keep Away" in letters at least 3 inches in height, shall be installed at intervals of not more than 500 feet along each fence enclosing the rights–of–way, at every gate and at each station or passenger loading platform, at a height between 5 and 6 feet from the finished ground outside Authority property. The signs may carry other information relative to the hazard present, but the three required phrases "Danger", "High Voltage Lines", and "Keep Away" shall be larger size type than the type used for additional items.

Signs bearing the message "No Trespassing" in letters of at least 3 inches in height, and including the California Penal Code section number for trespassing in smaller letter size, shall be installed along the fence at a minimum, every 500 feet, at a height between 5 and 6 feet from the finished ground outside Authority property.

Signage shall be consistent throughout the Authority system.

7.8.2 Access Control by Type of HST Trackway

Access to non-public Authority property shall be controlled by installing perimeter fences (AR) along the right-of-way with locked gates to allow access and egress of maintenance and emergency personnel.

Within the vicinity of a passenger station the right-of-way fencing shall be installed to guide the passengers to the designated platform entrances and to prevent unsafe shortcut to the platform.

7.8.2.1 At-Grade Trackway

AR fencing shall be provided continuously along each side of at-grade trackway sections, including transitions to underground or aerial sections. Fence construction shall be designed, installed and maintained in such manner as to deny access over, under or through the fencing

to animals and unauthorized persons. The HST system shall have no at-grade public road crossings or at-grade crossings of other rail systems.

7.8.2.2 At-Grade Trackway within Roadway Corridor

A combination of AR fence and an appropriate rigid traffic barrier shall be constructed along the Authority right-of-way when it is at-grade, runs parallel and within Caltrans Clear Recovery Zone to a roadway, including locations where the trackway shares a common corridor in a roadway median.

The rigid traffic barrier shall be located within the Authority right-of-way at a minimum distance of 1 foot inside the Authority right-of-way.

Refer to the *Rolling Stock and Vehicle Intrusion Protection* chapter for traffic barrier requirements.

7.8.2.3 At-Grade Trackway Adjacent to Conventional Railroad

Protection against accidental intrusion shall be provided where a HST trackway is in close proximity to a conventional railroad corridor. Refer to the *Rolling Stock and Vehicle Intrusion Protection* chapter for additional requirements.

7.8.2.4 At-Grade Trackway through High-Risk Trespassing Areas

Special consideration shall be given to areas determined to have a high-risk of trespass such as, but not limited to, HST trackway adjacent to parks, playgrounds, schoolyards, highly populated urban areas or areas within the pathway to and from any of these places, which require a higher degree of security. The AR fence at high-risk trespassing areas shall be expanded metal mesh. The surface under the fence shall be paved to prevent undermining or fence fabric shall be embedded a minimum of 1 foot into the ground.

7.8.2.5 Trackway in Cut or Fill (Embankment) Section

AR fencing shall be used for HST trackway along embankment and cut sections. AR fences shall not be placed on the slope surfaces of the cut or embankment sections.

When the HST trackway section is in cut, AR fences shall be located at a distance from the top of slope, after slope rounding:

- Recommended 15 feet
- Minimum 10 feet

When the HST trackway section is on embankment, AR fences shall be located at a distance from the toe of slope:

- Recommended 15 feet
- Minimum 10 feet

7.8.2.6 Trackway on Aerial Structure

At abutments of aerial structures, AR fencing from adjoining sections shall be continued beyond the abutment to a point where the soffit of the structure is 10 feet or more above the finished grade. At that point, the right-of-way fences on each side of the aerial structure shall be joined under the aerial structure.

Where the ground level is less than 10 feet below the soffit of the structure, aerial structure sections shall be protected with AR fencing located 15 feet from the drip-line of the structure. Fencing is not required under an aerial structure where the right-of-way adjoins property which is already fenced in a manner consistent with these criteria.

Fencing is not required on aerial structure except at abutments. Area around the columns and foundations shall remain accessible for 15 feet outside of the foundation limits.

7.8.2.7 Trackway on Retained Fill

Retained fill trackways shall have at least 1 vertical wall exceeding 5 feet in height measured from finished surface along the non-trackway side of the wall.

AR fencing shall be installed on top of retaining walls along retained fill sections on the following conditions:

- When retaining walls are located at the right-of-way line along HST trackway
- The adjacent land outside Authority property is less than 10 feet below the top of the wall. Refer to *Standard and Directive Drawings* for fence details.

The combined height of the wall with traffic barrier and fence above the adjacent ground outside the Authority right-of-way shall not be less than 8 feet.

Where a retaining wall is within the right-of-way line, security fencing shall not be placed on top of the wall. However, railing shall be required along the top of wall for fall protection, refer to the *Structures* chapter.

Fencing between at-grade and retained fill sections shall be continuous.

Where a retaining wall is used as support for both fencing and poles supporting lights, overhead contact system (OCS), or signs, the open space between the fence and the pole shall be less than 4 inches. Refer to the *Overhead Contact System and Traction Power Return System* chapter for OCS safety barrier requirements.

7.8.2.8 Trackway on Retained Cut

Retained cut trackways are defined as trackways having at least 1 of its vertical walls exceeding 5 feet in height measured from the top of rail.

AR fencing shall be installed on top of retaining walls or rigid traffic barriers along retained cut sections on the following conditions:

- When retaining walls are located at the right-of-way line along HST trackway and the adjacent land outside Authority property is less than 10 feet above the top of the wall. Refer to *Standard and Directive Drawings* for fence details.
- Concrete barriers located adjacent to a HST trackway on the right-of-way line.

The combined height of the wall or traffic barrier and the fence above the adjacent ground outside the Authority right-of-way shall be not less than 8 feet..

Where a retaining wall is well within the right-of-way line, security fencing shall be located in accordance with other requirements and shall not be placed on top of the wall. However, railing shall be required along the top of wall for fall protection, refer to the *Structures* chapter.

Fencing between at-grade and retained sections shall be continuous.

Where a retaining wall is used as support for both, fencing and poles supporting lights, OCS or signs, the open space between the fence and the pole shall be less than 4 inches.

7.8.2.9 Trackway Underground (Bored, Mined, and Cut-and-Cover Tunnels)

Where at-grade sections adjoin underground sections, the right-of-way AR fencing shall extend beyond the portal by a minimum of 30 feet where possible and be continuous across the right-of-way at that point.

Where the minimum of 30 feet cannot be achieved because of physical constraints or an adjacent public way, the fencing shall extend across the right-of-way at the point of constraint.

Authority property above underground sections of HST trackway shall be protected in accordance with these criteria and the facility and/or use of the land above ground. If the use of the land above ground has not been defined and no HST facility has been constructed, perimeter AD fencing with gates shall be installed to prevent unauthorized access to the property.

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Table 7-4: Access Control Fencing – Trackway

High-Speed Train Infrastructure	Fence Type AR	Walls / Barrier, Other
At-grade	✓	
At-grade adjacent to Roadways(1)	✓	✓
At-grade within Highway Corridor	✓	✓
At-grade adjacent to Conventional Railroad(1)	✓	✓
At-grade through High Risk Trespassing Areas	✓	
Sloped Cut or Fill (Embankment) Section	✓	
Aerial structure	✓	
Retained Fill	✓	✓
Retained Cut	✓	✓
Underground (Bored, Mined and Cut-and-Covered Tunnels)	✓	

(1) Use of walls and barriers for intrusion protection shall be made in conjunction with site-specific risk assessment. Refer to the *Rolling Stock and Vehicle Intrusion Protection* chapter for additional requirements.

7.8.3 Access Control by Type of Facility

This section prescribes right-of-way fencing for wayside facilities such as yards, maintenance facilities, train control, communications, and traction power facilities.

7.8.3.1 Yards and Maintenance Facilities

AR fencing with vehicular and pedestrian access gates equipped with locking devices shall be installed along the perimeter of Authority facility.

7.8.3.2 Train Control, Communications and Traction Power Facilities

Train control, traction power facilities, and communications equipment locations shall be either fenced with AR fencing or an 8 foot minimum high wall enclosure with secured gates.

Where there is public access or trespass is likely, anti-climbing protection shall be provided at buildings and other structures supporting energized parts of the OCS. In addition to anti climbing protection measures, warning signs shall be installed on the fence or the wall indicating "DANGER HIGH VOLTAGE". Access to fixed ladders, particularly at signal poles and signal gantries, and the means of access to any roof or other place which could allow non-authorized persons to approach energized parts, shall be secured or otherwise protected.

For fencing placement and further requirements at OCS, communications, train control and traction power facilities refer to the *Traction Power Supply System, Overhead Contact System and Traction Power Return System, Communications,* and *Automatic Train Control* chapters.

7.8.3.3 Passenger Station

Station area fence (SA), shall be installed along the right-of-way within the vicinity of a station platform to prevent unsafe shortcuts to the platform and to guide passengers to the designated station entrances. Refer to the *Stations* chapter for station area fence standards.

A. Limits of Platforms

Station area fences with locked gates shall be installed at the ends of station platforms, along the sides of platforms perpendicular to the tracks, to prevent unauthorized access to the trackway.

B. Inter-Track Fencing or Protection Screens (Walls)

Inter-track fences or protection screens (walls) shall be provided between through track and station track or between adjacent tracks at station platforms for the full length of the platforms and at least 150 feet beyond each platform end. For track spacing refer to the *Trackway Clearances* chapter and for additional criteria on inter-track fencing/protection screens refer to the *Stations* chapter.

Table 7-5: Access Control Fencing – Authority Facilities

High-Speed Train Infrastructure	Fence Type		Walls / Barrier, Other
	AR	AD	
Yard and Maintenance Facilities	✓		
Train Control and Traction Power Facilities	✓		
Passenger Stations	✓		
• Limits of Platforms			✓(1)
• Inter-Track Fencing / Protection Screens			✓(1)
Parking Facilities		✓	

(1) Station Area Fence

7.8.4 Access Control at Other Locations

7.8.4.1 End of Line and Storage Tracks

End of line tracks and end of storage tracks that extend from the station tracks, shall be protected with AR fencing located at the following:

- One (1) foot minimum distance from the Authority right-of-way line in the direction parallel to the tracks, and
- Two (2) feet minimum distance from the right-of-way side of the bumping structure in the direction perpendicular to the tracks.

7.8.4.2 Roadway Overhead Crossing HST Trackway

Where HST trackway is traversed by a roadway overhead crossing, the overhead crossing shall be provided with a modified AD combination of rigid traffic barrier and a protective solid barrier. The protective solid barrier shall be installed on top of traffic barriers. The limits of the solid barrier shall be over the entire HST right-of-way. For protective solid barrier requirements refer to the *Overhead Contact System and Traction Power Return System, Grounding and Bonding Requirements* chapters and *Standard and Directive Drawings*. For further roadway vehicle containment requirements, refer to the *Rolling Stock and Vehicle Intrusion Protection* chapter.

The modified AD with protective solid barrier at roadway overhead crossings with sidewalk shall be constructed with a curved top to prevent the throwing of objects onto HST trackway. The minimum height of the modified AD with protective solid barrier with the traffic barrier shall be 8 feet. Refer to *Standard and Directive Drawings*.

7.8.4.3 Streets Ending at HST Trackway

A rigid traffic barrier shall be installed at the end of dead-end streets, cul-de-sacs, or "T" intersections adjacent to at-grade segments of HST trackway. The barrier length and height shall be sufficient to intercept all possible vehicular paths from within the traveled way of the approaching street.

Case 1 – Where the longitudinal grade of the streets dead-ending at HST trackway is 2 percent maximum going down towards Authority property, the barrier shall be a minimum of 4 feet–8 inches above the street surface at the barrier.

Case 2 – Where steep grades and close proximity of the track require a substantial physical barrier against runaway vehicles, the barrier shall consist of an 18-inch thick reinforced concrete wall. The top of the barrier shall be from 4 feet–8 inches to 6 feet above the street surface at the barrier. Design drawing for these concrete walls shall be submitted to Authority for review and concurrence.

7.8.4.4 Authority Roadways

If conditions along areas of the Authority roadways require installation of traffic barriers, semi-flexible traffic barriers shall be installed, provided that the location of such barriers do not obstruct the clear pathway from walkways to emergency exits or encroach into the clearance envelope of any Authority facility.

Access roads and service roads are not required to be protected with fence.

7.8.4.5 Emergency Exits and Equipment Rooms in Tunnels

Emergency exits, rooms containing fixed equipments, corridors, stairwells, and other controlled areas in tunnels shall have doors and/or gates with a lock system capable of preventing unauthorized access from outside and a release mechanism that makes it possible to open them from the inside for evacuation purposes.

For additional system-wide criteria on securing exits refer to the *System Safety and Security* chapter.

7.8.4.6 Drainage Structures

Where drainage requires passage under the trackway, pipes or box culvert structures shall be used.

HST trackway over box culvert structures shall be protected with AR fencing around headwall as shown in *Standard and Directive Drawings*.

HST trackway over box culvert structures shall be evaluated for their security risk potential by preparation of a threat and vulnerability analysis. If action is required to enhance the structure to address security concerns, options considered shall not conflict with structures that have been designed as designated wildlife crossings. If culvert crossings are designated as wildlife crossing, no grates shall be installed at the entrances of the culverts, subject to approval by appropriate regulatory agency.

For culvert structure sizing refer to the *Drainage* chapter.

Open ditches alongside the trackway may require to be connected to a drainage system outside the Authority access controlled right-of-way. In such cases, open ditches crossing under AR fence shall not be allowed unless the ditch is concrete lined and the open section of the ditch is protected by steel welded grid as shown on *Standard and Directive Drawings*.

Table 7-6: Access Control Fencing – Other Locations

High-Speed Train Infrastructure	Fence Type		Walls / Barrier, Other
	AR	AD	
End of Line and Storage Tracks	✓		
On Roadway Overhead Crossings HST		✓(1)	✓
Streets Dead-Ending at HST Trackway • Roadway is 2% maximum going down towards Authority property	✓		✓
• Steep grades and close proximity of the track	✓		✓
Access Roads			✓
Service Roads			
Emergency Exits and Equipment Rooms			✓
Drainage Structures			✓

(1) Modified AD with protective solid barrier, refer to Section 7.8.4.2.

7.9 Wildlife Crossing

Authority facilities shall be designed and constructed such that wildlife movement corridors are preserved and do not create a barrier to wildlife movement in the area.

Refer to Final Environmental Impact Statement, Biological Resources and Wetlands Section for identified wildlife movement corridors that need to be preserved and mitigations measures to follow.

The mitigations measures to be incorporated as a project design feature include wildlife corridor undercrossing, wildlife fencing, and wildlife artificial dens.

7.10 Maintenance and Protection of Traffic during Construction

For the duration of the CHSTP construction, every effort shall be made to minimize the interruption of surface traffic, be that pedestrian and vehicular, adjacent to, under or over the construction site.

Access provisions for the following shall be maintained within construction zones:

- Emergency services and emergency vehicles
- Local access to businesses and residences

Temporary interruptions to business and residence access shall be coordinated and approved by the local authority having jurisdiction.

7.10.1 Railroad Operations

Construction activities affecting surface transportation, including freight or other rail operator, shall be planned and scheduled in cooperation with the relevant authorities/agencies. Temporary structures for the support and maintenance of surface traffic adjacent to under or over the construction site shall be designed and constructed in accordance with prevailing codes, standards and regulations and are subject to review and approval by the local authority having jurisdiction and the Authority.

During construction, interruption of, and interference with passenger and freight rail operations shall be avoided unless otherwise approved by the authority having jurisdiction. Wherever possible, the design and the sequencing of the construction activities shall allow for such uninterrupted railway operations.

streambed and increasing the distance between embankments. Where applicable, energy dissipators may be provided in accordance with criteria provided in Section 8.5.2.4.

8.6.3.3 Pier Design and Location

For structures over waterways, the spacing and location of the structural piers can significantly affect the hydraulic characteristics of the existing waterways. In locations where pier columns and protection walls interfere with drainage, an alternative drainage facility shall be provided to collect and carry water to a drainage system.

Piers shall be located outside of drainage channels and natural washes, where possible, to minimize negative impacts associated with scour and erosion at the pier. Where piers are located within channels, a streamlined design at the pier nose shall be considered. This shall be obtained by providing circular or rounded shapes at the upstream and downstream faces of piers in order to reduce flow separation, aligning bents with the direction of flow and increasing the length of the bridge to decrease velocities.

Debris buildup may occur at piers which can reduce the hydraulic capacity of the channel, increase the local scour, and potentially cause the pier to fail. The design shall consider the type of debris that could impact the pier. Depending on the debris type, protective devices such as steel plates, debris deflectors, wingwalls, and upstream debris catchment structures shall be used.

8.6.3.4 Deck Drainage System

Stormwater on a bridge or aerial structure surface can affect the water spread on the structure into the trackway, cause complications with maintenance, and negatively impact the aesthetics of the structure, by corrosion or debris. The deck drainage system includes the bridge or aerial structure deck, gutters, inlets, pipes, downspouts and end collectors, which are discussed in the following subsections.

A. Bridge/Aerial Structure Deck

A longitudinal drainage system shall be provided along the deck to minimize standing water on the bridge or aerial structure. Criteria for bridge or aerial structure deck design are as follows:

- For bridges and aerial structures with ballasted track, the minimum size of a half circle or U-shaped perforated corrugated galvanized drain channel shall be 8 inches. The drain channel shall be installed on top of the bridge deck waterproofing membrane over the invert of the deck, refer to Standard and Directive Drawings.
- For bridges and aerial structures with non-ballasted track, a drainage trough shall be designed to convey the deck drainage.
- The cross slope of the bridge/aerial structure deck shall be 2 percent.
- Standing water on the bridge or aerial structure shall not be permitted.

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B. Inlets and End Collectors

The bridge and aerial structure end collectors are drainage inlets that collect flow before it reaches the structure and prevent flow from leaving the bridge or aerial structure. End collectors are typically drop inlets which convey a higher capacity; slotted drains may be used. Stormwater upstream of a bridge or aerial structure shall be fully collected prior to reaching the structure. To avoid flooding on the bridge or aerial structure and backup in the pipes, inlets and drains on the bridge or aerial structure shall account for a 50 percent clogging factor. For ballasted bridge/aerial structure decks, the half dome drain channel shall be terminated at inlets before the bridge deck expansion joint, refer to Standard and Directive Drawings. Inlets shall be provided at intervals to collect the flow into the storm drainage system.

C. Pipes and Downspouts

The minimum longitudinal slope of drain pipes inside the box girder shall be 1 percent or generate a minimum velocity of 2 feet per second. Downspouts shall be considered in the aesthetics of the bridge or aerial structure. Pipes and downspouts located within the concrete of the structure provide more challenges for access and maintenance. Cleanouts shall be provided at convenient and accessible locations along the pipe. Cleanouts shall be located such that these can be reached from the ground for easy access for personnel, and at places where the pipes bend and debris build-up may occur. Cleanout locations shall be identified.

Outfalls from downspouts may discharge directly into storm drains, or nearby receiving water, considering the water is treated before discharging offsite. If the downspout discharge is directly to surface drainage, the free-falling water shall not come into contact with the structure members to avoid corrosion and deterioration. Stormwater from the bridge or aerial structure shall also not negatively impact the surface below; erosion control devices may be necessary at the outfall location and the surface channel shall be designed to carry and transfer the increase in flow. Downspouts that discharge directly to a storm drain shall connect to a manhole for easy access. The outfall invert shall be a minimum of 0.25 feet higher than the manhole invert to avoid debris clogging the storm drain.

Refer to Standard and Directive Drawings for drainage of aerial structures.

8.6.4 Tunnels

For drainage requirements in tunnels, refer to Standard and Directive Drawings. Drainage from tunnel and cut-and-cover structures shall discharge to portals or to a low-point sump in pump station.

8.6.5 Retaining Walls

Provide a concrete lined gutter behind retaining walls to redirect storm runoff away from the walls, refer to Standard and Directive Drawings. For other drainage requirements at retaining walls, refer to the *Geotechnical* chapter.

- In the event that there are no standards, design shall be in accordance with the requirements of this chapter.

9.4 HST Utilities

HST utilities are defined as utilities and supporting facilities that serve HST facilities.

9.4.1 Electrical

Electrical service utilities and supporting facilities transmit electrical power from its traction power or facility power substations to facilities such as Overhead Contact System (OCS), ventilation structures, train control houses, passenger stations, and other appurtenant wayside facilities.

Various local or regional power companies provide power to traction power and facility power substations.

If a power company's substation is located within the Authority's right-of-way, the design of the substation site shall follow the requirements of that power company, Section 9.5.5.8 of this chapter on Aboveground Utility Facilities, the *Facility Power and Lighting Systems*, and the *Traction Power Supply System* chapters.

Electrical distribution facilities shall be surface mounted on foundations, supported on structures, or installed underground. Refer to the *Facility Power and Lighting Systems* chapter for design requirements.

Unless otherwise specified, each utility power company designs, furnishes, and installs all of its cables and/or overhead conductors, including all high voltage (HV) utilities and supporting facilities and connection, from the utility's network up to the point of common coupling (interface connection point).

HST Core Systems (Traction Electrification, Overhead Contact System, Automatic Train Control, and Communications) ductbanks, manholes, conduits and cables located within the Authority's right-of-way or from interface connection point shall be designed by the Designer.

9.4.1.1 Ductbanks

For design of underground ductbanks, refer to the *Facility Power and Lighting Systems* chapter, *Communications* chapter, and Standard Specifications.

9.4.1.2 Manholes and Handholes

Standard manhole and handhole sizes shall be used whenever possible. Refer to the *Facility Power and Lighting Systems* chapter, *Communications* chapter, and Standard Specifications for more information.

9.4.2 Fuel Lines

The design and installation of fuel lines (gas and petroleum) to facilities from service main up to the meter is performed by the individual utility companies providing the fuel, unless otherwise indicated in the agreement between the Authority and the utility company.

The size of fuel supply line and the meter shall be based on peak-demand calculations provided by the Designer.

The clearance requirements for the fuel pipe shall be per the requirements of the utility owner (up to the meter) and of this chapter (from the meter to the facilities).

The design and installation fuel lines within Authority's right-of-way shall comply with the requirements of NFPA 30 and local jurisdictional requirements.

The meter for fuel lines shall be in public right-of-way or in a location accessible to the utility company.

Corrosion control measures for fuel pipelines shall be applied in accordance with the following:

- Federal Safety Standards for Gas Lines, Title 49 CFR, Part 192
- Section 9.5.6.4 of this chapter on Cathodic Protection and Corrosion Control
- The utility company standards and practice

9.4.3 Water

Fire and domestic (potable and non-potable) water service connections shall be designed by the Designer and installed by the Contractor. The size of the domestic connection and meter shall be based upon a peak-demand pressure-loss calculation. The domestic service meter shall be located in public right-of-way or in a location accessible to the utility company and shall meet the requirements of the water company providing the water meter.

Fire flow and pressure data in the existing water main will be furnished by the municipal agency in consultation with the Fire Marshal having jurisdiction. Unless otherwise specified, the fire service in public right-of-way and domestic services up to the Authority's right-of-way and including the meter is installed by the utility. Location of fire hydrants within the Authority's right-of-way shall be coordinated with and approved by the Fire Marshal having jurisdiction of the site. For standpipe design and installation within passenger station areas and HST tunnels, refer to the *Fire Protection* chapter.

9.4.4 Sewer

Sewer services shall meet the requirements of the Sanitary Sewer District and the appropriate municipal building code. The Designer shall be responsible for sizing and establishing the slope of the sewer services, however, the minimum allowable diameter for a sanitary sewer shall be 8

inches with a minimum slope of 0.7 percent. Location of sanitary sewer manholes shall be accessible to maintenance staff.

9.4.5 Public Telephones

Conduits and wiring for public telephones in passenger stations and parking lots, from the telephone service points to each public telephone location, shall be designed by the Designer and installed by the Contractor. The location and elevation of the conduit stub at the property line shall be indicated on the plans. Unless otherwise specified in the agreement between the Authority and the public telephone service provider, the design and installation of conduits and wirings from telephone distribution network to the Authority's right-of-way will be performed by the public telephone service provider and the portion within the Authority's right-of-way shall be performed by the Contractor. Public telephones are installed by the telephone company or the service provider. All public telephone service provider conduits and cables shall be terminated at the Entrance Facility Room at each passenger station, building, or facility as described in the *Communications* chapter. Also, refer to the *Stations* chapter for general location, quantity, and description of public phones in passenger station areas.

9.4.6 Service Connections to HST Utilities

Utility service connections to utilities and supporting facilities that lie outside of structures, such as traction power substations, train control houses, etc., shall be shown on the utilities plans. The Designer shall coordinate the service connections with other items of work. The Designer shall ensure that service connections are indicated on its plans and plans for the adjacent construction contracts.

For utility service connections, the Designer is responsible for design of utility service lines from the interface point (i.e., a manhole or a meter) to HST facilities. The utility owner is responsible for design and construction of the utility service through the interface point unless otherwise stated in a utility agreement.

9.5 Third Party Utilities

Third party utilities are defined as utilities and supporting facilities belonging to governmental agencies, public utility corporations, railroads, privately owned companies, and private parties for the provision of sewer, water, drainage, gas, electrical, steam, telephone, cable TV, petroleum product pipelines, fiber optics, and other communications systems. Third party utilities are mainly transmission lines, distribution lines, and the service connections to adjacent properties that are not related to HST operations.

Third party utilities to be relocated, abandoned, or protected in place during construction, whether done by the Contractor or the utility owner, shall be addressed in the construction documents.

- The utility will be located in such a manner that it can be serviced, maintained, and operated without being accessed from within the Authority's right-of-way and will not adversely affect safety or cause damage to HST system and supporting facilities.

9.5.3.1 Longitudinal Encroachments

Existing Utility Longitudinal Encroachments – Longitudinal utility encroachments within the Authority's right-of-way shall be considered on a case-by-case basis.

Existing longitudinal utilities located within the existing or proposed Authority's right-of-way shall be relocated to the outside of the Authority's right-of-way unless it can be shown to meet the encroachment justification requirements noted above.

New Utility Longitudinal Encroachments – New third party utilities are not be permitted to be installed longitudinally within access controlled areas. Deviation from this requirement requires Authority's approval.

9.5.3.2 Transverse Encroachments

New utility installations and adjustments or relocation of existing utilities may be permitted to cross the Authority's right-of-way.

To the extent feasible and practicable, they should cross on a line generally normal to, but not less than 60 degrees from the railroad longitudinal alignment.

Transverse crossings that are at less than 60 degrees from the railroad longitudinal alignment shall be classified as a longitudinal encroachment.

Transverse utility encroachments shall comply with the encroachment justification requirements noted above.

With the exception of HV transmission lines and the utilities that can be placed in roadway structures or independent utility bridge structure with a solid surface going over Authority's right-of-way, all utility transverse crossings shall be undergrounded. Refer to the *Overhead Contact System and Traction Power Return System* chapter for HV clearance requirements over HST OCS facilities.

Air space leases for wireless communications facilities fall under the general guideline for transverse encroachments and are to be reviewed by and concurred with the Authority which may develop special guidelines for wireless communication facilities.

9.5.4 Rearrangement

To the extent that is reasonable and feasible, proposed third party utilities shall be located outside the Authority's right-of-way. The location, design, and construction of relocated or proposed utilities shall meet the requirements of CPUC GOs and the provisions of this chapter.

All utilities and supporting facilities within the construction area shall be positively located within 0.5 feet for both horizontal and vertical location. For transverse utilities and supporting facilities, the positive location should be made on either side of the trackway and other critical locations. For longitudinal utilities and supporting facilities, the locations shall be done at intervals sufficient to establish the location of the line but in no event at greater than 100-foot intervals. Machine excavation to expose the High Risk or Low Risk utilities and supporting facilities in order to physically locate them shall be done by, or at the authorization of, the utility/facility owner.

9.5.4.4 Level of Service and Service Interruptions

A level of service equivalent to the existing service shall be maintained for adjacent properties, residents, and businesses throughout construction by supporting utilities in place, diverting utilities, or providing alternative temporary utilities and supporting facilities.

Interruption of existing utilities service shall be minimized. Service shall not be interrupted without the prior written consent of utility owners.

9.5.4.5 Placement

Pipes shall be designed to support dead loads imposed by earth, subbase, pavement, ballast, structures, track, and dynamic forces exerted by anticipated train loads when the pipe is operated with the design range of internal pressure from maximum to zero.

Utility lines crossing beneath at-grade trackway shall conform to the Pipelines section of the AREMA Manual for Railway Engineering, except as modified in these criteria, and the following:

- Casing pipes shall be provided for all utility carrier pipes crossing trackway and structure foundations and buildings.
- Electrical ducts, telephone, and fiber optic conduits in ducts may not require casing pipe where the ducts are encased in concrete and the strength of the utility facility is capable of withstanding rail system loading. Refer to the *Structures* chapter for rail system loading requirements.
- Where new trackways are constructed over existing utilities that are not in conflict with the construction and operations of the HST Core Systems conduits and existing utilities to be continued in service, the utility facilities shall be uncovered and encased in accordance with this Design Criteria.
- Utilities shall not be placed in any manner or position which may cause damage to or impair the safety of the HST Core Systems conduits.
- Utilities shall not be placed within culverts and/or under waterway crossings.
- Where a utility crosses a HST utility within the Authority's right-of-way, the HST utility shall be maintained above the third party utility.

When utility and supporting facility rearrangement are designed by the utility or facility owner, the Designer shall coordinate and furnish data so that the owner may complete its design in a timely fashion. The Designer shall review the facility owner's proposal to ensure that it is compatible with the HST Core Systems conduit design and that of other affected owners. The Designer shall include such arrangement as facility alignments on its plans and shall provide appropriate copies for distribution to affected facility owners.

9.5.4.6 Carrier Pipes

For non-flammable substances, the carrier pipe and joints within the Authority's right-of-way shall be of acceptable material and construction per AREMA requirements. Joints for carrier pipe operating under pressure shall be mechanical or welded per AREMA and ASTM requirements. Resilient type joints shall be used where the combination of fill height and foundation soil compressibility could adversely affect the permanence and watertightness of rigid type joints.

For flammable substances, the carrier pipe that has to be relocated or replaced within the Authority's right-of-way shall be designed, installed, and tested in accordance with the current standards of the utility owner and the following:

- Title 49 CFR Part 192 "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards", Part 193 "Liquefied Natural Gas Facilities: Federal Safety Standards", and Part 195 "Transportation of Hazardous Liquids by Pipeline"
- California Government Codes, Section 51010–51019.1
- ASME B31.8 "Gas Transmission and Distribution Piping Systems" and ASME B31.4 "Liquid Transportation System for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols"
- "API Recommended Practice (RP 1102) Steel Pipeline Crossing Railroads and Highways"
- CPUC GO No. 112-E "Rules Governing Design, Construction, Testing, Operation, and Maintenance of Gas Gathering, Transmission, and Distribution Piping Systems" except that allowable stresses for the design of steel pipe shall conform to AREMA requirements
- Steel carrier pipes shall be protectively coated and provided with a cathodic protection system and test monitoring facilities in conformance with the requirements of this chapter and the *Corrosion Control* chapter.
- Pipelines carrying flammable gas products shall, where practicable, cross any portion of the HST Core Systems conduits where tracks are carried on an embankment.
- Liquid-petroleum lines in proximity or crossing underground structures shall also conform to the requirements of NFPA 30.
- Steel natural gas pipeline facilities crossing under Authority's right-of-way may be uncased provided that they meet the following requirements:

- Design and installation of the pipeline shall be in accordance with the AREMA requirements for uncased natural gas pipeline crossing

- Inspection and maintenance of natural gas pipeline shall be performed by the gas company without entering the Authority's right-of-way

- Sectionalizing valves for natural gas pipeline shall be installed and maintained in accordance with 49 CFR Part 192 and shall be activated to shut off the flow of gas across the Authority's right-of-way in case of emergency

- In case of a gas leak, the pipeline under Authority's right-of-way shall be abandoned in place with the requirements of the Authority and a new pipeline be installed

9.5.4.7 Casings

Underground utilities and supporting facilities located within the Authority's access controlled right-of-way shall be encased. Casings are required to protect HST safe operation and facilitate maintenance of utilities crossing under Authority's access restricted right-of-way without the need to enter Authority's right-of-way.

- Casings shall consist of steel, corrugated steel, ductile iron, or reinforced concrete pipe in accordance with the latest industry codes and standards, AREMA requirements, and the requirements specified below.
- Steel casings shall be 3/8 inch minimum thickness with welded joints.
- Electrical and communication lines can be installed in non-metallic casing.
- Casing pipes and joints shall be watertight and shall be capable of withstanding train loading as specified in the *Structures* chapter.
- Casings shall be sloped to drain.
- Casings shall be protected against corrosion by using corrosion resistant casing material and interior and exterior protective coatings, or other approved methods in conformance with the requirements of this chapter and the *Corrosion Control* chapter. Care shall be taken to select materials which will not be damaged through contact with dissimilar metal.
- Casings shall be cathodically protected per the requirements of this chapter and the requirements of the utility owners.
- Metallic casings shall be grounded and bonded in conformance with the requirements of the *Grounding and Bonding Requirements* chapter.
- Steel casing pipe shall have a minimum yield strength of 35,000 psi. Wall thickness for steel casing pipe shall conform to AREMA requirements for steel casing pipe for E80 loading.

- Ductile iron pipe may be used for a casing provided the method of installation is by open trench. Ductile iron pipe shall conform to ANSI/AWWA C151/A21.51 "Ductile-Iron Pipe, Centrifugally Cast". The pipe shall be of the mechanical-joint type or plain-end pipe with compression-type couplings.
  - For non-flammable substances the strength of ductile iron pipe shall be computed in accordance with ANSI/AWWA C150/A21.50 "Thickness Design of Ductile-Iron Pipe", to sustain external loads.
  - For flammable substances ductile iron pipe shall conform to ANSI/AWWA C151/A21.51 "Ductile-Iron Pipe, Centrifugally Cast".
- Reinforced concrete pipe, with gasketed watertight joints, can be used for a casing pipe for non-pressurized utilities.
- The inside diameter of the casing pipe shall be sized to allow the carrier pipe to be removed subsequently without disturbing the casing pipe or trackway. All joints or couplings, supports, insulators, and centering devices for the carrier pipe within a casing shall be taken into account. In no case shall the casing pipe be sized smaller than the following:
  - The inside diameter of the casing pipe shall be at least 4 inches greater than the largest outside diameter of the carrier pipe, joints and couplings.
  - The minimum size of a casing pipe shall not be less than 24 inches.
- Casing pipe shall extend beyond the Authority's right-of-way to a sufficient distance to allow for access to the casing by open excavation. The minimum distance outside the right-of-way shall be 3 feet plus the distance between the bottom of the casing and top of finished grade at the right-of-way line, measured at the right angle to the right-of-way. For flammable utilities, the extent of casing shall not be less than 45 feet from the track centerline, measured at the right angle to the track centerline.
- Where the ends of the casing are below ground, they shall be properly protected against the entrance of foreign material, but shall not be tightly sealed.
- Where the ends of the casing are at or above ground surface and above high-water level, they may be left open provided drainage is afforded in such a manner that leakage will be conducted away from the tracks or structures.
- CPUC GO No. 128, "Rules for Construction of Underground Electrical Supply and Communication Systems" shall govern for all pertinent applications.
- Casings carrying fluids and gases shall be properly vented. Vent pipes shall be of sufficient diameter, but in no case less than 2 inches in diameter, projecting through the ground surface beyond the Authority's right-of-way line. Vent pipes shall extend no less than 4 feet above the ground surface. Top of vent pipes shall be fitted with a down-turned elbow, properly screened.

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9.5.5 Utility Clearances

The minimum requirements for utility clearances shall be as defined by the CPUC GOs as applicable, Caltrans HDM and PDPM, AREMA, utility owner's requirements, and these Design Criteria. These requirements apply to HST Core Systems related facilities as well as those owned by others.

In addition, High Risk and Low Risk utilities shall comply with the following requirements:

- High Risk Utilities
  - Maintain 500 feet minimum horizontal separation from flammable gas or hazardous liquid utility to other High Risk utilities
  - Maintain 50 feet minimum horizontal separation from non-flammable gas or hazardous liquid utility to other High Risk utilities
  - Maintain 5 feet minimum horizontal separation from Low Risk utilities
  - Maintain 20 feet minimum horizontal separation from non-load carrying and load carrying structural elements, including OCS pole foundations and downguys
  - Maintain 3 feet minimum vertical separation from drainage pipes/structures
- Low Risk Utilities
  - Maintain 3 feet minimum horizontal separation from other Low Risk utilities
  - Maintain 5 feet minimum horizontal separation from load carrying structural elements, including OCS pole foundations and downguys, and 3-foot minimum horizontal separation from other structures
  - Maintain 3 feet minimum vertical separation from drainage pipes

The above clearances are minimum requirements. The Designer shall verify the adequacy of these standards.

Electrical and communication lines within the Authority's right-of-way shall comply with the above requirements except that a concrete encased ductbank can be used in lieu of steel casing pipe. All underground electrical utilities and supporting facilities within the planned construction area shall meet the minimum clearance requirements as defined in CPUC GOs.

9.5.5.1 Underground Utilities within At-Grade Section

Where a portion of the utility line crosses under HST right-of-way, the utility shall be encased. The casing under the track shall be a minimum of 6 feet below top of rail and a minimum of 3 feet below the flow line of the ditch or drainage pipe next to the track. Refer to Standard and Directive Drawings for utility clearance requirements. Casing shall be provided for utilities

located outside HST right-of-way but within the zone of train loading influence or if the future utility maintenance requires excavation that can impact the integrity of HST infrastructure.

Casing pipes shall not be placed within the limits of prepared subgrade unless the backfill material for the culvert and its compaction meet the requirements of prepared subgrade, refer to the *Geotechnical* chapter for limits of prepared subgrade, material, and compaction requirements. Casing pipes shall not be less than 6 feet below top of rail and at the closest point. Deeper installations may be required to avoid conflicts with the HST Core Systems under track conduits and buried facilities. Casing for flammable gas or hazardous liquid utility pipe shall be a minimum of 10 feet below top of rail.

Where the casing is not directly beneath the trackbed, the depth of ground cover shall not be less than 4 feet. A 6-inch-thick layer of reinforced red concrete shall be placed over the casing pipe if 3 feet of ground cover cannot be provided between top of casing pipe and bottom of ditch.

Utilities that cannot be relocated underground shall be located on an independent utility bridge structure, encased, and appropriately protected from 25 kV Electrification System. The independent utility bridge structure shall meet the following requirements:

- Have a solid surface to prevent casings from falling off the bridge and provide walking surface for inspection
- Constructed independent of the HST infrastructure for its intended use and maintained in accordance with recognized industry standards
- Be part of utility owner's system and hence included in owner's inspection and maintenance plan. However, the inspection and maintenance of the utility bridge and the utility crossing Authority's right-of-way shall be limited to non-operating hours of HST
- Have warning signs be installed per the regulatory requirements
- Be grounded and bonded in accordance with the *Grounding and Bonding Requirements* chapter
- Meet the clearances requirements of the *Trackway Clearances* chapter

9.5.5.2 Underground Utilities within HST Core Systems Facility Sites

Utilities located within the HST Core Systems facility sites, such as traction power facility and Stand Alone Radio Sites, shall be relocated outside of the Authority's right-of-way.

9.5.5.3 Underground Utilities within Authority's Roadways and Parking Lots

Underground utilities within roadways and parking areas shall have a minimum of 3 feet cover over casings. Additional cover shall be provided where necessary to comply with the utility owner's standards.

9.5.5.4 Underground Utilities within HST Aerial Structure Section

Underground utilities within 5 feet of a HST pier or abutment foundation shall be relocated in accordance with the requirements of this chapter and the utility owner's clearance requirements. Existing utilities that do not need to be relocated shall be encased in accordance with the requirements of this chapter with the following exceptions:

- Where utilities are within a jurisdictional authority's roadway or railroad's right-of-way
- Casings do not need to be designed per Cooper E-80 loading requirements but are subject to site specific loading requirements.

Access manholes to utilities shall be relocated outside Authority's right-of-way unless such manholes are located within roadways or access roads of other jurisdictional authorities.

Designer shall submit a utility protection and monitoring plan for utilities within the zone of influence of excavation limits to the utility owner for review and approval.

9.5.5.5 Underground Utilities within HST Trench Section

Where a trench section is 8 feet or less from the original ground, the utilities shall cross under trench sections in casing and top of casing shall be a minimum of 8 feet below top of rail.

Where a trench section is deeper than 8 feet, utilities shall cross over the trench section in an independent utility bridge structure that spans the entire width of trench section. The minimum clearance from the bottom of utility bridge structure shall be per requirements of the *Trackway Clearances* chapter and the Standard and Directive Drawings for trench sections.

In all other cases, the utility shall be relocated so that the utility crossing is outside the trench limits.

9.5.5.6 Underground Utilities within HST Tunnel Section

For utility clearance requirements within a tunnel section, refer to Standard and Directive Drawings for tunnel sections.

9.5.5.7 Overhead Utilities

Overhead utilities shall cross the tracks at public roadway, or highway overpasses. Such utilities shall be contained within the overpass structure such that in case of failure the overhead lines fall on the roadway structure or inside a casing embedded in the overpass structure. The casing shall be per the requirements of this chapter and shall be grounded and bonded in accordance with the *Grounding and Bonding Requirements* chapter. Where electrical lines with voltage less

than 25 kV and communication lines cannot be accommodated in an overpass structure, they shall be relocated underground per clearance requirements established in this chapter.

Clearances for overhead electrical lines with voltage higher than 25 kV shall be governed by CPUC GO No. 95 "Overhead Electric Line Construction" or National Electrical Safety Code (ANSI C2/NESC) wire to wire clearance requirements, whichever is more stringent. Design and construction of overhead electrical lines shall also comply with the requirements of CPUC GO No. 176.

9.5.5.8 Aboveground Utility Facilities

All above ground utilities shall be moved outside the Authority's right-of-way or conform to the requirements of Sections 9.5.5.1 to 9.5.5.5.

9.5.6 Safety and Protection Measures

The Designer shall support the Authority in preparation of emergency response access and procedures to handle a situation in which a pipeline leak or railroad derailment or incident may jeopardize the integrity of the pipeline. Local conditions shall be considered when developing these procedures. Refer to the *System Safety and Security* chapter for guidelines.

9.5.6.1 Call Before You Dig

The Designer shall include in its plans the instruction to contact Underground Service Alert and other railroad owners, such as Union Pacific Railroads' "Call Before You Dig" requirements, within the railroad's right-of-way prior to any excavation.

9.5.6.2 Shut-off Valves

Accessible emergency shut-off valve(s) shall be located as close to the Authority's right-of-way as practicable and as mutually agreed to by the Designer, the Authority, and the utility owner. These valves shall be marked with signs for identification. Where there are existing automatic control shut-off valve stations at locations and within distances acceptable to the Authority, additional valves may not be required. Valves shall not be located within the Authority's right-of-way.

9.5.6.3 Utility Markers

Utility markers shall be placed at points where the centerline of the utilities intersects the boundaries of the right-of-way line as they enter and exit the Authority's right-of-way.

Markers shall identify each utility, its owner, HST milepost, and depth. Markers shall consist of a metal target plate with reflective background mounted on a metal post.

The front face of the target plate shall be marked as indicated in Standard and Directive Drawings for wayside signage and graphics or as required by the utility owner with the

- Earthen or soil supporting structures removed from HST track, such as retaining walls, embankments, cut and existing slopes, and reinforced earth structure, where potential damage would not affect HST track or service.

Secondary structures owned by the Authority shall be subject to the seismic criteria in this chapter.

Secondary structures owned by Third Parties shall be subject to the seismic criteria of the governing local jurisdiction.

For retrofit of existing Secondary structures, see Section 11.5.3.

11.4.2 Technical Classification

Structures shall be technically classified, in order to determine the scope of seismic design requirements.

Complex Structures – Structures that have complex response during seismic events are considered Complex. Complex structural features include:

- Irregular Geometry – Structures that include multiple superstructure levels, variable width or bifurcating superstructures, tight horizontal curves (inside radius of curvature < 400 feet), large subtended horizontal angles (angle > 30°), or adjacent frames with corresponding transverse or longitudinal fundamental periods of vibration varying by greater than 25%.
- Unusual Framing – Structures with straddle, outrigger, or C-bent supports, or unbalanced mass and stiffness distribution not complying with CSDC's balanced stiffness and balanced frame geometry requirements.
- Short Columns – Structures with concrete columns having a ratio of clear height to greatest cross sectional dimension (H/D) less than 2.5. The clear height (H) is the visible length of column above grade and shall not include any embedded portion. The clear height (H) may be increased by the use of isolation casings extending below grade, provided that the casings allow access for column inspection.
- Pier Walls – Structures consisting of a wall on a footing or piles having a ratio of clear height to maximum wall width (H/W) less than 2.5. This is not applicable to seat type abutments with sacrificial transverse shear keys, refer to Section 11.7.5.9.
- Tall Columns – Structures with concrete columns having a ratio of clear height to least cross sectional dimension (H/D) > 10 in single curvature, or > 15 in double curvature.
- Long Span Structures – Structures that have spans greater than 300 feet.
- Skewed Structures – Primary Type 1 Structures with skewed bents or abutments > 15 degrees. Primary Type 2 or Secondary Structures with skewed bents or abutments > 30 degrees.

12 Structures

12.1 Scope

This chapter provides design criteria for Primary Type 1, Primary Type 2 and Secondary structures supporting California High-Speed Train (HST) service including but not limited to bridges, aerial structures, grade separations, earth retaining structures, cut-and-cover underground structures, station structures, surface facilities and buildings.

12.2 Regulations, Codes, Standards, and Guidelines

Refer to the *General* chapter for requirements pertaining to regulations, codes, and standards. Design shall meet applicable portions of the general laws and regulations of the State of California and of respective local authorities.

The provisions within this chapter shall govern structural design. The following current documents are either referenced by this chapter, or shall be considered as guidelines when sufficient criteria are not provided by this chapter.

American Concrete Institute (ACI)

- ACI 318: Building Code Requirements for Structural Concrete
- ACI 350: Code Requirements for Environmental Engineering Concrete Structures and Commentary

- American Welding Society (AWS)
  - AWS D1.1/D1.1M: Structural Welding Code-Steel
  - AWS D1.8/D1.8M: Structural Welding Code-Seismic Supplement
- American Association of State Highway and Transportation Officials (AASHTO)
  - AASHTO/AWS D1.5M/D1.5: Bridge Welding Code
  - AASHTO Guide Specifications for LRFD Seismic Bridge Design
  - AASHTO Guide Specifications for Seismic Isolation Design
  - AASHTO LRFD Bridge Construction Specifications
  - AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges
- California Building Code (CBC)

be considered to have a nonstandard fastener configuration (NSFC). These structures require an approved design variance and special RSI analysis per Section 12.6.8.6.

For TSI-critical structures that do not meet the uniformity criteria, the structure shall be considered to have a non-uniform fastener configuration (NUFC). These structures require an approved design variance and a special RSI analysis per Section 12.6.8.6.

The total number of longitudinal bi-linear coupling springs per each span shall not be less than 10 and the spacing between the springs shall not be more than 10 feet.

For vertical and lateral (i.e., transverse) stiffness of fasteners, defined as per foot of track (pair of rails) the following properties shall be used as applicable:

- Non-ballasted track:
  - Vertical compressive stiffness: 4100 k/ft per foot of track
  - Vertical tensile (uplift) stiffness: 75 to 4100 k/ft per foot of track
  - Lateral Stiffness: 420 k/ft per foot of track
- Ballasted track:
  - Vertical compressive stiffness: 2100 k/ft per foot of track
  - Vertical tensile (uplift) stiffness: 2.8 k/ft to 2100 k/ft per foot of track
  - Lateral Stiffness: 420 k/ft per foot of track

In accordance with above, assumed vertical fastener stiffness (compression and tension) as well as assumed lateral fastener stiffness shall be shown on the plans.

As a means to meet RSI criteria per Section 12.6.5, the Contractor may propose alternative track solutions (e.g., NSFC, NUFC, Rail Expansion Joints) through the design variance approval process. The design variance shall be supplemented with a special RSI analysis per Section 12.6.8.6.

12.6.8.6 Special Rail-Structure Interaction Analysis

RSI limits in Section 12.6.5are developed considering typical fastener configurations on typical structures. For those systems that do not meet these assumptions, new limits shall be developed using a refined analysis.

A special RSI analysis shall be required for those structure and track designs requiring a design variance related to Section 12.6.5. Specific design variances requiring special RSI analysis include, but are not limited to: designs requiring nonstandard fastener configurations (NSFC), non-uniform fastener configurations (NUFC), structures with thermal units (L_{TU}) greater than 330 feet, and rail expansion joints (REJs).

The Contractor shall identify and document structure types requiring special RSI analysis as part of the Type Selection process described in Section 12.8.1.1. After completion of Type

accessible areas, as well as grounding and bonding of the track structure (where appropriate), shall be designed to avoid inadmissible touch and step voltages and also to meet the requirements of the signaling system.

22.5.4 Aerial Structures (Viaducts and Underbridges)

22.5.4.1 Concrete Structures

For concrete aerial structures, over which the high-speed trains travel, the following criteria shall apply. The static wire shall be electrically grounded through all aerial structure columns and abutments. The ground resistance from any grounding plate installed in concrete aerial structures shall be 25 ohms or less. The reinforcement steel within the individual concrete elements comprising a concrete aerial structure, including parapet walls, shall be bonded together to achieve an equipotential structure. A sufficient number of reinforcement bars shall be bonded together to create a 4/0 AWG copper equivalent electrical path for each grounding circuit. Jumpers, both internal between rebar and grounding plates and external between grounding plates, shall be a minimum size of 4/0 AWG copper, but alternate materials of equivalent electrical capacity may be adopted. Jumpers shall be flexible and shall be of sufficient length to accommodate structure movements. Appropriate measures shall be adopted where dissimilar metals are interconnected. Surface-mounted grounding plates shall be a minimum of 6 inches x 6 inches in size and shall have 4/0 AWG copper equivalent electrical capacity, shall resist corrosion and staining of the concrete structures and accommodate exothermic welding of the copper jumpers. Structural grounding and bonding equipment shall be designed to meet the design life of the structure in which it is embedded.

Concrete Columns, and Abutments and Foundations

The reinforcement steel in all column foundations and abutment foundations shall be electrically connected to the reinforcement steel in the columns and abutments, respectively. For abutments, an exothermically welded 4/0 AWG copper jumper shall connect the abutment reinforcement to a surface-mounted grounding plate near the top and bottom of the abutment to provide a minimum of 4 grounding plates per abutment. For columns, an exothermically welded 4/0 AWG copper jumper shall connect the column reinforcement to a surface-mounted grounding plate near the top and bottom of, and on transverse faces of, the column to provide a minimum of 4 grounding plates per column.

Concrete Superstructure Units

A “superstructure unit” is defined as a singular, horizontally-installed, reinforced concrete structure of any length that is supported by one or more columns and/or abutments. The reinforcement steel in concrete aerial superstructure unit shall be electrically interconnected and similarly jumper-connected to surface-mounted grounding plates on both sides of and near the bottom of the superstructure unit, such that an external jumper can be installed to electrically connect the superstructure grounding plates to the grounding plates at the top of each supporting column and abutment. The number and location of the superstructure unit surface-

mounted grounding plates shall be coordinated and aligned with the grounding plate locations on supporting columns and abutments – refer to Overhead Contact System Directive Drawings.

For superstructure units that are 150 feet or less in length, grounding plates that are electrically bonded to the reinforcing steel shall be installed at or close to the midpoint of each superstructure unit on the surface of the deck slab near both trackside cable trough walls and on the surface of both parapet walls for connection to the track slab grounding plates. The parapet grounding plates shall be used for exothermically welded grounding connections to the OCS poles and to other systems elements, such as ATC and communications cubicles or houses, and wayside power control cubicles, and shall be sized to accommodate not less than 4 separately-installed exothermically welded jumpers. For superstructure units that are more than 150 feet in length, additional grounding plates shall be installed such that the along-track spacing between deck-slab and parapet plates is a maximum of 150 feet.

22.5.4.2 Steel Structures

For steel girder structures, over which the high-speed trains run, the static wire shall be electrically grounded by means of jumpers with bolted lug connections to the OCS pole baseplates and exothermic weld connections to the grounding plates on the structure columns and/or abutments. The steel bridge girders shall be interconnected at the “fixed ends” with exothermically welded flexible bonds (sized as indicated above), which shall be connected to the reinforcement steel (within the bridge piers or abutments) at 2 grounding plates, each with a ground resistance of 25 ohms or less, similar to the requirements indicated above for the concrete structures. To provide electrical continuity at the “sliding end’, the 2 outer girders shall each be connected by an exothermically welded flexible jumper (of sufficient length to allow for expansion and contraction of the girders and sized as indicated above) to a grounding plate that is connected to the reinforcement steel (within the bridge pier or abutment). Where non-ballasted track is installed on the steel support structures, flexible jumpers shall be exothermically welded between the track slab grounding plates and the steel support girders.

22.5.5 Track Support Structure

Steel reinforcing bar (rebar) loops in concrete supporting running rails can cause inductive loading or undesired coupling between track circuits. To avoid these adverse effects, all rebar in any structure that is within 1 foot of a CHST running rail shall be grounded in 1 of the following configurations. The Contractor shall determine the most appropriate configuration and shall use the same configuration in all similar applications. Structures to be treated include track slabs, viaduct decks, etc.:

- Long comb – In each affected structure, longitudinal rebars (those parallel to the running rails) are electrically connected in a 'comb' pattern to a single lateral (perpendicular to the running rails) connecting rebar at 1 end only of the longitudinal rebars. The lateral connecting rebar shall be connected to an external connection to the reinforcement that is

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32.4 Goals

The goals of System Safety and Security are to achieve acceptable levels of hazard and security risk resulting in the following:

- Prevention of fatalities or injuries to passengers, employees, emergency responders, and the general public
- Prevention or minimization of damage to infrastructure and interruptions in service
- Protection of people (employees, contractors, emergency responders and passengers) and Authority property (facilities and equipment) from criminal acts

32.5 Hazard and Security Risk Management

32.5.1 Hazard Management

A hazard is a condition or circumstance that could lead to an unplanned or undesired event, which, when it occurs, can cause injury, illness, death, damage or loss of equipment or property, or severe environmental damage.

Hazards shall be managed to an acceptable level of risk in order to provide the Authority with a reasonable assurance that the CHSTS is designed, built, and placed into service in a safe and secure manner. An acceptable level of risk is achieved through the following:

- The identification of hazards that can reasonably be expected to occur during the life-cycle of the CHSTS
- Analyzing the hazards for severity and probability in order to assign a Hazard Risk Index (HRI)
- Application of appropriate mitigations that reduce the HRI to an acceptable level
- Tracking the application of mitigations to ensure that efforts to reduce the HRI to an acceptable level are effective and complete

Detailed procedures for hazard management, including roles and responsibilities of Designers, can be found in the Safety and Security Management Plan (SSMP).

32.5.2 Security Risk Management

Security risk is determined by evaluating potential threats against system vulnerabilities. Threats are defined as specific intentional acts that may damage the system, its facilities, or endanger passengers, employees or the general public. Threats include intentional actions that detract from overall security. These range from terrorist attack and major crime to crimes that

Emergency exit signs shall be provided in buildings per the CBC. Emergency exit signs shall also be provided on aerial structures and bridges, and in trenches and tunnels.

32.18.1.8 Potential Hazard Adjacency

Wind Farms Setback Requirements – Horizontal separation between the center line of the nearest CHSTS track and any wind turbine shall be no less than 1.5 times the overall wind turbine machine height (measured from grade to the top of the structure, including the uppermost extension of any blade).

Oil and Gas Well Setback Requirements – Active oil and gas wells shall be relocated outside the CHSRP right-of-way. Abandoned oil and gas wells located with the CHSRP right-of-way shall be re-abandoned per current State requirements.

Adjacent Trees/Vegetation - Adjacent properties shall be assessed for the presence of large trees or other vegetation that could reasonably have the potential to fall into or otherwise damage the CHSTS right-of-way in the event of a large storm event. Every effort shall be made to work with adjacent landowners to mitigate the effects of identified hazardous trees/vegetation.

Adjacent Structures – Adjacent properties shall be assessed for the presence of buildings and other tall structures that could reasonably have the potential to fall into or otherwise damage the CHSTS right-of-way during an earthquake or other event that compromises the integrity of the structure. Every effort shall be made to work with adjacent landowners to mitigate the effects of identified hazardous structures.

Adjacent Hazardous Materials Facilities - Adjacent properties within 500 feet of the CHSTS right-of-way shall be assessed for the presence of hazardous materials storage, processing, or distribution facilities, as defined by the California Health and Safety Code, Sections 25500-25520. Identified properties shall be analyzed for conditions that could reasonably have the potential to effect the safe operation of the CHSTS trains and every effort shall be made to work with adjacent landowners to mitigate the effects of identified hazardous materials facilities.

Other Adjacent Hazardous Facilities – Other hazardous facilities located adjacent the CHSTS trackway shall be analyzed for their potential to impact the safety or security of the CHSTS.

32.18.2 At Grade Alignments

32.18.2.1 Access Roads

Access from public roadways to the access/egress points shall be made via access roads per the criteria found in the *Civil* chapter. Access roads shall lead directly to the access point for the trackway and be protected from unauthorized use by an access control system. Access roads will continue inside the CHSTS fence line where practicable.

In addition to access/egress stairways at nominal 2.5 mile intervals, alignments with restricted access to the right-of-way through the fence (aerial structures, trench structures) require additional opportunities for emergency access. Access to aerial structures by aerial ladder trucks shall be afforded at nominal 2,500 feet intervals with a maximum interval of 3,000 feet. Access can be made from public roadways, but provision must be made for access through private property where public property access is not available within the required interval distances.

Every effort must be made to design facilities that allow for egress from aerial structures by other than aerial ladder truck.

32.18.6.3 Spaces underneath Elevated Structures

Spaces under elevated structures shall be owned and controlled by the Authority with the following potential exceptions:

- Controlled public spaces, inclusive of Fire or Police Stations or Public Transportation facilities where safety and security measures can be determined to be effective and maintained ; or
- Uncontrolled public spaces that minimize combustible materials, including landscape materials, and provide for the creation of safe spaces appropriate for public gatherings.

In no case shall space underneath elevated structures include hazardous materials, explosives, flammable materials, or other elements that might pose a safety or security risk to the CHSTS operation.

Public structures or activities that are considered for placement under elevated structures shall undergo a site-specific safety and security assessment to ensure that the structure or activity does not increase the risk to the Authority.

Uncontrolled private buildings or spaces will not be allowed under the elevated ROW without review and approval by the Authority.

Requests for waivers to this policy will be considered through a safety and security risk assessment to determine the risk of the specific structure or activity on the operation and assets of the Authority.