

California High-Speed Train System



TECHNICAL MEMORANDUM

Safety and Security Design Requirements for Infrastructure Elements TM 2.8.1

Prepared by: Signed Document on File 15 November 12
John Cockle, System Safety Date

Checked by: Signed Document on File 16 November 12
Pete Loverso, System Security Date

Approved by: Signed Document on File 04 December 12
Joseph Metzler, Operations Manager Date

Released by: Signed Document on File 25 January 13
Brent Felker, PE, Program Director Date

Reviewed by: Signed Document on File 14 January 13
Michael D. Lewis, PE, Project Management Oversight Date

Reviewed by: Signed Document on File 5 February 13
Jon Tapping, Risk Manager. Authority Date

Accepted by: Signed Document on File 6 February 13
Jeffrey Morales, CEO, Authority Date

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System Level Technical and Integration Reviews

The purpose of the review is to ensure:

- Technical consistency and appropriateness
- Check for integration issues and conflicts

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

System Level Technical Reviews by Subsystem:

Systems:	<u>Signed document on file</u> Rick Schmedes	<u>30 November 12</u> Date
Infrastructure:	<u>Signed document on file</u> John Chirco, PE	<u>16 September 12</u> Date
Operations & Maintenance:	<u>Signed document on file</u> Joseph Metzler	<u>20 November 12</u> Date
Regulatory Approvals:	<u>Signed document on file</u> Vladimir Kanevskiy	<u>18 October 12</u> Date
Rolling Stock:	<u>Signed document on file</u> Frank Banko	<u>12 October 12</u> Date
Project Management Oversight:	<u>Signed document on file</u> Michael D. Lewis, PE	<u>09 October 12</u> Date

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ABSTRACT

This technical memorandum identifies basic infrastructure elements necessary to support safe and secure operation of the California High-Speed Train System (CHSTS) to be considered for the Preliminary Engineering for Procurement level of design. High-level safety and security design requirements are identified and reference is made to discipline-specific technical memoranda in which detailed design requirements are found. The high-level design requirements in this technical memorandum shall be in conformance to the detailed design requirements found in the technical memoranda and other source documents.

The principle of Prevention through Design is employed in the hazard management approach taken in the CHSTS so that safety hazards and security vulnerabilities can be identified and mitigated as part of the preliminary design phase rather than as a reaction to hazards and vulnerabilities discovered during the construction or even operational phases. Identification and incorporation of safety and security considerations at an early design stage promotes a cost effective, less obtrusive, more efficient, and ultimately, a more safe and secure design.

Safety and security infrastructure for existing high-speed train systems, conventional passenger rail, other transportation modes, and buildings are considered in developing these infrastructure elements and corresponding guidelines and standards.

The following categories of safety and security infrastructure will be addressed in this technical memorandum to mitigate hazards which may affect the safety of passengers, employees, emergency responders and the general public:

- General design principles and strategies
- Access/egress
- Fire and life safety facilities
- Security facilities
- Access control for public and non-public spaces
- Facilities infrastructure, including tunnels, bridges, platforms, lighting, mechanical, electrical and power, and fire protection
- Hazard detection systems, including monitoring for seismic, climatic, intrusion, detection and security elements

As safety and security issues affect all aspects of the California High-Speed Train System, this document is not intended to be all-inclusive of the detailed design, construction, operation and maintenance requirements for safe and secure high-speed train operations. Rather, this document is intended to serve as a reference to discipline-specific project documents that have been issued or are under development to provide infrastructure design requirements. In order to avoid redundancy, this technical memorandum will describe general safety design requirements but will not duplicate detailed technical information included in the source documents. This document will focus on the identification of the infrastructure elements required to support safety and security requirements defined by Safety, Security, Operations, Engineering, Rolling Stock, Core Systems and other high-speed train subsystems through the development of Preliminary Hazard Analysis (PHA), as well as through the development of the Threat and Vulnerability Assessment.



1.0 INTRODUCTION

1.1 PURPOSE OF TECHNICAL MEMORANDUM

The purpose of this technical memorandum is to describe safety and security design guidelines for infrastructure elements that promote safe and secure high-speed train service. This memorandum presents high-level requirements for the design of the infrastructure elements necessary to support safety and security requirements as defined by Safety, Operations and other high-speed train subsystems through the development of Preliminary Hazard Analysis and Threat/Vulnerability Assessment.

This document is intended to serve as a reference to discipline-specific project documents that have been issued or are under development to provide infrastructure design requirements. In order to avoid redundancy, this technical memorandum will describe general safety and security design requirements but will not duplicate detailed technical information included in the source documents. Reference to the appropriate source document will be made where necessary. Precedence will be to the source document to resolve any conflict arising between this technical memorandum and the source document.

1.2 STATEMENT OF TECHNICAL ISSUE

This document presents design requirements for basic safety and security infrastructure elements in order to advance design so that spatial requirements are considered during the Preliminary Engineering for Procurement level of design. Safety is a principal requirement of the high-speed train project and almost all system components have functional requirements pertaining to safety. This document will reference criteria for the following high-speed train safety and security elements:

- General design principles and strategies
- Access/egress
- Fire and life safety facilities
- Security facilities
- Access control for public and non-public spaces
- Facilities infrastructure, including tunnels, bridges, platforms, lighting, communications, automatic train control (ATC) as it relates directly to infrastructure elements, mechanical, electrical and power, and fire protection
- Hazard detection systems, including monitoring for seismic, climatic, intrusion detection and security elements

While code and safety requirements are cited, actual design will require a thorough code assessment and application.

1.3 GENERAL INFORMATION

1.3.1 Definition of Terms

The following technical terms and acronyms used in this document have specific connotations with regard to California High-Speed Train system.

<u>Accessibility</u>	The ease with which a site or facility may be reached by passengers and others necessary to the facility's intended function. Also, the extent to which a facility is usable by disabled persons.
<u>Alignment</u>	The horizontal and vertical route of a transportation corridor or path.
<u>Americans with</u>	Federal regulation establishing legal requirements for accessibility.



Disabilities Act (ADA)

<u>At Grade</u>	At ground surface level; used to describe roadways, river crossings, and track alignments.
<u>Authority</u>	California High-Speed Rail Authority
<u>Authority Having Jurisdiction</u>	The Office of the State Fire marshal is the Authority Having Jurisdiction for fire and life-safety issues associated with the California High-Speed Train System.
<u>Design Guidelines</u>	Provide a preferred but not necessarily required direction for a particular design feature.
<u>Design Standards</u>	Uniform criteria, methods, processes and practices developed by a regulatory body, agency, industry association, or organizations, such as trade unions and trade associations, or other professional affiliations, that represent accepted requirements or a benchmark to measure against.
<u>Grade-Separated High-Speed Train</u>	At different elevations; on separate levels. Refers to a train designed to operate safely and reliably at 220 mph.
<u>Platform</u>	Station area adjacent to tracks where trains stop to allow passengers to board and alight.
<u>Safety</u>	The control of recognized hazards to achieve an acceptable level of risk.
<u>Security</u>	The systematic approach to asset protection that reduces the risk of loss resulting from adverse events (sabotage, malicious destruction, theft of assets, conflict of interest, and workplace violence).
<u>Traction Power Facilities</u>	All wayside facilities that support the traction power system, including substations, switching stations, and paralleling stations. This does not include utility facilities not directly under the control and responsibility of the Authority
<u>Trainway</u>	The area along the CHSTS alignment within the access control fencing.

Acronyms

ADA	Americans with Disabilities Act (ADA)
AHJ	Authority Having Jurisdiction
AREMA	American Railway Engineering and Maintenance-of-Way Association
ATC	Automatic Train Control
CBC	California Building Code
CCR	California Code of Regulations
CCTV	Closed Circuit Television
CENELEC	European Committee for Electrotechnical Standardization
CFR	Code of Federal Regulations
CHSTS	California High-Speed Train System



CISN	California Integrated Seismic Network
CPTED	Crime Prevention through Environmental Design
CPUC	California Public Utilities Commission
DHS	Department of Homeland Security
DSA	Division of the State Architect
EEW	Earthquake Early Warning
EMT	Engineering Management Team
EN	European Norm (Standard)
FRA	Federal Railroad Administration
GO	General Order
HVAC	Heating, Ventilation and Air Conditioning
HST	High-Speed Train
ICP	Incident Command Post
IESNA	Illuminating Engineering Society of North America
NFPA	National Fire Protection Association
OCC	Operations Control Center
OCS	Overhead Contact System
OSFM	Office of the State Fire Marshal
PHA	Preliminary Hazard Analysis
PtD	Prevention through Design
RCC	Regional Control Center
SSHA	Site-Specific Hazard Analysis
SSMP	Safety and Security Management Plan
SR	System Requirement
TM	Technical Memorandum
TSA	Transportation Security Administration
TVA	Threat and Vulnerability Assessment



2.0 DESIGN STANDARDS AND GUIDELINES

2.1 GENERAL

This document provides initial requirements on safety and security elements to be provided in the design of high-speed train infrastructure for the Preliminary Engineering for Procurement level of design. It is based on currently available information on other rail transportation services and common standards. Where available, this information is based on current international, Federal, State and transit industry standards, guidelines and best practices.

2.2 LAWS AND CODES

This technical memorandum presents design standards and guidelines specifically for the construction and operation of a high-speed railroad based on international best practices and applicable state and federal requirements. The Federal Railroad Administration (FRA) has issued safety regulations for the operation of trains up to 150 mph, and is developing further regulations for operation of trains at even higher speeds. Criteria for design elements not specific to high-speed train operations will be governed by existing applicable codes, regulations, design standards and guidelines.

The Department of Homeland Security (DHS) and the Transportation Security Administration (TSA) have provided guidance but no regulations regarding the security of a high-speed rail system.

The CHSTS design standards and guidelines may differ from local jurisdictions' codes and standards. Because the Authority is an agency of the State government, development of buildings within the state's right-of-way shall fall under the jurisdiction of the Division of the State Architect (DSA) and the Office of the State Fire Marshall (OSFM) along with input and coordination with local jurisdictions. Although state agency projects are not subject to local city or county codes, the high-speed train system will connect with other passenger rail and transit services, as well as with the communities surrounding the station areas, and therefore will require integration. In the case of such connections, consideration of local codes and other transit guidance will be appropriate. In the case of differing standards for work outside of the state-owned right-of-way, conflicts in design requirements will be resolved by using the higher standard or that deemed to be the most appropriate by the California High-Speed Rail Authority (Authority). The standard required for securing regulatory approval will be followed. In addition to the Division of the State Architect and the Office of the State Fire Marshall, approvals may also be required from the Army Corps of Engineers, California Coastal Commission, Caltrans, and other agencies and authorities at specific locations. Local emergency response agencies shall provide their input to the Final Design through their respective Fire and Life Safety and Security Committee, but the Office of the State Fire Marshal is the authority having jurisdiction.

Applicable codes, rules, standards and guidelines may include but are not limited to:

- 49 CFR Parts 200-299 Federal Railroad Administration Regulations
- 49 CFR Parts 27, 37 and 38 *Transportation for Individuals with Disabilities at Intercity, Commuter, and High-Speed Passenger Railroad Station Platforms*
- ADAAG: ADA Guidelines for Buildings and Facilities
- ANSI 117.1 – Accessible and Usable Buildings and Facilities Standards
- ANSI Z590.3-2011: *Prevention Through Design, Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes*
- CCR Title 8, *Division of Occupational Safety and Health Regulations*
- CCR Title 24, Part 2 *California Building Code 2010*



- CCR Title 24, Part 9 *California Fire Code 2010 Based on the 2009 International Fire Code*
- CCR Title 24, Part 433 *Fixed Guideway Transit Systems (Stations)*
- California Public Utilities Commission General Orders (CPUC GO)
- EN 50126-1 *Railway applications – The specification and demonstration of Reliability, Availability, Maintainability, and Safety (RAMS)*
- NFPA 101: *Life Safety Code*, 2012 Edition
- NFPA 130: *Standard for Fixed Guideway Transit and Passenger Rail Systems*, 2010 Edition
- The Manual for Railway Engineering of the American Railway Engineering and Maintenance-of-Way Association (AREMA Manual)
- Technical Specifications for Interoperability for the Trans-European Transport Network

2.3 APPLICABILITY TO CODE OF FEDERAL REGULATIONS

The Federal Railroad Administration (FRA) regulates the operations of railroads in the United States through the development and enforcement of 49 CFR Parts 200-299. Current track safety standards (49 CFR Part 213), train control safety standards (49 CFR 236), and equipment safety standards (49 CFR Part 238) allow for the operation of trains, under certain conditions, up to a speed of 150 mph. The FRA is developing regulations specific to the operation of high-speed trains; until such time as these regulations are developed, the Program Management Team is working closely with the FRA to identify appropriate system requirements through the development of a *CHSTS Guidance Document of Required Safety Elements*. This resulting technical memorandum (2.8.1) conforms to the *CHSTS Guidance Document of Required Safety Elements*.

2.4 POLICY ASSUMPTIONS

Safety and security policy assumptions can significantly influence the type and size of high-speed train infrastructure as well as how it functions. In developing this document, design assumptions were made that will require confirmation based on Authority policy. Potential approaches to addressing these issues are summarized in the following sections. Each policy assumption is cited below and subject to revision.

The Authority has the responsibility for setting the safety and security policies for the CHSTS.

2.4.1 Fire and Life Safety

Fire and life safety provisions for the CHSTS trainway, including aerial and tunnel structures, will be developed in the spirit of guidance contained in NFPA 130 *Standard for Fixed Guideway Transit and Passenger Rail Systems* but with provisions added for the specific characteristics of high-speed train operations and as approved by the Office of the State Fire Marshal. NFPA guidelines will be used for stations and other buildings.

2.4.2 Security Personnel

The policing of the high-speed train system will be a necessary and important element of CHSTS operations. The security force could be provided through arrangements with local law enforcement agencies; by private, off-site vendors; a HST-dedicated on-site security force; or any combination of the aforementioned. Each of these arrangements would require different on-site security facilities. The CHSTS will deploy security forces as dictated by site-specific TVA. Locations could include high-speed train repair and maintenance facilities, as well as dedicated space in all CHSTS operations centers to monitor detection systems, access control and CCTVs, and coordinate security and police responses to incidents.



3.0 ASSESSMENT/ANALYSIS

3.1 DESIGN PRINCIPLES AND STRATEGIES

Design of infrastructure shall promote and support a safe and secure high-speed train system. Safety is a principal requirement of the CHSTS and many system components have functional requirements pertaining to safety. The implementation of safety and security measures improves the actual and perceived safety and security. The goal is to manage safety hazards and security vulnerabilities so as to achieve a level of safety and security that is acceptable to the Authority. Two design strategies for achieving an acceptable level of safety and security are Prevention through Design and Crime Prevention through Environmental Design.

Prevention through Design (PtD)

PtD is the concept of addressing safety and health needs in the design and redesign process to prevent or minimize the hazards and risks associated with the construction, manufacture, use, maintenance, retrofitting, and disposal of facilities, processes, materials, and equipment. PtD prescribes the application of a hierarchy of controls as follows:

1. Elimination
2. Substitution
3. Engineering Controls
4. Warnings
5. Administrative Controls
6. Personal Protective Equipment

More information on PtD can be found in ANSI Z590.3-2011: *Prevention through Design, Guidelines for Addressing Occupational Hazards and risks in Design and Redesign Processes*

Crime Prevention through Environmental Design (CPTED)

CPTED will be applied as appropriate throughout the system to prevent and mitigate crime. CPTED practices will be integrated early in the design process. Design shall focus on natural access control, natural surveillance, defensible space, and reinforcement of territory. By incorporating CPTED principles and considerations early in site planning, perimeter definition, sightlines, lighting, landscaping and other site design elements, implementation of alternate, more expensive engineering solutions can be avoided during later stages of design.

CPTED principles include improving sightlines and eliminating areas of concealment. Areas, spaces or structures that provide concealment shall be avoided, particularly in stations, station sites, parking facilities, bridges, tunnels, and structures, and can be improved through organization of space, architecture and lighting.

Additional information about CPTED is available from these references:

- National Institute of Law Enforcement and Criminal Justice publications
- *Crime Prevention through Environmental Design*, Crowe, Timothy D., National Crime Prevention Institute.

Safety and Security Management Plan (SSMP)

Infrastructure shall be designed in conformance with the hazard management processes described in the Safety and Security Management Plan (SSMP). The SSMP defines the safety and security goals and objectives, specifies safety and security related activities and processes, and assigns responsibilities for ensuring that activities are conducted and objectives are met. The SSMP is based on FRA guidance for system safety, FTA's Circular C5800.1 *Safety and Security Management Guidance for Major Capital Projects*, and the European standard EN50126-1 *Railway applications – The specification and demonstration of Reliability, Availability, Maintainability, and Safety (RAMS)*.



3.1.1 Safety Strategies

Hazard Management – The safety of passengers, employees, emergency responders and the general public is of primary concern in the design and implementation of the CHSTS. Design of system and subsystem elements that could impact the safety of passengers, employees, emergency responders and the general public shall include hazard management as part of the design process. Hazards shall be identified and assessed for their potential probability of occurrence and consequential effects to the system and hazard risk shall be mitigated to an acceptable level.

Hazards shall be assessed at the program level using Preliminary Hazard Analysis (PHA) techniques, and then assessed at the site-specific level using Site-specific Hazard Analysis (SSHA) techniques. The hazard management program is described in detail in the SSMP.

Site Selection - The site selection for CHSTS facilities shall consider safety hazards during the site selection process. Consideration shall be given to appropriate adjacent land uses and application of perimeter buffer zones to isolate the CHSTS.

Separation - Separation of the CHSTS trainway from the general public is an effective way to avoid safety hazards. The margin for safety is small where trains are operating at 220 mph and elimination of hazards is the most effective approach to hazard management. In contrast to standard railroad operations in the United States, high-speed train operations shall be isolated to the extent possible. All at-grade highway-rail grade crossings on exclusive use corridors shall be eliminated through closure or grade separated from the CHSTS trainway. CHSTS alignments located above, below, or adjacent to other railroad systems and roadways shall use lateral and/or vertical separation (where supported by hazard assessment) to prevent potential intrusion of vehicles into the CHSTS trainway and to protect CHSTS operating infrastructure. Additional physical elements such as earthen berms and barrier walls shall be used at locations where deemed appropriate through site-specific hazard assessment.

Access Control - The operation of trains at high speeds (defined by FRA as greater than 110 mph) presents unique hazards to passengers, employees, and the general public. All access to the trainway will be controlled in order to mitigate the hazards associated with higher speeds. Non-employee access will be restricted to public areas in which engineering controls have been applied to ensure the safety of the public.

Redundancy - Safety-critical systems shall be robust and redundant with sufficient space for expanded, additional, and contingency measures. Alternative operating facilities shall be identified to allow for ongoing operation of essential functions.

Detection - System-wide hazard detection shall identify those hazardous conditions that could affect the safety of the CHSTS including intrusion detection for persons, vehicles and other large objects, rolling stock conditions, fire and smoke, and natural phenomena including earthquakes, climatic conditions (temperature, wind and rain), wildfire, mudslides, falling rocks, and high water.

Monitoring – The CHSTS shall be equipped with an integrated system for detecting, monitoring, surveillance, and response to environmental conditions, the railroad operating system, normal operations, and emergencies in real time. Monitoring detectors shall be linked to the central control system, the Operations Control Center (OCC) and/or Regional Control Centers (RCC), the Automatic Train Control (ATC) system, and the traction power supply and distribution systems. Unsafe conditions shall be immediately conveyed through communications systems so that appropriate action may be taken.

Communications - Wired and wireless transport networks, command and control systems, and detection and monitoring systems shall detect, notify and respond to safety and security incidents. High-speed train communications systems shall be interoperable and functional across the system and with applicable third-party emergency responders.

Lighting - The proper use of illumination can reduce accidents. Facilities, such as walkways, stairways, access/egress points, station platforms and other public areas, shall be well-lit to



mitigate potential hazards identified in the site-specific hazard analysis. Walkways in tunnels will be lit in accordance with the requirements of NFPA 130.

Fire Protection - The fire protection system shall include fire prevention, fire detection, fire suppression, and mitigation from fire damage including sufficient and safe evacuation capacity. Facilities shall be constructed of fire resistant materials, where practicable, and include fire detection, suppression and smoke removal systems.

Emergency Evacuation – Facilities shall provide capacity for safe emergency evacuation and compliance with emergency procedures. This includes the sizing and location of access and egress points, support infrastructure such as walkways, stairways, and access roads, and support systems such as lighting and communications.

Signage - Passenger and staff warning signs shall be used where appropriate or required. Unless required for safety reasons, signs indentifying sensitive areas shall not be used for security reasons.

3.1.2 Security Strategies

Minimal Access Points – The number of access points shall be limited to those required for operational, maintenance, and emergency access to improve security and cost efficiency. Design shall strive to achieve fewer, more functional, and more maintainable access points. However, there shall be adequate frequency and sizing of access points for normal and emergency operations.

All access points to non-public areas shall be secured with high grade locking devices at a minimum. The Threat and Vulnerability Assessment for each specific area will further identify additional security enhancements, to include but not be limited to CCTV, intrusion detection, security lighting, signage and non-climbable fencing with barbed wire topping.

All stations, maintenance facilities, and offices of the CHSTS shall have the ability to be “locked down” to prevent entry by any unauthorized person.

Electronic Access Control – The use of communications systems or other electronic means to control access to facilities or information systems.

Lighting – The proper use of illumination can deter criminal activity. Facilities, such as walkways, steps or platform edges, shall be well-lit to mitigate potential vulnerabilities. Higher lighting levels shall be applied where deemed necessary by a TVA.

Natural Surveillance – The use of windows, clear lines of sight and walkways can enhance security by increasing the perception of security.

Monitoring – An integrated system for surveillance and protection of critical infrastructure shall include intrusion detection, closed-circuit television and access control, reporting both locally and to the Operations Control and the appropriate Regional Control Centers.

Structures – Access to tunnels, sub-grade alignment (trenches), elevated structures and other wayside facilities shall be secured.

Air Intakes – Air intakes shall be elevated and secured. Station and facilities HVAC equipment will be designed in accordance with appropriate security considerations.

Utilities – Incoming utilities shall be protected and secured. Essential utilities shall be redundant to the extent practical.

Security / Law Enforcement – Facilities to support a security or law enforcement presence for the high-speed train shall be included in infrastructure design.

3.2 ACCESS/EGRESS

For egress, the principal operational strategy for incidents of emergency (fire, earthquake, derailment, etc.) is to continue operation of the train (if safely practicable) to the nearest station



platform for passenger evacuation. If it is not possible to move the train, a second train will be brought to the scene (if safely practicable) to facilitate evacuation of the passengers. In the event that operation of a second train is not possible, passengers must still be afforded the safe and efficient means of egress from the trainway in the event of an incident that requires immediate evacuation by means other than normal routes or methods. The design of the means of egress must consider the worst-case scenario in terms of passenger load (up to 1000 people per train) and reasonable adverse conditions (night time, inclement weather). Typical passengers include the elderly and children, and they must be treated in a manner that provides for their particular safety needs. Egress analysis shall be performed to support the site-specific access/egress design requirements.

Access requirements for emergency response operations must also be provided to allow emergency responders to respond to incidents, such as fire, derailment/collision, or passenger or employee injury. The design of the means of emergency access must consider the typical fire engine size and operating characteristics as defined by the California Fire Code. Evacuation of a large number of people from underground structures or via aerial ladder truck is challenging, time-consuming, and difficult, especially when conducted from an extreme height. Every effort must be made to design facilities that allow for egress from elevated viaducts by other than aerial ladder truck.

Current Guidance – NFPA 130 provides guidance for the access/egress for transit and passenger rail systems in the United States. The Office of the State Fire Marshal has indicated that following the guidance contained in NFPA 130 for access/egress is appropriate in the development of the CHSTS for the location, frequency, and characteristics of access/egress routes. *NFPA 130-6.2 Egress and Emergency Access* provides guidance for the design of walkways, crosswalks, handrails, lighting, cross-passageways and other access/egress support infrastructure.

NFPA 101 provides guidance for the configuration of stairways used for access/egress.

California Code of Regulations, Title 24, Part 9 *California Fire Code 2010*, Appendix D provides guidance on the design of access roads to support operation of fire apparatus. Fire apparatus considered in the development of *California Fire Code 2010* are larger and more restrictive than other vehicles that could reasonably be expected to use the CHSTS access roads; access roads designed to the *California Fire Code 2010* shall be able to support the needs of emergency access/egress operations and routine operations and maintenance activities.

3.2.1 Alignment Configurations

In a train evacuation incident, where the train set is unusable and it is not possible to move another train into position to recover the passengers in a period of time that adequately provides for their welfare (OCS damage, earthquake damage, etc.), the passengers must be removed from the trainway, their well-being provided for, and they must be transported away from the site as quickly and safely as possible.

From an operational and safety perspective, the evacuation of passengers from a train is to be considered in only the most extreme of circumstances. Train crews are to be instructed to exhaust other remedies before resorting to a right-of-way evacuation. It is, however, reasonable to assume that a train crew might be required to evacuate passengers prior to the arrival of emergency responders at night and onto a remote section of the alignment. Once an evacuation is conducted, there must be additional mechanisms which offer safe resolution of the passengers' condition. Facilities shall be provided which ensure that, within a reasonable time and distance, the passengers will be able to remove themselves from the trainway to a place of safe refuge. A walking speed of roughly two miles per hour for a group would convey them approximately 1.25 miles in 45 minutes which may be the maximum time and distance that can be expected from a portion of passengers. Consideration must be given for the mental stress and confusion that accompanies an incident and the evacuation of the very young and old passengers.

Walkways – For egress pathways the CHSTS shall be equipped with a continuous walkway to allow passengers to evacuate a train to a station or place of safety at any point along the



trainway. Walkways shall be located adjacent to each track where practicable, and may be located between and shared by two adjacent tracks. Walkways will consist of a uniform, slip-resistant surface. The walkway envelope shall be a minimum 3.0 feet wide by 7.5 feet tall, with the upper 1.5 feet tapering to a width of 2.5 feet, free of any obstructions. Crosswalks, connecting the two sides of the trainway with a walking surface uniform to the top of rail, shall be located at access/egress points, special trackwork (switches and crossovers), and cross passageways. Raised walkways shall be provided with a continuous handrail along the side opposite the trainway.

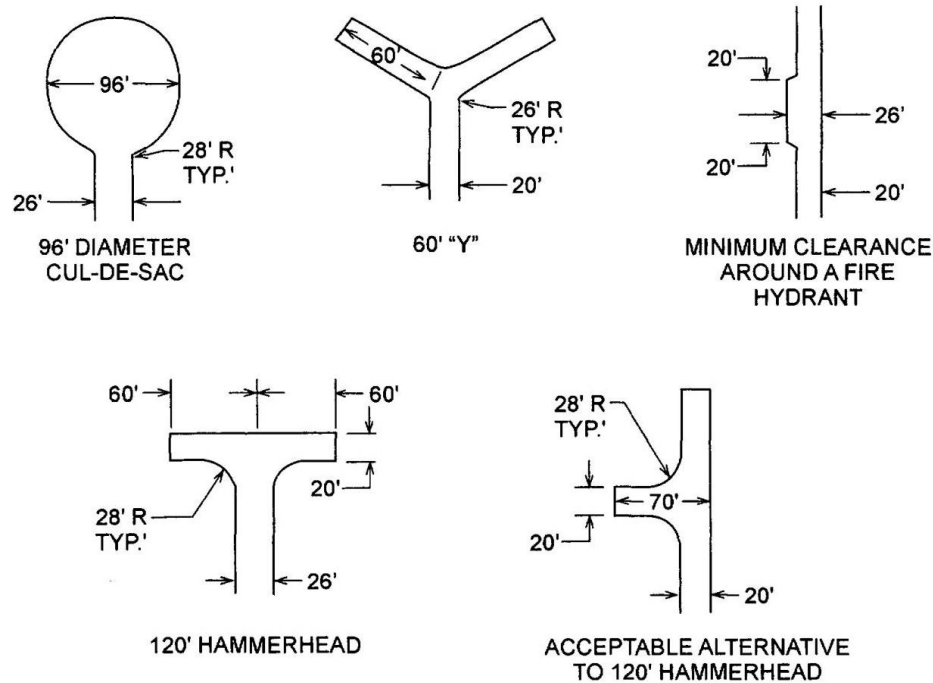
Access/Egress Points – Access/egress points for all alignment configurations shall be provided at nominal 2.5 mile intervals, with a maximum 3.0 mile interval. Access/egress points will alternate sides of the trainway where possible. Crosswalks, connecting the two sides of the trainway with a walking surface uniform to the top of rail, shall be located at access/egress points. Where several alignment configurations are present (at-grade, raised embankment, aerial viaduct, etc.) the nominal distance shall be calculated over the combination of the various alignment configurations, retaining a continuous walkway configuration not to exceed the maximum 3.0 mile interval. Signage mounted on the handrail, fence or retaining wall structure at 1000 foot intervals will direct passengers to the nearest access/egress point.

Access Roads – Access from public roadways to the access/egress points shall be made via access roads with the following characteristics:

- Dimensions - Access roads shall have an unobstructed width of not less than 22 feet inclusive of shoulders and an unobstructed vertical clearance of not less than 14.5 feet.
- Surface - Access roads shall be designed and maintained to support the imposed loads of fire apparatus and shall be provided with a surface that provides for all-weather use. Minimum surface designed to withstand a 75,000 pound (37.5 ton) load.
- Turning radius - The minimum turning radius shall be 45 feet outside radius.
- Dead ends – Dead end access roads in excess of 150 feet in length shall be provided with space appropriate for the turn-around of fire apparatus as identified in Figure 3-1. This space can also provide room for emergency vehicle staging.
- Bridges - When a bridge is required to be used as part of an access road, it shall be designed, constructed and maintained for a live load sufficient to carry the imposed loads of fire apparatus, derailment cleanup equipment, and track repair and construction equipment. Vehicle load limits shall be posted at both entrances to bridges.

- Grade - The gradient for an access road shall not exceed 10% maximum. Grades steeper than 10% will require approval by the AHJ.
- Gates - Where gates restrict public access to the access road, such gates shall have a minimum opening of 20 feet, constructed of the swinging or sliding type, the ability to be opened by one person, and shall provide vehicle access to the trainway.



Figure 3-1 – Access Road Dead End Turn-Arounds

Access/egress points that open to the trainway shall be equipped with basic facilities for emergency response: access-control gate, lighting, a communications link to the Operations Control Center and nearest Regional Control Center, and a traction power indication panel.

3.2.2 At-Grade Alignments

Walkways shall be located outside the OCS support poles on both sides of the trainway, but close enough to be accessible directly from the train via portable ramp or ladder equipment.

Access/egress points for at-grade alignments shall be co-located with traction power facilities (substations, switching stations, and paralleling stations), interlocking houses, stand-alone radio sites, and other wayside facilities where practicable. Access roads will continue along the interior of the trainway where practicable.

Technical Memorandum 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities* identifies in greater detail the access/egress requirements for at-grade alignments.

3.2.3 Raised Embankments and Retained Fills

Walkways shall be located outside the OCS support poles on both sides of the trainway, but close enough to be accessible directly from the train via portable ramp or ladder equipment. Sufficient shoulder on the raised embankment or retained fill shall be provided for the walkways at track level. Retained fills with a precipice of greater than 30 inches shall be provided with a fall-restraint barrier such as handrailing or parapet walls. The barrier design shall conform to the requirements of CCR Title 8, Chapter 4, Section 3210 Guardrails at Elevated Locations.

Access/egress points for raised embankments or retained fills shall be provided by stairways or ramps which meet the minimum requirements of NFPA 101 at nominal 2.5 mile intervals with a maximum 3.0 mile interval and co-located with traction power facilities, interlocking houses, stand-alone radio sites, and other wayside facilities where practicable. Such stairways or ramps shall alternate sides where possible and shall be located within 100 feet of the emergency vehicle staging area and protected by an access-control pedestrian gate with a minimum 48 inch opening.



Technical Memorandum 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities* identifies in greater detail the access/egress requirements for raised embankments and retained fills.

3.2.4 Aerial Structures (Bridges and Viaducts)

Walkways shall be located on the outer edges of the aerial viaducts, inside of the OCS support poles. Aerial structures shall be equipped with a fall-restraint barrier such as handrailing or continuous parapet walls to prevent persons from falling from the structure. The barrier design shall conform to the requirements of CCR Title 8, Chapter 4, Section 3210 Guardrails at Elevated Locations.

Access/egress for aerial alignments shall be provided by stairways which meet the minimum requirements of NFPA 101 at nominal 2.5 mile intervals with a maximum 3.0 mile interval and co-located with traction power facilities, interlocking houses, stand-alone radio sites, and other wayside facilities where practicable. Such stairways shall alternate sides where possible and shall be located within 100 feet of the emergency vehicle staging area and protected by an access-control pedestrian gate or enclosure with a minimum 48 inch opening.

In addition to access/egress stairways at nominal 2.5 mile intervals, alignments with restricted access to the right-of-way through the fence (elevated viaducts, trench structures) require additional opportunities for emergency access. Access to elevated viaduct structures by aerial ladder trucks shall be afforded at nominal 2500 feet intervals with a maximum interval of 3000 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.

Technical Memorandum 2.3.3 *Design Guidelines for High-Speed Train Aerial Structures* identifies in greater detail the access/egress requirements for aerial structures.

3.2.5 Sub-Grade (Trench) Structures

Walkways shall be located along the trench walls on the same side as the access/egress points where possible. Walkways shall be illuminated to provide safe passage in the event of an evacuation.

Aerial ladder trucks cannot reach into trench structures due to the presence of the overhead contact system. Access/egress for sub-grade trainway alignments shall be provided by stairways which meet the minimum requirements of NFPA 101 at nominal 2500 feet intervals with a maximum 3000 feet interval. Such stairways shall be located within 100 feet of the emergency vehicle staging area and protected by an access-control pedestrian gate with a minimum 48 inch opening.

3.2.6 Tunnels

Walkways shall be located along the tunnel walls on the same side as the access/egress points or cross passageways where possible. Walkways shall be illuminated to provide safe passage in the event of an evacuation, in accordance with the requirements of NFPA 130.

Egress from twin bore single-track tunnel structures shall be provided by passage to a place of refuge at 800 feet intervals. Cross-passageways shall be equipped with fire doors with self-closing mechanisms at each opening. Egress from single bore double-track tunnels equipped with center walls shall be provided by fire doors opening to the opposite track. Doors shall be hinged to open in the exit direction where possible, or sliding doors if required due to obstructions on the other side of the door or where the doorway opens directly to another trainway. Doors shall be 1.5 hour fire-rated and equipped with self-closing mechanisms. Egress from single bore two-track tunnels not equipped with center walls shall be provided by lateral or vertical exits to the surface every 2500 feet.



The cross-passageway envelope shall be a minimum 44 inches wide by 7 feet tall, free of any obstructions. Cross-passageways shall be illuminated in the event of an incident requiring evacuation.

Technical Memorandum 2.4.2 *Basic High-Speed Train Tunnel Configuration* identifies in greater detail the access/egress requirements for tunnels.

3.2.7 Station Facilities

The guidance for access/egress at station facilities can be found in NFPA 101, NFPA 130 and California Building Code section 433 (as corrected to reflect the six minute evacuation rule).

Emergency responders shall be provided access to all areas in and around the station in the event of an incident of emergency response. Fire Lanes will be designated in the vehicle roadways and parking areas surrounding the station. At least one entrance shall be designated as the Emergency Access Entrance and identified as such in the Emergency Action Plan for the facility.

Evacuation routes must be available to evacuate all passengers from the affected station platform (Platform Occupant Load) in four minutes or less and from the most remote point on the platform to a point of safety in six minutes or less. Once the last passenger has set foot upon a platform escalator or stair, sufficient escape routes shall be provided to enable evacuation to a point of safety within the remainder of the total six minutes. At least two means of egress, remote from each other shall be provided from each station platform.

Evacuation routes shall be planned so that a passenger confronted by an outbreak of fire can turn away and make a safe escape. To achieve this goal, the maximum travel distance to an escape route, such as an escalator, stair, passageway or entrance, shall not exceed 325 feet. Fare gates shall assume an emergency exit mode in the event of loss of power to the fare gates or upon actuation of a manual or remote control.

Technical Memorandum 2.2.2 *Station Program Design Guidelines* identifies in greater detail the requirements for evacuation from stations and emergency access into stations.

3.2.8 Support Facilities

The guidance for access/egress at all other support facilities can be found in NFPA 101, NFPA 130, and California Code of Regulations, Title 24, Part 9 *California Fire Code*.

Design of access/egress for all support facilities shall be in compliance with the requirements of California Code of Regulations, Title 24, Part 9 *California Fire Code*.

3.3 FIRE AND LIFE SAFETY INFRASTRUCTURE

Achieving an acceptable level of fire and life safety is a principal goal for the CHSTS. Each type of high-speed train facility shall have location-specific fire and life safety infrastructure, standards, plans and procedures. The principal guidance for fire and life safety infrastructure is found in NFPA 130, modified as appropriate to the peculiar characteristics of high-speed train operations and as amended by other NFPA standards. Fire protection strategies and designs shall focus on prevention, retardation of fire growth, detection, suppression, containment, and evacuation in order of precedence. CHSTS facilities shall be constructed of fire resistant materials to the extent practicable and comply with state and local fire codes where applicable. The Office of the State Fire Marshal is the authority having jurisdiction, but local fire codes will be applied where deemed appropriate by OSFM. Fire detection, suppression, and smoke removal systems shall be implemented. Capacity and facilities for safe emergency evacuation and emergency procedures shall be provided. Fire suppression strategies shall recognize that the use of water and conductive chemicals is not compatible with the OCS. Response to fire on trains or within the trainway must be first coordinated with the Power Director within the OCC who is responsible for ensuring the protection of the high voltage power in the OCS.



3.3.1 Stations

Stations, by their nature, are locations where activities with the potential for fire or other life safety hazards are present. In addition, the presence of large concentrations of passengers leads to unique requirements for fire and life safety facilities. Worst-case scenarios for occupant load and incident must be considered. NFPA 130 is the principal guidance document except where modified by CBC 433.

An automatic sprinkler protection system shall be provided in areas of stations used for concessions, storage areas, trash rooms, and in the steel truss areas of all escalators and other similar areas with combustibles loadings, except trainways. Equipment rooms with electrical and electronic equipment, such as communications and ATC equipment rooms, shall have special fire protection provisions as defined in the respective discipline-specific technical memoranda. Fire protection standpipe and hose systems shall be installed in accordance with NFPA 14 and as modified by NFPA 130. Fire hose cabinets and portable fire extinguishers shall be provided as required by NFPA 130.

Emergency lighting for passenger areas and emergency egress pathways shall be provided in accordance with NFPA 101 and as modified by NFPA 130. Backup electrical power will be supplied by an emergency standby generator for select electrical loads including fire protection systems, ventilation systems, emergency lights and signage, communication systems, train controls systems, and low-voltage direct-current battery supply systems to support emergency lighting and communications.

Station facilities shall include a law enforcement office for the principal purpose of providing security to the CHSTS. The station control room shall also be equipped to act as an Incident Command Post (ICP) in the event of an incident that requires enacting the Incident Command System. ICP elements shall include copies of the Emergency Action Plan for the station, emergency communications systems, stations plans, and fire protection system and ventilation system controls, as applicable. Underground stations shall be provided with a fire command center in accordance with NFPA 72.

Technical Memorandum 2.2.2 *Station Program Design Guidelines* identifies in greater detail the fire and life safety infrastructure for stations.

3.3.2 Tunnel Interiors

Tunnels, by their nature, present unique challenges to the fire and life safety response efforts in the event of an incident. The physical space is confined for operational response, access is extremely limited, and the environment can be unfamiliar and confusing to both passengers and emergency responders. Careful planning for and development of emergency response plans, communications and infrastructure, and training programs for passengers, employees, and emergency responders can mitigate the effects of a fire and life safety incident in and around a tunnel.

Fire and life safety infrastructure inside tunnels shall include emergency walkways and access/egress infrastructure as described in Section 3.2.6. Additional fire and life safety infrastructure shall include dry standpipe systems with universal fire hose connections, radio communications systems for railroad operations and fire and life safety operations separately, hard-wired communications stations at each cross passageway or other access/egress point, signage directing to the nearest egress point, and lighting. Lighting for the walkways shall be provided in all tunnels in excess of 250 feet in length. NFPA 130 is the primary source of guidance.

Ventilation systems shall be installed in tunnels greater than 1000 feet in length where supported by a Fire Hazard Analysis report. Ventilation systems shall be sized to allow maintenance of a smoke-free environment for duration sufficient to allow passenger egress to a place of safe refuge.

Technical Memorandum 2.4.2 *Basic Tunnel Configuration* identifies in greater detail the tunnel walkway requirements.



3.3.3 Tunnel Portals

Tunnel portals are potential locations for congestion and confluence of emergency response operation during an incident, requiring greater fire and life safety infrastructure. In the event of an incident inside the tunnel that requires evacuation or emergency response, the tunnel portal will be a confluence of evacuees from the tunnel environment, emergency responders attempting to access the tunnel to implement fire and life safety operations, and smoke discharge from the tunnel fire. Each of these three incident response elements must be considered and allowed for when designing tunnel portal layout and facility requirements. Additionally, tunnel portal facilities are generally located at environmental transitions (hillsides) that tend to be space-constrained and require particular consideration for layout.

Fire and life safety infrastructure at tunnel portal facilities for passenger egress shall include paved emergency egress walkways from tunnels, train surface evacuation and fire control zones for each track, designated crosswalks at top-of-rail height, area lighting, and a rescue area/passenger assembly area. Infrastructure for firefighting operations and other emergency response operations include an access road, emergency vehicle assembly and turnaround area, fire hydrants and emergency water supply, an emergency power supply, cross track emergency vehicle access, emergency communication facilities for hard-wired and radio communication systems, overhead contact system motorized disconnect switches, an incident command post, and a helicopter landing pad where the installation of an access road is impracticable. Infrastructure for the extraction of smoke from the tunnel, where supported by Fire Hazard Analysis, includes a portal ventilation building.

A site-specific hazard analysis shall be conducted for each tunnel portal to determine the appropriate fire and life safety infrastructure to be provided at each specific tunnel portal. Consideration shall be given to tunnel length, proximity to other tunnels, surrounding topography, and access/egress routes. Technical Memorandum 2.4.6 *Tunnel Portal Facilities*, Section 6.3 provides details on how to determine the appropriate requirements of fire and life safety infrastructure for different categories of tunnels.

Security infrastructure at tunnel portal facilities includes intrusion protection fence, security gates, intrusion detections systems, and landscaping designed with CPTED principles in mind.

Technical Memorandum 2.4.6 *Tunnel Portal Facilities* identifies in greater detail the fire and life safety infrastructure elements at portal facilities by type of tunnel.

3.3.4 Support Facilities

The guidance for fire and life safety infrastructure at all other support facilities can be found in NFPA 101, NFPA 130, and California Code of Regulations, Title 24, Part 9 *California Fire Code*.

Design of fire and life safety infrastructure all support facilities shall be in compliance with the requirements of California Code of Regulations, Title 24, Part 9 *California Fire Code*.

3.3.5 Other Locations

Fire and life safety infrastructure at all other access/egress points shall include an access road, emergency vehicle assembly and turnaround area, area lighting, pedestrian crosswalk connecting the two sides of the trainway with a walking surface uniform to the top of rail, and emergency communication facilities for a hard-wired connection to the OCC and appropriate RCC.

3.4 SECURITY FACILITIES

Facilities to support security services and employees must be included in the high-speed train infrastructure. The security force, potentially comprised of both sworn and unsworn personnel, will inspect and patrol all CHSTS property, facilities and equipment; respond to all alarms and calls for service; staff the security desk at the OCC monitoring CCTVs, alarms, detection systems, access control and train radio communications, coordinating emergency responses; staff access-control points to CHSTS facilities; support emergency responders in non-criminal



incidents; and investigate, apprehend, detain, arrest and transport persons who violate the law on CHSTS property.

3.4.1 Law Enforcement Space/Facilities

High-speed train stations shall have office and vehicle parking space for sworn law enforcement officers as defined in TM 2.2.2 *Station Program Design Guidelines*. This includes areas where suspects can be detained and complainants interviewed separately. Guidelines for other law enforcement spaces and facilities are to be developed.

3.4.2 Security Guard Space/Facilities

The CHSTS will deploy a security force at each station, maintenance facility, the OCC/RCCs and other locations as identified by a site-specific TVA. Space for locker rooms as well as parking for both personal and agency vehicles must be provided. A fleet of agency vehicles will be necessary to provide alignment patrols as needed to support the CHSTS security program. High-speed train stations shall have security offices as defined in TM 2.2.2. Guidelines for other security spaces and facilities are to be developed.

3.5 ACCESS CONTROL

3.5.1 Control of Access

FRA's *High-Speed Passenger Rail Safety Strategy* calls for the isolation of the passenger system from hazards, including the degree of security that can be established on the trainway. With train operation at up to 220 mph, the hazards presented to both train operations and pedestrians can reasonably be expected to be catastrophic when persons or other obstructions are present on the trainway. The trainway shall be fully access-controlled so that only persons authorized to be in non-public areas are present.

Public spaces, such as those at stations, shall be able to be fully closed outside of operational hours or during emergencies. Trains and some spaces within stations (e.g., platforms, paid areas) shall only be accessible to members of the public holding a valid ticket. In order to protect non-revenue or secure areas from unauthorized access, secured perimeters, including fencing, walls, or other physical barriers, electronic barriers like sensors and alarms, and natural barriers shall be implemented. The location and design of the secured perimeter shall consider effectiveness and functionality.

Control of Access is addressed in Technical Memorandum 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities*. This document defines both the infrastructure used to control access as well as what devices will be used on different facilities. Topics covered in TM 2.8.2 include:

- Access Control Devices (fences, walls, traffic barriers, gates, signage, vegetation control)
- Access Control by Type of CHSTS Trackway
- Access Control by Type of Facility (yards and maintenance facilities, ATC, communications, traction power facilities, passenger stations, parking structures)
- Access Control at Other Locations (end of line and storage tracks, highway overpasses crossing CHSTS trackway, streets dead-ending at CHSTS trackway, access roads, maintenance roads, emergency exits and equipment rooms in tunnels, drainage structures)

Doors shall be controlled by electronic control devices such as card readers or pin pads. Doors used for normal operations shall have natural surveillance where practicable. Emergency exit doors shall have both audio and visual alarms and shall comply with appropriate fire codes.

Staffed guard stations may be appropriate at high-speed rail facilities such as heavy maintenance yards. Devices such as turnstiles, tire shredders, roll-up gates, pop-up barriers or drop gates, may be used to prevent unauthorized passage. Stations shall be designed to promote maximum visibility over the surrounding area.



Electronic access points, including automatic gates, doors with access controls, sensor line gates and automated portals, shall be utilized over mechanical or staffed access control.

Access/egress points shall be secured from means of being opened by forcible entry tools, and shall also be equipped with a combination key box containing the key to the lock installed at the location. The combination to the key box shall be made known to local emergency responders. All access/egress locks must comply with the CBC.

3.5.2 Public Spaces

The public interface to the CHSTS occurs at specific, controlled locations: station facilities (including platforms, public concourse areas for ticketing, waiting, and vendor facilities, drop-off and pickup areas, and parking facilities), aboard trains, and at highway and pedestrian walkway overcrossings/undercrossings. These spaces shall be open to public access, although station facilities will be segregated into paid and non-paid areas in order to control ticket possession and validation. Use of Authority-controlled public spaces shall be subject to conformance to Authority policy for use, including hours of access, congregations of people (intentional or not), demonstrations, vending, and other factors affecting the safety and flow of passengers.

Control of access beyond station platforms is described in TM 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities*. Stations shall be equipped with barriers at the ends of the platforms that deter entry into the trainway while also complying with CPUC side clearance regulations. Inter-track barriers shall be installed to restrict the movement of persons from the platform track to the inner tracks used by trains that do not stop at the station. All barriers delineating the limits of public access shall be equipped with appropriate signage for trespass and warning of hazards.

Non-station public spaces shall be separated from the CHSTS trainway by access control fencing, walls, and other permanent barriers as described in TM 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities*. Highway overpasses shall be equipped with a combination of rigid traffic barrier and access-restricting fencing to prevent the intrusion of both vehicles and persons. Access-restricting fences at highway overpasses shall have a curved top section to deter the throwing of objects onto the trainway. In addition, a solid barrier shall be installed directly above the trainway to prevent contact with the OCS wires.

3.5.3 Non-Public Spaces

Access control infrastructure for non-public spaces is described in detail in TM 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities*. Facilities, rooms, and spaces used in the operation of high-speed trains shall be secured with locks and detection systems. Traction power facilities, ATC housings, communications equipment, and other core systems facilities, where located outside the right-of-way, shall be protected by an access restricting fence or wall enclosure with secured gates.

Buildings, systems and other facilities that are critical to high-speed train operation shall be made secure when located adjacent to public entrances, public vehicle circulation, public parking or other publically accessible areas. These components include emergency generators, fuel storage, fire pumps, universal power supply facilities, critical HVAC systems, and emergency power distribution feeders.

3.6 OTHER INFRASTRUCTURE ELEMENTS

3.6.1 Highway and Rail Vehicle Intrusion Protection

The proposed CHSTS will operate adjacent to or within a shared right-of-way with other transportation systems at several locations along the high-speed rail alignment. These transportation systems include conventional railroad lines, mass transit lines, and state or local highways/roadways. It is the intent to protect the CHSTS operating space from intrusion by errant railroad or highway vehicles. At locations, where high-speed rail alignment is in close proximity to other transportation systems, assessment will be made to determine the need and



type of intrusion protection for the respective modes and services. Site-specific hazard analyses, risk assessment, and implementation of appropriate mitigations to reduce the potential for intrusion will allow the CHSTS to safely operate in proximity to existing transportation systems.

Protection against intrusion by adjacent rail and mass transit operations shall be achieved through the implementation of possible mitigations, including horizontal separation between track center lines greater than 102 feet, vertical separation, installation of berms and/or ditches, or installation of intrusion prevention crash walls. Location and configuration of the intrusion protection infrastructure shall be supported by site-specific hazard analysis.

Protection against intrusion by highway vehicles from adjacent roadways shall be achieved by locating the CHSTS trainway beyond a Clear Recovery Zone from the edge of the roadway, as identified by Caltrans in its Highway Design Manual. Where such separation cannot be met, a site-specific hazard analysis shall be conducted to determine the requirements for a physical barrier to avert intrusion. The barrier may consist of metal beam guard rails or concrete barriers and shall meet the requirements of Caltrans Traffic Manual, Chapter 7 and the CHSTS Technical Memorandum 2.1.7.

Technical Memorandum 2.1.7 *Rolling Stock and Vehicle Intrusion Protection* identifies in greater detail the infrastructure elements required for rail and highway vehicle intrusion protection.

3.6.2 Fire and Smoke Prevention and Mitigation

Fire (and resulting smoke) represents one of the greatest hazards to passengers and employees in the CHSTS. Even though the potential for fire is greatly reduced through the use of fire-resistant construction materials, compartmentation, and fire suppression systems, the potential for fire still exists and must be considered when designing CHSTS infrastructure. A Fire Hazard Analysis to support the requirements for ventilation and smoke removal systems for tunnels is under development.

Fire Prevention and Mitigation -- The prevention of fire is achieved through the use of non-flammable materials in the construction of infrastructure and rail vehicles. The effects of a fire, should one occur, can be mitigated through the installation of on-board fire suppression systems in the high-speed trains; compartmentation in the design of the trains and interior spaces of infrastructure such as tunnels, stations, maintenance facilities, employee facilities, and traction-power facilities; standpipe systems in tunnel and sub-grade (trench) alignments; ventilation systems in tunnels greater than 1000 feet in length; and access/egress points at nominal 2.5 mile intervals for above-ground alignments and at 800 feet intervals for twin bore single-track tunnel structures and single bore double-track tunnels equipped with center walls. Egress from single bore two-track tunnels not equipped with center walls shall be provided by lateral or vertical exits to the surface every 2500 feet.

Smoke Removal -- In the event of a fire, a smoke removal system in enclosed spaces, such as tunnels, underground stations, station concourses, and other confined environments, is critical for the safe and efficient passage of passengers and employees to a place of safe refuge. A mechanical ventilation system shall be provided in tunnels greater than 1000 feet in length where supported by Fire Hazard Analysis. Smoke removal equipment shall be located away from high risk areas, protected and connected to emergency power. Separate smoke removal systems for different areas of a facility may be considered. Smoke removal equipment shall have the ability to be controlled by both the OCC/RCC and local control panels in case the remote connection is lost.

Reliability -- Fire protection water systems shall have redundancies in order to overcome a local failure and be encased, buried and otherwise protected from potential damage. Where appropriate, a dual fire pump arrangement shall be considered with one electric pump and one diesel pump.

3.6.3 Station Platforms

Station platforms provide the passengers with direct interface with the high-speed trains and present safety hazards not found in other parts of the CHSTS. Special consideration must be



made for the hazards peculiar to station platforms including platform configuration, walking surfaces and markings, platform edge treatment, the effects of passing trains, Americans with Disabilities Act (ADA) requirements, and other mitigations for platform hazards.

Platform configuration will be site-specific but conforming to certain safety guidelines including minimum widths of 30 feet for two-track platforms and 20 feet for single-track platforms, height that allows for level boarding to the CHSTS equipment (when selected), cross-slope away from the track, longitudinal slope in conformance to the rail alignment and tangent in alignment.

The platform edge shall be established 5.75 feet from the center line of the nearest track. When a final rail vehicle configuration is selected this measurement shall be adjusted accordingly. The gap between the platform edge and train sill door shall be no greater than 3 inches horizontally and plus/minus 5/8 inches vertically. Platform edges shall be identified for the visually impaired and marked with an appropriate setback for passengers when trains are passing. Under-platform refuge areas shall be constructed in order to provide a place of refuge should a person fall from the platform in front of a train.

Platform obstructions shall be assessed on a site-specific basis to ensure that they do not present visual or physical barriers to passengers, train operators, or law enforcement personnel.

OCS support poles shall be located away from the platform areas where possible. If an energized conductor has to be located above a station platform, the wire height shall be set to meet the minimum clearance requirements specified in Technical Memorandum 3.2.6 *Traction Electrification System Requirements for Grounding and Bonding and Protection against Electric Shock*. TM 3.2.6 also includes details pertaining to grounding requirements for platforms.

Inter track screen walls shall be installed to mitigate the effects of trains passing through the station facility on the center tracks at maximum authorized speed and to prevent people from crossing the tracks. The inter track screen walls are described in greater detail in Technical Memorandum 2.8.2 *Access Control for HSR ROW and Facilities*.

Safety and security design requirements for station facilities are addressed in Section 3.2.6, Section 3.3.1, and Section 3.5.2 of this document and in conformance with Technical Memorandum 2.2.2 *Station Program Design Guidelines*, and Technical Memorandum 2.2.4 *Station Platform Geometric Design, and System Requirements*. Technical Memorandum 2.2.2 addresses platform load (under both normal and emergency conditions), emergency evacuation, platform edge safety measures, platform ends, the Platform Agent Booth, weather protection, and CCTV systems. Technical Memorandum 2.2.4 *HST Station Platform Geometric Design* addresses in greater detail platform configuration, platforms adjacent to through tracks, setback to obstructions from the platform edge, and under-platform refuge area, and other platform design requirements.

3.6.4 Lighting

Lighting is an important element in the development of safety and security requirements. Lighting allows for walkway hazards and other obstructions to be seen more clearly, provides guidance for appropriate pathways, and enhances security sightlines by improving natural surveillance. Lighting shall complement CCTV systems to ensure CCTVs are an effective tool for surveillance and investigation. Lighting shall be installed in vandal-resistant coverings. Designers shall reference the Illuminating Engineering Society of North America (IESNA) for recommended safety and security lighting practices.

Stations and station sites including parking facilities, roadways, and walkways shall have adequate interior and exterior lighting as defined in TMs 2.2.2 and 2.2.3.

Other CHSTS facilities shall be illuminated to provide emergency egress for passengers and access for employees and emergency responders. Facilities include access/egress points, emergency vehicle assembly areas, walkways in tunnels, tunnel portal facilities, traction power facilities, and maintenance facilities.



3.6.5 Protection against Hydrology/Hydraulics Hazards

The CHSTS trainway shall be designed so as to mitigate the effects of water, considering the hydrology of the surrounding environment and the hydraulic requirements for drainage that preserves the safe operating conditions of the trainway. Hydrologic studies shall identify the ambient flood plain and determine the required mitigations; including raising the trainway above the flood plain or the installation of barriers to prevent intrusion of flood waters into the trainway. Hydraulic studies shall identify the potential runoff and determine the required mitigations, including drainage system requirements and outflow.

Technical Memorandum 2.6.5 *Hydraulics and Hydrology Design Guidelines* identifies in greater detail the assessment processes and infrastructure elements required for addressing hydraulic and hydrologic issues.

3.6.6 Utilities

The construction of the CHSTS trainway will result in interfaces with existing or new utilities (underground, overhead, and above-ground facilities). The strategy for addressing utility issues includes identification of existing utilities, evaluation of potential utility impacts, adjustment and protection of existing utilities within the CHSTS right-of-way, and abandonment of utilities where practicable.

Consideration must be given to the impact of and on utilities in both the Construction and Operational phases of the CHSTS.

Technical Memorandum 2.7.5 *Utilities Requirements* identifies in greater detail the assessment processes and infrastructure elements required for relocating and protecting existing and new utilities.

3.6.7 Facilities Power

The electrical system is essential to safe and secure operation of the high-speed train system. The system is drawn from the local utility grid and provides power for communication, lighting, essential building services and many other functions.

Distributed Emergency Power -- Emergency power infrastructure shall be installed separately, and as far apart as possible from normal electrical infrastructure. This includes electric panels, conduits and switchgear as well as electric distribution.

Normal and Emergency Fuel Storage -- Fuel storage shall be access restricted and protected. Main fuel storage shall be located away from loading docks, entrances and parking. Emergency fuel storage shall be sized based on the facility it is supporting. Emergency batteries or UPS may replace or supplement emergency generators at some sites.

Emergency Power -- An emergency generator shall be located away from the station building itself, loading docks, entrances, parking, and areas prone to flooding. The facility housing the generator shall be secured. Conduit and cabling shall be installed outside of a facility where practicable to enable mobile generator support of the facility's electrical system.

3.6.8 Traction Power Facilities

The traction power system will be fed directly from the public utility grid at nominally 115kV/220kV, stepped down to 25kV at traction power substations. Traction power facilities shall be provided at the following nominal intervals along the CHSTS trainway: traction power substations (30 miles), switching stations (15 miles), and paralleling stations (5 miles). The facilities shall share vehicle access roadways with access/egress points as described in Section 3.2. Access control measures shall be provided as described in Section 3.5.3. Design of fire suppression systems and other fire and life safety elements of traction power facilities shall be in compliance with the requirements of California Code of Regulations, Title 24, Part 9 *California Fire Code*.



Technical Memorandum 3.1.1.3 *Traction Power Facilities General Standardization Requirements* identifies in greater detail the fire and life safety infrastructure elements associated with traction power facilities.

3.6.9 Overhead Contact System

The overhead contact system (OCS) supplies the 25kV traction power to the trains. The operation of the OCS shall be controlled from the Operations Control Center (OCC) but shall have the ability to be isolated from the Operations Control Center or other remote locations. Generally grounding of the conductors must be done locally by qualified railroad employees. Emergency responders will be required to confirm isolation and grounding of the OCS prior to commencing operations that might interfere with or otherwise bring them into contact with the OCS.

The use of grounding switches is becoming a common safe practice to provide the ability to remotely isolate and ground the OCS in a confined area where people may be trapped. This allows a positive indication of the grounded OCS to be given to the emergency responders without having to wait for the qualified employee to arrive. The use of grounding switches can be studied in conjunction with the OCS design and their applicability determined on a site-specific basis for underground stations and tunnels.

Special considerations for the OCS system shall be included in the development of emergency response plans for all infrastructure elements. OCS poles shall be located outside of the dynamic train envelope and the walkway envelope.

Technical Memorandum 3.2.1 *OCS Requirements* identifies in greater detail the operation of and design requirements of the OCS system.

3.6.10 Radio Communication Sites

Stand-alone radio sites will be located along the CHSTS trainway at nominal 2.5 mile intervals, co-located with traction power or train control sites where possible. The facilities shall share vehicle access roadways with access/egress points as described in Section 3.2. Access control measures shall be provided as described in Section 3.5.3.

Collapsible radio towers will be designed so as to collapse away from the CHSTS operating envelope for maintenance or other purposes.

3.6.11 Grounding and Bonding

Grounding and bonding of the high-speed train traction electrification system is necessary for protection against electric shock. Technical Memorandum 3.2.6 *s Traction Electrification System Requirements for Grounding and Bonding and Protection against Electric Shock* defines grounding and bonding requirements generally, for traction power facilities, the overhead contact system, for passenger station platforms, for structures, and for overhead bridges. Additionally, the TM defines the requirements for protection against electric shock from induced voltage and lightning strikes.

3.6.12 Structures

Structure, Walls and Windows -- Glazing and strength requirements are to be developed.

Progressive Collapse -- Building and structure designs shall not be vulnerable to progressive collapse. A structure shall have adequate redundant load paths. Local damage to a structure shall not lead to complete collapse or failure.

Building Materials -- Building materials which have inherent ductility and are better able to respond to load reversals shall be given special consideration

Air Intakes -- Air intakes, especially those for tunnels, shall be monitored and access controlled. A security zone shall be established around the intake, which is access controlled with fencing, gate and appropriate signage. The distance from the edge of the security zone to the intakes shall be based on a standoff distance from possible explosive detonations. Intakes shall be



installed as high as practical from the ground with a minimum of 12 feet from ground level. If this is not feasible, the intake shall be covered with a vertical duct. The duct opening shall not be located at the height of the structure or at a point where it is easily accessible from the structure. Duct openings can be curved at the top but shall be angled and covered with a screen.

Air intakes design shall prevent recirculation of smoke into structures or tunnels. Air intakes on buildings shall be located on the roof or as high as possible as appropriate. Vent structures and buildings shall be nondescript and blend into the surrounding community.

Protecting Incoming Utilities -- Overhead utility systems shall be located at least 50 feet from loading docks, main entrances or parking areas. Incoming systems shall be concealed and properly protected, including possible burial or encasement.

3.6.13 Communications

Public Address -- Speakers and amplifiers shall provide coverage to all public areas.

Redundant Communications -- Multiple forms of communication shall be utilized in order to maintain communications in case of incident.

Alarm and Information Systems -- Alarm and information systems shall not be mounted in a single conduit or co-located.

Emergency Alarms and Telephones -- Emergency call buttons, alarms, or telephones shall be installed in stations, on station sites, in tunnels, on viaducts and bridges, and in other select places along the alignment.

Technical Memorandum 3.4.2 *Communications Site Requirements* addresses in greater detail the platform configuration, platforms adjacent to through tracks, setback to obstructions from the platform edge, and under-platform refuge area, and other platform design requirements.

3.6.14 Signage and Wayfinding

Appropriate safety and security signage shall be used throughout the system to ensure safety for passengers, staff, and the public. Confusing, inconsistent or non-existent signage can reduce site safety and security. Where applicable, signage shall cite California laws. Signage shall reflect general signage and wayfinding standards which are to be developed. Safety signage such as those pertaining to warnings, trespassing, danger, and loitering shall be used in stations, at bridges and overpasses, at right-of-way edges, on and around trainways, and around and inside tunnels. Unless required for safety reasons or by other standards, signs shall not identify sensitive areas.

Signage shall be consistent with System Requirement INF 3-48, and shall follow ADA, CPUC, NFPA 130, and CFR Title 29, Part 1910 standards and guidance.

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

3.6.15 Landscaping

Landscaping can improve or hinder safety and security. Soft and hardscape can direct circulation and limit access. Landscaping that could allow for concealment or reduce sightlines shall be avoided.

Trees should have, at a minimum, a six foot (6') canopy; hedges should not be taller than two feet (2'). Perimeter fencing and walls shall have a minimum ten foot (10') clearance from the nearest planting, allowing for easy observation of potential trespassers or weapons concealment.

3.6.16 Wind Turbine Adjacency

The safety hazard associated with the location of the CHSTS trainway adjacent to a wind farm is a physical one resulting from the intrusion into the CHSTS trainway of debris that has become disengaged from the wind turbine: ice throw, rotor failure, or structural collapse.



Although the potential for ice accumulation in California is slight, ice throw can be mitigated through shut-down procedures for the wind turbine during conditions that cause ice to form. Rotor failure and structural collapse represent the more significant hazards to the CHSTS trainway, and both can be mitigated through horizontal setback requirements.

Rotor failure occurs when the wind turbine revolves at a rate greater than its design speed and centrifugal force causes the rotor to come apart or deflect enough to strike the support tower. Possible causes of turbine overspeed include strong wind gusts, severe thunderstorms, and failure of the mechanical brake system under abnormal conditions, and manufacturing defects under normal conditions. Rotor throw—the loss of a rotor due to hub failure—is an uncommon occurrence in wind energy projects, but blade or rotor failure can occur due to extremely high winds, excess rotor speed or from electrical system failure. Modern wind turbines are equipped with safety and engineering features (including redundant braking systems) to reduce the risk of blade failure and are designed in accordance with international construction standards to ensure safe operation under normal conditions, but still the incidents occur. If the failure were to occur at the hub, the turbine could throw the entire rotor, posing the greatest potential for catastrophic intrusion into the CHSTS trainway. The hazard posed by a blade tip or fragment striking a CHST train, while lessened due to the smaller fragment size, still could pose a life-threatening hazard if it were to breach the CHSTS vehicle.

Structural collapse of the entire tower can occur if the wind turbine structure becomes unbalanced following the loss of a rotor, or if the tower itself is struck by a highly-deflected or thrown rotor. The tower can topple at a 90 degree angle (like a fallen tree), resulting in a debris throw a distance of at least the tower height and rotor length. Tower height is dependent on the nominal wind conditions and the surrounding terrain. Setback distances will require site-specific measurement of the particular wind turbines.

Setback Requirements – Horizontal separation between the CHSTS trainway and any wind turbine shall be no less than one and one-half (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).

Notifications and Operational Response - Mitigation for this hazard is the development of a protocol for the notification by the wind turbine operator to the CHSTS Operations Control Center of an adjacent wind turbine operating in an unsafe condition (overspeed, excessive winds, ice buildup, etc). The CHSTS Operations Control Center can then implement an appropriate response. The Operations response shall include a range of responses, from continued monitoring to stopping of trains, appropriate to the proximity and specific conditions of the wind turbine.

3.7 HAZARD DETECTION SYSTEMS

3.7.1 Seismic

The California High-Speed Train system shall employ a dedicated Earthquake Early Warning (EEW) system for CHSTS operations. EEW monitoring stations shall be installed at regular intervals along the CHSTS, and at locations where the trainway crosses known earthquake faults. The EEW system may be supplemented with information from the California Integrated Seismic Network (CISN) and other seismic data sources.

Additionally, monitoring systems shall be used near portals and other trackway locations to detect falling rocks and landslides associated with ground movement.

3.7.2 Climatic

Climatic conditions, including rain, wind and snow can affect high-speed train operation. Monitoring of climatic conditions will include temperature, wind, precipitation, humidity and other factors. Guidelines for climatic monitoring will be developed. Thresholds for automatic or manual operational response are under development.



High Water / Flood Detectors shall be installed where necessary taking into account drainage, culverts, bridges, overpasses, underpasses and flood plains. The system shall notify the ATC system and the OCC of any location where an accumulation of water exists in the right-of-way which may be a risk to the right-of-way, in-service equipment or passenger equipment.

Slide Detectors shall be installed at locations of potential landslides onto the CHSTS trainway, where supported by site-specific hazard analysis. Slide detectors shall transmit information to the OCC and directly to the train control system when certain hazard thresholds are achieved.

Cross Wind Detectors shall be installed where necessary based on area wind and weather patterns, topography (particularly mountain passes), and proximity to bodies of water. Wind speed data shall be transmitted continuously to the OCC.

Temperature Detectors shall be installed where necessary based on changing average temperatures along the corridor. Temperature data shall be transmitted continuously to the OCC.

3.7.3 Intrusion

Intrusion Detection shall be located along the right-of-way and at CHSTS facilities identified as high risk locations. Intrusion detection shall detect access to elevated trackways, air intakes, cross passages, subsurface to surface access locations, ATC interlocking houses, communications houses, traction power facilities, station platform edges, tunnel portals, and other critical infrastructure areas. Intrusion detection shall be employed at high risk locations for theft, vandalism, accidental and intentional entry or other types of intrusion where required by site-specific hazard or threat/vulnerability analysis. The intrusion detection system will not be contiguous for the whole of the route. Intrusion detection systems shall report to the OCC and appropriate RCC as well as local administrative and/or security offices depending on the location.

Fall Intrusion Detectors shall be located at overpasses and underpasses used by highway vehicles, animals, and non-CHSTS equipment. These will utilize detection systems appropriate to the specific site and application. Data output from the fall intrusion detectors shall be fed to the ATC system and available to railroad operations personnel.

Rock Fall Intrusion Detectors shall be located at tunnel portals and in areas adjacent to retained embankments and cut slopes that are prone to rock falls or other landslides. These will utilize detection systems appropriate to the specific site and application. Data output from the fall intrusion detectors shall be fed to the ATC system and available to railroad operations personnel.

Wayside Intrusion Detectors shall be installed in the fencing along the CHSTS right-of-way to detect intrusion to the maximum extent practical. This system shall be installed in all areas where intrusion may occur, as supported by site-specific hazard analysis or threat/vulnerability assessment. These detectors shall be connected to the ATC system and to the OCC and shall alert the OCC when intrusion occurs.

Closed Circuit Television (CCTV) will be used throughout the system at high-risk locations as identified in a site-specific TVA or hazard analysis to monitor and record activities. Possible locations include but are not limited to station buildings, platforms, station sites, parking facilities, trainways, bridges, overpasses, tunnel portal entrances, tunnel emergency entrances, tunnel portal crossovers, maintenance facility entrances, air intakes, and air intake cross passageways. CCTV will focus on points of access. CCTV feeds will be accessible from the OCC and local security facilities and be integrated with access control and intrusion detection equipment. Facility specific information about CCTVs is provided in other technical memoranda. Station CCTV is addressed in TM 2.2.2 *Station Program Design Guidelines*.

In spaces where lighting is inappropriate due to environmental impacts, infrared receptors with infrared cameras or other appropriate technologies may be used.

3.7.4 Equipment Detection

On-Board Diagnostic Systems shall be installed to monitor the CHSTS vehicles for performance and to detect the presence of hazards such as fire and smoke. Information from the



on-board diagnostic systems shall be transmitted to the train operator, Operations Control Center, and vehicle maintenance facilities.

Dragging Equipment Detectors shall be installed at locations where underframe repair or maintenance is performed and other locations as deemed necessary. The detector shall transmit data to the OCC.

3.7.5 Other Hazards

Ambient Gas Detectors shall be installed in tunnels, trenches, underground stations, and other below-grade locations identified by site-specific hazard analysis, and at locations adjacent to solid-waste disposal sites regulated by California Code of Regulations Title 27, Chapter 6, Section 20921 and as supported by site-specific hazard analysis.

Explosive, chemical, biological and radiological detection equipment shall be installed at high-risk locations as identified in a site-specific TVA. Locations may include but are not limited to stations, tunnels, and air vent locations.



4.0 SUMMARY AND RECOMMENDATIONS

Design of infrastructure shall promote and support a safe and secure high-speed train system. Safety is a principal requirement of the CHSTS and many system components have functional requirements pertaining to safety. The implementation of safety and security measures improves the actual and perceived safety and security. The goal is to manage safety hazards and security vulnerabilities so as to achieve a level of safety and security that is acceptable to the California High-Speed Rail Authority. Two design strategies for achieving an acceptable level of safety and security are Prevention through Design and Crime Prevention through Environmental Design, as described in Section 3.1.

It is recommended that the high-level strategies for infrastructure elements (as presented in Section 6.0) that support an acceptable level of safety and security are implemented in the development of the California High-Speed Train System.



5.0 SOURCE INFORMATION AND REFERENCES

- CHSTS Design Basis Document – California High-Speed Train System – High-Speed Rail System Design Comparison
- CHSTS Guidance Document of Required Safety Elements Necessary for FRA Regulatory Approval
- CHSTS Safety and Security Management Plan
- CHSTS Technical Memoranda
 - TM 1.1.21 – Typical Cross-Sections for 15% Design
 - TM 2.2.2 – Station Program Design Guidelines
 - TM 2.2.3 – Station Site Design Guidelines
 - TM 2.2.4 – Station Platform Geometric Design
 - TM 2.3.3 - Design Guidelines for High-Speed Train Aerial Structures
 - TM 2.4.2 – Basic High-Speed Train Tunnel Configuration
 - TM 2.4.5 – High-Speed Train Tunnel Structures
 - TM 2.4.6 – Tunnel Portal Facilities
 - TM 2.5.1 – Structural Design of Surface Facilities and Buildings
 - TM 2.7.5 - Utilities
 - TM 2.8.2 – Access Control for High-Speed Rail Right-of-Way and Facilities
 - TM 3.1.1.3 – Traction Power Facilities General Standardization Requirements
 - TM 3.2.1 – OCS Requirements
 - TM 3.2.6 – Traction Electrification System Requirements for Grounding and Bonding and Protection against Electric Shock
 - TM 3.3.2 – ATC Site Requirements
 - TM 3.4.2 - Communications Site Requirements
 - TM 300.05 – CHSTS Reliability, Availability, Maintainability, and Safety (RAMS) Program Policy
 - TM 500.01 – Safety and Security Policy Statement
- CHSTS System Requirements
 - 3-16.1 Maximum pressure variations in tunnels
 - 3-16.2 Piston effect in underground stations
 - 3-17 Effect of Crosswinds
 - 3-20.1 Speed of trains through station platforms
 - 3-20.7 Prevention of electric shock on station platforms
 - 3-21 Fire safety and safety in railway tunnels
 - 3-22 Access to or intrusion into line installations
 - 3-23.1 Lateral space alongside of tracks for passengers and onboard staff in the event of derailment outside of station



- 3-23.2 Escape walkways in tunnels
- 3-33.3 Protection of workers against aerodynamic effects
- 3-43 Vegetation Control
- 3-45 Derailment Containment
- 3-48 Signage and Graphics
- 4-02.2 Prevention of unauthorized access to emergency exits and equipment rooms
- 4-02.3 Fire Protection requirements for structures
- 4-02.4 Fire safety requirements for structural and non structural construction materials
- 4-02.5 Automatic fire detection
- 4-02.6 Facilities for self-rescue, evacuation and rescue in case of an incident
- 4-02.8 Emergency lighting on evacuation routes in tunnels
- 4-02.9 Emergency exit signage in tunnels
- 4-02.10 Emergency communication
- 4-02.11 Access for rescue services
- 4-02.12 Rescue areas outside tunnels
- 4-02.13 Water Supply
- 4-03-5 Reliability of electrical installations
- CHSTS Preliminary Hazard Analysis (PHA) and Certifiable Elements and Hazard Log (CEHL)
- CHSTS Preliminary Threat and Vulnerability Assessment (TVA) Report
- CHSTS Concept of Operations (ConOps) document
- CHSTS Rolling Stock Specifications
- California Code of Regulations
 - Title 8, Division of Occupational Safety & Health Regulations
 - Title 24, Part 9 California Building Code 2010
 - Title 24, Part 9 California Fire Code 2010 Based on the 2009 International Fire Code
 - California Code of Regulations Title 24, Part 433 Fixed Guideway Transit Systems
- California Public Utilities Commission General Orders
- Federal Railroad Administration regulations found in 49 CFR Parts 200-299
- National Fire Protection Association Standards
 - NFPA 14 – Standard for the Installation of Standpipe and Hose Systems (2010 Edition)
 - NFPA 72 – Fire Alarm and Signaling Code (2010 Edition)
 - NFPA 101 – Life Safety Code (2012 Edition)



- NFPA 130 - Standard for Fixed Guideway Transit and Passenger Rail Systems (2010 Edition)
- CENELEC Standard EN 50126-1 Railway applications – The specification and demonstration of Reliability, Availability, Maintainability, and Safety (RAMS)
- The Manual for Railway Engineering of the American Railway Engineering and Maintenance-of-Way Association (AREMA Manual)
- Technical Specifications for Interoperability for the Trans-European Transport Network.
- American National Standards Institute Standards
 - ANSI 117.1 –Standard for Accessible Design for Persons with Disabilities
 - ANSI Z590.3-2011: *Prevention Through Design, Guidelines for Addressing Occupational Hazards and risks in Design and Redesign Processes*
- National Institute of Law Enforcement and Criminal Justice (NILECJ) publications
- Crime Prevention through Environmental Design, Crowe, Timothy D., National Crime Prevention Institute
- Illuminating Engineering Society of North America (IESNA) standards for lighting
- FOX Proposed Rule of Particular Applicability. Sec 243.233 Wayside Detectors
- Recommended Security Guidelines for Airport Planning, Design and Construction. Transportation Security Administration. June 15, 2006
- Facilities Standards for the Public Buildings Service. US General Services Administration. Office of the Chief Architect. March 2005. Chapter 8: Security Design
- Taiwan High Speed Rail Corporation. Volume 9 Design Specifications - Section 8: System Safety and System wide Interface Design Specification
- Safety and Security in High-Speed Rail Lines. APTA-UIC International Practicum on Implementing High-Speed Rail in the United States



6.0 DESIGN MANUAL CRITERIA

6.1 DESIGN PRINCIPLES AND STRATEGIES

Design of infrastructure shall promote and support a safe and secure high-speed train system. Safety is a principal requirement of the CHSTS and many system components have functional requirements pertaining to safety. The implementation of safety and security measures improves both actual and perceived safety and security. The goal is to manage safety hazards and security vulnerabilities so as to achieve a level of safety and security that is acceptable to the Authority. Two design strategies for achieving an acceptable level of safety and security are Prevention through Design and Crime Prevention through Environmental Design.

Prevention through Design (PtD)

PtD is the concept of addressing safety and health needs in the design and redesign process to prevent or minimize the hazards and risks associated with the construction, manufacture, use, maintenance, retrofitting, and disposal of facilities, processes, materials, and equipment. PtD prescribes the application of a hierarchy of controls as follows:

1. Elimination
2. Substitution
3. Engineering Controls
4. Warnings
5. Administrative Controls
6. Personal Protective Equipment

Crime Prevention through Environmental Design (CPTED)

CPTED will be applied as appropriate throughout the system to prevent and mitigate crime. CPTED practices will be integrated early in the design process. Design shall focus on natural access control, natural surveillance, defensible space, and reinforcement of territory. By incorporating CPTED principles and considerations early in site planning, perimeter definition, sightlines, lighting, landscaping and other site design elements, implementation of alternate, more expensive engineering solutions can be avoided during later stages of design.

CPTED principles include improving sightlines and eliminating areas of concealment. Areas, spaces, or structures that provide concealment shall be avoided, particularly in stations, station sites, parking facilities, bridges, tunnels, and structures and can be improved through organization of space, architecture and lighting.

Safety and Security Management Plan (SSMP)

Infrastructure shall be designed in conformance with the hazard management processes described in the Safety and Security Management Plan (SSMP). The SSMP defines the safety and security goals and objectives, specifies safety and security related activities and processes, and assigns responsibilities for ensuring that activities are conducted and objectives are met.

6.1.1 Safety Strategies

Hazard Management – The safety of passengers, employees, emergency responders and the general public is of primary concern in the design and implementation of the CHSTS. Design of system and subsystem elements that could impact the safety of passengers, employees, emergency responders and the general public shall include hazard management as part of the design process. Hazards shall be identified and assessed for their potential probability of occurrence and consequential effects to the system and hazard risk shall be mitigated to an acceptable level.

Hazards shall be assessed at the program level using Preliminary Hazard Analysis (PHA) techniques, and then assessed at the site-specific level using Site-specific Hazard Analysis (SSHA) techniques. The hazard management program is described in detail in the SSMP.



Site Selection – The site selection for CHSTS facilities shall consider safety hazards during the site selection process. Consideration shall be given to appropriate adjacent land uses and application of perimeter buffer zones to isolate the CHSTS.

Separation – Separation of the CHSTS trainway from the general public is an effective way to avoid safety hazards. The margin for safety is small where trains are operating at 220 mph and elimination of hazards is the most effective approach to hazard management. In contrast to standard railroad operations in the United States, high-speed train operations shall be isolated to the extent possible. All at-grade highway-rail grade crossings on exclusive use corridors shall be eliminated through closure or grade separated from the CHSTS trainway. CHSTS alignments located above, below, or adjacent to other railroad systems and roadways shall use lateral and/or vertical separation (where supported by hazard assessment) to prevent potential intrusion of vehicles into the CHSTS trainway and to protect CHSTS operating infrastructure. Additional physical elements, such as earthen berms and barrier walls, shall be used at locations where deemed appropriate through site-specific hazard assessment.

Access Control – The operation of trains at high speeds (defined by FRA as greater than 110 mph) presents unique hazards to passengers, employees, and the general public. All access to the trainway will be controlled in order to mitigate the hazards associated with higher speeds. Non-employee access will be restricted to public areas in which engineering controls have been applied to ensure the safety of the public.

Redundancy – Safety-critical systems shall be robust and redundant with sufficient space for expanded, additional, and contingency measures. Alternative operating facilities shall be identified to allow for on-going operation of essential functions.

Detection – System-wide hazard detection shall identify those hazardous conditions that could affect the safety of the CHSTS including intrusion detection for persons, vehicles and other large objects, rolling stock conditions, fire and smoke, and natural phenomena including earthquakes, climatic conditions (temperature, wind, and rain), wildfire, mudslides, falling rocks, and high water.

Monitoring – The CHSTS shall be equipped with an integrated system for detecting, monitoring, surveillance, and response to environmental conditions, the railroad operating system, normal operations, and emergencies in real time. Monitoring detectors shall be linked to the central control system, the Operations Control Center (OCC) and/or Regional Control Centers (RCC), the Automatic Train Control (ATC) system, and the traction power supply and distribution systems. Unsafe conditions shall be immediately conveyed through communications systems so that appropriate action may be taken.

Communications – Wired and wireless transport networks, command and control systems, and detection and monitoring systems which shall detect, notify and respond to safety and security incidents. High-speed train communications systems shall be interoperable and functional across the system and with applicable third-party emergency responders.

Lighting – The proper use of illumination can reduce accidents. Facilities, such as walkways, stairways, access/egress points, station platforms and other public areas shall be well-lit to mitigate potential hazards identified in the site-specific hazard analysis. Walkways in tunnels will be lit in accordance with the requirements of NFPA 130.

Fire Protection – The fire protection system shall include fire prevention, fire detection, fire suppression, and mitigation from fire damage including sufficient and safe evacuation capacity. Facilities shall be constructed of fire resistant materials, where practicable, and include fire detection, suppression and smoke removal systems.

Emergency Evacuation – Facilities shall provide capacity for safe emergency evacuation and compliance with emergency procedures. This includes the sizing and location of access and egress points, support infrastructure such as walkways, stairways, and access roads, and support systems such as lighting and communications.



Signage – Passenger and staff warning signs shall be used where appropriate or required. Unless required for safety reasons, signs indentifying sensitive areas shall not be used for security reasons.

6.1.2 Security Strategies

Minimal Access Points – The number of access points shall be limited to those required for operational, maintenance, and emergency access to improve security and cost efficiency. Design shall strive to achieve fewer, more functional, and more maintainable access points. However, there shall be adequate frequency and sizing of access points for normal and emergency operations.

All access points to non-public areas shall be secured with high grade locking devices at a minimum. The Threat and Vulnerability Assessment for each specific area will further identify additional security enhancements, to include but not be limited to CCTV, intrusion detection, security lighting, signage and non-climbable fencing with barbed wire topping.

All stations, maintenance facilities and offices of the CHSTS shall have the ability to be “locked down” to prevent entry by any unauthorized person.

Electronic Access Control – The use of communications systems or other electronic means to control access to facilities or information systems.

Lighting – The proper use of illumination can deter criminal activity. Facilities, such as walkways, steps or platform edges, shall be well-lit to mitigate potential vulnerabilities. Higher lighting levels shall be applied where deemed necessary by a TVA.

Natural Surveillance – The use of windows, clear lines of sight and walkways can enhance security by increasing the perception of security.

Monitoring – An integrated system for surveillance and protection of critical infrastructure shall include intrusion detection, closed-circuit television and access control, reporting both locally and to the Operations Control and the appropriate Regional Control Centers.

Structures – Access to tunnels, sub-grade alignment (trenches), elevated structures and other wayside facilities shall be secured.

Air Intakes – Air intakes shall be elevated and secured. Station and facilities HVAC equipment will be designed in accordance with appropriate security considerations.

Utilities – Incoming utilities shall be protected and secured. Essential utilities shall be redundant to the extent practical.

Security / Law Enforcement – Facilities to support a security or law enforcement presence for the high-speed train shall be included in infrastructure design.

6.2 ACCESS/EGRESS

For egress, the principal operational strategy for incidents of emergency (fire, earthquake, derailment, etc) is to continue operation of the train (if safely practicable) to the nearest station platform for passenger evacuation. If it is not possible to move the train, a second train will be brought to the scene (if safely practicable) to facilitate evacuation of the passengers. In the event that operation of a second train is not possible, passengers must still be afforded the safe and efficient means of egress from the trainway in the event of an incident that requires immediate evacuation by means other than normal routes or methods. The design of the means of egress must consider the worst-case scenario in terms of passenger load (up to 1000 people per train) and reasonable adverse conditions (night time, inclement weather). Typical passengers include the elderly and children, and they must be treated in a manner that provides for their particular safety needs. Egress analysis shall be performed to support the site-specific access/egress design requirements.



Access requirements for emergency response operations must also be provided to allow emergency responders to respond to incidents such as fire, derailment/collision, or passenger or employee injury. The design of the means of emergency access must consider the typical fire engine size and operating characteristics as defined by the California Fire Code. Evacuations of a large number of people from underground structures or via aerial ladder truck are challenging, time-consuming, and difficult, especially when conducted from an extreme height. Every effort must be made to design facilities that allow for egress from elevated viaducts by other than aerial ladder truck.

6.2.1 Alignment Configurations

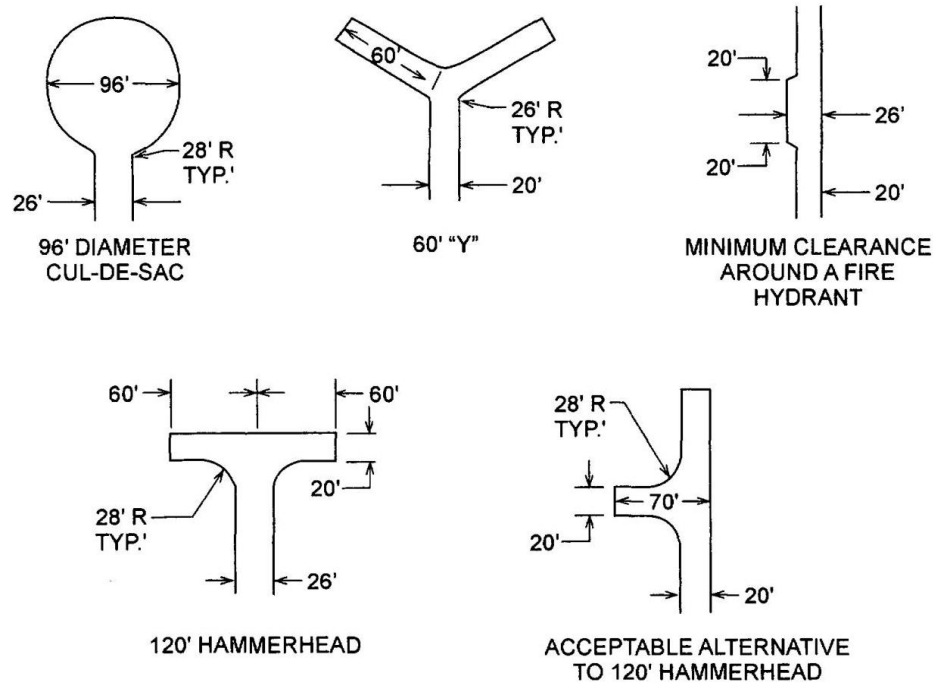
Walkways – For egress pathways the CHSTS shall be equipped with a continuous walkway to allow passengers to evacuate a train to a station or place of safety at any point along the trainway. Walkways shall be located adjacent to each track where practicable, and may be located between and shared by two adjacent tracks. Walkways will consist of a uniform, slip-resistant surface. The walkway envelope shall be a minimum 3.0 feet wide by 7.5 feet tall, with the upper 1.5 feet tapering to a width of 2.5 feet, free of any obstructions. Crosswalks, connecting the two sides of the trainway with a walking surface uniform to the top of rail, shall be located at access/egress points, special trackwork (switches and crossovers), and cross passageways. Raised walkways shall be provided with a continuous handrail along the side opposite the trainway.

Access/Egress Points – Access/egress points for all alignment configurations shall be provided at nominal 2.5 mile intervals, with a maximum 3.0 mile interval. Access/egress points will alternate sides of the trainway where possible. Crosswalks, connecting the two sides of the trainway with a walking surface uniform to the top of rail, shall be located at access/egress points. Where several alignment configurations are present (at-grade, raised embankment, aerial viaduct, etc.) the nominal distance shall be calculated over the combination of the various alignment configurations, retaining a continuous walkway configuration not to exceed the maximum 3.0 mile interval. Signage mounted on the handrail, fence or retaining wall structure at 1000 foot intervals will direct passengers to the nearest access/egress point.

Access Roads – Access from public roadways to the access/egress points shall be made via access roads with the following characteristics:

- Dimensions - Access roads shall have an unobstructed width of not less than 22 feet inclusive of shoulders and an unobstructed vertical clearance of not less than 14.5 feet.
- Surface - Access roads shall be designed and maintained to support the imposed loads of fire apparatus and shall be provided with a surface that provides for all-weather use. Minimum surface designed to withstand a 75,000 pound (37.5 ton) load.
- Turning radius - The minimum turning radius shall be 45 feet outside radius.
- Dead ends - Dead-end access roads in excess of 150 feet in length shall be provided with space appropriate for the turn-around of fire apparatus as identified in Figure 6-1. This space can also provide room for emergency vehicle staging.
- Bridges - When a bridge is required to be used as part of an access road, it shall be designed, constructed and maintained for a live load sufficient to carry the imposed loads of fire apparatus. Vehicle load limits shall be posted at both entrances to bridges.
- Grade - The gradient for an access road shall not exceed 10% maximum. Grades steeper than 10% will require approval by the AHJ.
- Gates - Where gates restrict public access to the access road, such gates shall have a minimum opening of 20 feet, constructed of the swinging or sliding type, the ability to be opened by one person, and shall provide vehicle access to the trainway



Figure 6-1 – Access Road Dead End Turn-Arounds

Access/egress points that open to the trainway shall be equipped with basic facilities for emergency response: access-control gate, lighting, a communications link to the Operations Control Center and nearest Regional Control Center, and a traction power indication panel.

6.2.2 At-Grade Alignments

Walkways shall be located outside the OCS support poles on both sides of the trainway, but close enough to be accessible directly from the train via portable ramp or ladder equipment.

Access/egress points for at-grade alignments shall be co-located with traction power facilities (substations, switching stations, and paralleling stations), interlocking houses, stand-alone radio sites, and other wayside facilities where practicable. Access roads will continue along the interior of the trainway where practicable.

Technical Memorandum 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities* identifies in greater detail the access/egress requirements for at-grade alignments.

6.2.3 Raised Embankments and Retained Fills

Walkways shall be located outside the OCS support poles on both sides of the trainway, but close enough to be accessible directly from the train via portable ramp or ladder equipment. Sufficient shoulder on the raised embankment or retained fill shall be provided for the walkways at track level. Retained fills with a precipice of greater than 30 inches shall be provided with a fall-restraint barrier such as handrailing or parapet walls. The barrier design shall conform to the requirements of CCR Title 8, Chapter 4, Section 3210 Guardrails at Elevated Locations.

Access/egress points for raised embankments or retained fills shall be provided by stairways which meet the minimum requirements of NFPA 101 at nominal 2.5 mile intervals with a maximum 3.0 mile interval and co-located with traction power facilities, interlocking houses, stand-alone radio sites, and other wayside facilities where practicable. Such stairways shall alternate sides where possible and shall be located within 100 feet of the emergency vehicle staging area and protected by an access-control pedestrian gate with a minimum 48 inch opening.



Technical Memorandum 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities* identifies in greater detail the access/egress requirements for at-grade alignments.

6.2.4 Aerial Structures (Bridges and Viaducts)

Walkways shall be located on the outer edges of the aerial viaducts, inside of the OCS support poles. Aerial structures shall be equipped with a fall-restraint barrier such as handrailing or continuous parapet walls to prevent persons from falling from the structure. The barrier design shall conform to the requirements of CCR Title 8, Chapter 4, Section 3210 Guardrails at Elevated Locations.

Access/egress for aerial alignments shall be provided by stairways which meet the minimum requirements of NFPA 101 at nominal 2.5 mile intervals with a maximum 3.0 mile interval and co-located with traction power facilities, interlocking houses, stand-alone radio sites, and other wayside facilities where practicable. Such stairways shall alternate sides where possible and shall be located within 100 feet of the emergency vehicle staging area and protected by an access-control pedestrian gate or enclosure with a minimum 48 inch opening.

In addition to access/egress stairways at nominal 2.5 mile intervals, alignments with restricted access to the right-of-way through the fence (elevated viaducts, trench structures) require additional opportunities for emergency access. Access to elevated viaduct structures by aerial ladder trucks shall be afforded at nominal 2500 feet intervals with a maximum interval of 3000 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.

Technical Memorandum 2.3.3 *Design Guidelines for High-Speed Train Aerial Structures* identifies in greater detail the access/egress requirements for aerial structures.

6.2.5 Sub-Grade (Trench) Structures

Walkways shall be located along the trench walls on the same side as the access/egress points where possible. Walkways shall be illuminated to provide safe passage in the event of an evacuation.

Aerial ladder trucks cannot reach into trench structures due to the presence of the overhead contact system. Access/egress for sub-grade trainway alignments shall be provided by stairways which meet the minimum requirements of NFPA 101 at nominal 2500 feet intervals with a maximum 3000 feet interval. Such stairways shall be located within 100 feet of the emergency vehicle staging area and protected by an access-control pedestrian gate with a minimum 48 inch opening.

6.2.6 Tunnels

Walkways shall be located along the tunnel walls on the same side as the access/egress points or cross passageways where possible. Walkways shall be illuminated to provide safe passage in the event of an evacuation, in accordance with the requirements of NFPA 130.

Egress from twin bore single-track tunnel structures shall be provided by passage to a place of refuge at 800 feet intervals. Cross-passageways shall be equipped with fire doors with self-closing mechanisms at each opening. Egress from single bore double-track tunnels equipped with center walls shall be provided by fire doors opening to the opposite track. Doors shall be hinged to open in the exit direction where possible, or sliding doors if required due to obstructions on the other side of the door or where the doorway opens directly to another trainway. Doors shall be 1.5 hour fire-rated and equipped with self-closing mechanisms. Egress from single bore two-track tunnels not equipped with center walls shall be provided by lateral or vertical exits to the surface every 2500 feet.

The cross-passageway envelope shall be a minimum 44 inches wide by 7 feet tall, free of any obstructions. Cross-passageways shall be illuminated in the event of an incident requiring evacuation.



Technical Memorandum 2.4.2 *Basic High-Speed Train Tunnel Configuration* identifies in greater detail the access/egress requirements for tunnels.

6.2.7 Station Facilities

The guidance for access/egress at station facilities can be found in NFPA 101, NFPA 130 and California Building Code section 433 (as corrected to reflect the six minute evacuation rule).

Emergency responders shall be provided access to all areas in and around the station in the event of an incident of emergency response. Fire Lanes will be designated in the vehicle roadways and parking areas surrounding the station. At least one entrance shall be designated as the Emergency Access Entrance and identified as such in the Emergency Action Plan for the facility.

Evacuation routes must be available to evacuate all passengers from the affected station platform (Platform Occupant Load) in four minutes or less and from the most remote point on the platform to a point of safety in six minutes or less. Once the last passenger has set foot upon a platform escalator or stair, sufficient escape routes shall be provided to enable evacuation to a point of safety within the remainder of the total six minutes. At least two means of egress, remote from each other shall be provided from each station platform.

Evacuation routes shall be planned so that a passenger confronted by an outbreak of fire can turn away and make a safe escape. To achieve this goal the maximum travel distance to an escape route, such as an escalator, stair, passageway or entrance, shall not exceed 325 feet. Fare gates shall assume an emergency exit mode in the event of loss of power to the fare gates or upon actuation of a manual or remote control.

Technical Memorandum 2.2.2 *Station Program Design Guidelines* identifies in greater detail the requirements for evacuation from stations and emergency access into stations.

6.2.8 Support Facilities

Design of access/egress for all support facilities shall be in compliance with the requirements of California Code of Regulations, Title 24, Part 9 *California Fire Code*.

6.3 FIRE AND LIFE SAFETY INFRASTRUCTURE

Achieving an acceptable level of fire and life safety is a principal goal for the CHSTS. Each type of high-speed train facility shall have location-specific fire and life safety infrastructure, standards, plans and procedures. The principal guidance for fire and life safety infrastructure is found in NFPA 130, modified as appropriate to the peculiar characteristics of high-speed train operations and as amended by other NFPA standards. Fire protection strategies and designs shall focus on prevention, retardation of fire growth, detection, suppression, containment, and evacuation in order of precedence. CHSTS facilities shall be constructed of fire resistant materials, where practicable, and comply with State and local fire codes where applicable. The Office of the State Fire Marshal is the authority having jurisdiction, but local fire codes will be applied where deemed appropriate by OSFM. Fire detection, suppression, and smoke removal systems shall be implemented. Capacity and facilities for safe emergency evacuation and emergency procedures shall be provided. Fire suppression strategies shall consider that the use of water and conductive chemicals is not compatible with the OCS. Response to fire on trains or within the trainway must be first coordinated with the Power Director within the OCC who is responsible for ensuring the protection of the high voltage power in the OCS.

6.3.1 Stations

Stations, by their nature, are locations where activities with the potential for fire or other life safety hazards are present. In addition, the presence of large concentrations of passengers leads to unique requirements for fire and life safety facilities. Worst-case scenarios for occupant load and incident must be considered. NFPA 130 is the principal guidance document except where modified by CBC 433.



An automatic sprinkler protection system shall be provided in areas of stations used for concessions, storage areas, trash rooms, and in the steel truss areas of all escalators and other similar areas with combustibles loadings, except trainways. Equipment rooms with electrical and electronic equipment, such as Communications and ATC equipment rooms, shall have special fire protection provisions as defined in the respective discipline-specific technical memoranda. Fire protection standpipe and hose systems shall be installed in accordance with NFPA 14 and as modified by NFPA 130. Fire hose cabinets and portable fire extinguishers shall be provided as required by NFPA 130.

Emergency lighting for passenger areas and emergency egress pathways shall be provided in accordance with NFPA 101 and as modified by NFPA 130. Backup electrical power will be supplied by an emergency standby generator for select electrical loads including fire protection systems, ventilation systems, emergency lights and signage, communication systems; train controls systems, and low-voltage direct-current battery supply systems to support emergency lighting and communications.

Station facilities shall include a law enforcement office for the principal purpose of providing security to the CHSTS. The station control room shall also be equipped to act as an Incident Command Post (ICP) in the event of an incident that requires enacting the Incident Command System. ICP elements shall include copies of the Emergency Action Plan for the station, emergency communications systems, stations plans, and fire protection system and ventilation system controls, as applicable. Underground stations shall be provided with a fire command center in accordance with NFPA 72.

Technical Memorandum 2.2.2 *Station Program Design Guidelines* identifies in greater detail the fire and life safety infrastructure for stations.

6.3.2 Tunnel Interiors

Tunnels, by their nature, present unique challenges to the fire and life safety response efforts in the event of an incident. The physical space is confined for operational response, access is extremely limited, and the environment can be unfamiliar and confusing to both passengers and emergency responders. Careful planning for and development of emergency response plans, communications and infrastructure, and training programs for passengers, employees, and emergency responders can mitigate the effects of a fire and life safety incident in and around a tunnel.

Fire and life safety infrastructure inside tunnels shall include emergency walkways and access/egress infrastructure as described in Section 6.2.6. Additional fire and life safety infrastructure shall include dry standpipe systems with universal fire hose connections, radio communications systems for railroad operations and fire and life safety operations separately, hard-wired communications stations at each cross passageway or other access/egress point, signage directing to the nearest egress point, and lighting. Lighting for the walkways shall be provided in all tunnels in excess of 250 feet in length. NFPA 130 is the primary source of guidance.

Ventilation systems shall be installed in tunnels greater than 1000 feet in length where supported by a Fire Hazard Analysis report. Ventilation systems shall be sized to allow maintenance of a smoke-free environment for duration sufficient to allow passenger egress to a place of safe refuge.

Technical Memorandum 2.4.2 *Basic Tunnel Configuration* identifies in greater detail the tunnel walkway requirements.

6.3.3 Tunnel Portals

Tunnel portals are potential locations for congestion and confluence of emergency response operation during an incident, requiring greater fire and life safety infrastructure. In the event of an incident inside the tunnel that requires evacuation or emergency response, the tunnel portal will be a confluence of evacuees from the tunnel environment, emergency responders attempting to access the tunnel to implement fire and life safety operations, and smoke discharge from the



tunnel fire. Each of these three incident response elements must be considered and allowed for when designing tunnel portal layout and facility requirements. Additionally, tunnel portal facilities are generally located at environmental transitions (hillsides) that tend to be space-constrained and require particular consideration for layout.

Fire and life safety infrastructure at tunnel portal facilities for passenger egress shall include paved emergency egress walkways from tunnels, train surface evacuation and fire control zones for each track, designated crosswalks at top-of-rail height, area lighting, and a rescue area/passenger assembly area. Infrastructure for fire-fighting operations and other emergency response operations include an access road, emergency vehicle assembly and turnaround area, fire hydrants and emergency water supply, an emergency power supply, cross track emergency vehicle access, emergency communication facilities for hard-wired and radio communication systems, overhead contact system motorized disconnect switches, an incident command post, and a helicopter landing pad where the installation of an access road is impracticable. Infrastructure for the extraction of smoke from the tunnel, where supported by Fire Hazard Analysis, includes a portal ventilation building.

A site-specific hazard analysis shall be conducted for each tunnel portal to determine the appropriate fire and life safety infrastructure to be provided at each specific tunnel portal. Consideration shall be given to tunnel length, proximity to other tunnels, surrounding topography, and access/egress routes. Technical Memorandum 2.4.6 *Tunnel Portal Facilities*, Section 6.3 provides details on how to determine the appropriate requirements of fire and life safety infrastructure for different categories of tunnels.

Security infrastructure at tunnel portal facilities includes intrusion protection fence, security gates, intrusion detections systems, and landscaping designed with CPTED principles in mind.

Technical Memorandum 2.4.6 *Tunnel Portal Facilities* identifies in greater detail the fire and life safety infrastructure elements at portal facilities by type of tunnel.

6.3.4 Support Facilities

Design of fire and life safety infrastructure all support facilities shall be in compliance with the requirements of California Code of Regulations, Title 24, Part 9 *California Fire Code*.

6.3.5 Other Locations

Fire and life safety infrastructure at all other access/egress points shall include an access road, emergency vehicle assembly and turnaround area, area lighting, pedestrian crosswalk connecting the two sides of the trainway with a walking surface uniform to the top of rail, and emergency communication facilities for a hard-wired connection to the OCC and appropriate RCC.

6.4 SECURITY FACILITIES

Facilities to support security services and employees must be included in the high-speed train infrastructure.

6.4.1 Law Enforcement Space/Facilities

High-speed train stations shall have office and vehicle parking space for sworn law enforcement officers as defined in TM 2.2.2 *Station Program Design Guidelines*. This includes areas where suspects can be detained and complainants interviewed separately. Guidelines for other law enforcement spaces and facilities are to be developed.

6.4.2 Security Guard Space/Facilities

The CHSTS will deploy a security force at each station, maintenance facility, the OCC/RCCs and other locations as identified by a site-specific TVA. Space for locker rooms as well as parking for both personal and agency vehicles must be provided. A fleet of agency vehicles will be necessary to provide alignment patrols as needed to support the CHSTS security program. High-speed train stations shall have security offices as defined in TM 2.2.2. Guidelines for other security spaces and facilities are to be developed.



6.5 ACCESS CONTROL

6.5.1 Control of Access

FRA's *High-Speed Passenger Rail Safety Strategy* calls for the isolation of the passenger system from hazards, including the degree of security that can be established on the trainway. With train operation at up to 220 mph the hazards presented to both train operations and pedestrians can reasonably be expected to be catastrophic when persons or other obstructions are present on the trainway. The trainway shall be fully access-controlled so that only persons authorized to be in non-public areas are present.

Public spaces, such as those at stations, shall be able to be fully closed outside of operational hours or during emergencies. Trains and some spaces within stations (e.g., platforms, paid areas) shall only be accessible to members of the public holding a valid ticket. In order to protect non-revenue or secure areas from unauthorized access, secured perimeters, including fencing, walls, or other physical barriers, electronic barriers like sensors and alarms, and natural barriers shall be implemented. The location and design of the secured perimeter shall consider effectiveness and functionality.

Control of Access is addressed in Technical Memorandum 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities*. This document defines both the infrastructure used to control access as well as what devices will be used on different facilities. Topics covered in this document include:

- Access Control Devices (fences, walls, traffic barriers, gates, signage, vegetation control)
- Access Control by Type of CHSTS Trackway
- Access Control by Type of Facility (yards and maintenance facilities, ATC, communications, traction power facilities, passenger stations, parking structures)
- Access Control at Other Locations (end of line and storage tracks, highway overpasses crossing CHSTS trackway, streets dead-ending at CHSTS trackway, access roads, maintenance roads, emergency exits and equipment rooms in tunnels, drainage structures)

Doors shall be controlled by electronic control devices such as card readers or pin pads. Doors used for normal operations shall have natural surveillance where practicable. Emergency exit doors shall have both audio and visual alarms and shall comply with appropriate fire codes.

Staffed guard stations may be appropriate at high-speed rail facilities such as heavy maintenance yards. Devices, such as turnstiles, tire shredders, roll-up gates, pop-up barriers or drop gates, may be used to prevent unauthorized passage. Stations shall be designed to promote maximum visibility over the surrounding area.

Electronic access points, including automatic gates, doors with access controls, sensor line gates and automated portals, shall be utilized over mechanical or staffed access control.

Access/egress points shall be secured from means of being opened by forcible entry tools, and shall also be equipped with a combination key box containing the key to the lock installed at the location. The combination to the key box shall be made known to local emergency responders. All access/egress locks must comply with the CBC.

6.5.2 Public Spaces

The public interface to the CHSTS occurs at specific, controlled locations: station facilities (including platforms, public concourse areas for ticketing, waiting, and vendor facilities, drop-off and pickup areas, and parking facilities), aboard trains, and at highway and pedestrian walkway overcrossings/undercrossings. These spaces shall be open to public access, although station facilities will be segregated into paid and non-paid areas in order to control ticket possession and validation. Use of Authority-controlled public spaces shall be subject to conformance to Authority policy for use, including hours of access, congregations of people (intentional or not), demonstrations, vending, and other factors affecting the safety and flow of passengers.



Control of access beyond station platforms is described in TM 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities*. Stations shall be equipped with barriers at the ends of the platforms that deter entry into the trainway while also complying with CPUC side clearance regulations. Inter-track barriers shall be installed to restrict the movement of persons from the platform track to the inner tracks used by trains that do not stop at the station. All barriers delineating the limits of public access shall be equipped with appropriate signage for trespass and warning of hazards.

Non-station public spaces shall be separated from the CHSTS trainway by access control fencing, walls, and other permanent barriers as described in TM 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities*. Highway overpasses shall be equipped with a combination of rigid traffic barrier and access-restricting fencing to prevent the intrusion of both vehicles and persons. Access-restricting fences at highway overpasses shall have a curved top section to deter the throwing of objects onto the trainway. In addition, a solid barrier shall be installed directly above the trainway to prevent contact with the OCS wires.

6.5.3 Non-Public Spaces

Access-control infrastructure for non-public spaces is described in detail in TM 2.8.2 *Access Control for High-Speed Rail Right-of-Way and Facilities*. Facilities, rooms, and spaces used in the operation of high-speed trains shall be secured with locks and detection systems. Traction power facilities, ATC housings, communications equipment, and other core systems facilities, where located outside the right-of-way, shall be protected by an access-restricting fence or wall enclosure with secured gates.

Buildings, systems and other facilities that are critical to high-speed train operation shall be made secure when located adjacent to public entrances, public vehicle circulation, public parking or other publically accessible areas. These components include emergency generators, fuel storage, fire pumps, universal power supply facilities, critical HVAC systems, and emergency power distribution feeders.

6.6 OTHER INFRASTRUCTURE ELEMENTS

6.6.1 Highway and Rail Vehicle Intrusion Protection

Protection against intrusion by adjacent rail and mass transit operations shall be achieved through the implementation of possible mitigations, including horizontal separation between track center lines greater than 102 feet, vertical separation, installation of berms and/or ditches, or installation of intrusion prevention crash walls. Location and configuration of the intrusion protection infrastructure shall be supported by site-specific hazard analysis.

Protection against intrusion by highway vehicles from adjacent roadways shall be achieved by locating the CHSTS trainway beyond a Clear Recovery Zone from the edge of the roadway, as identified by Caltrans in its Highway Design Manual. Where such separation cannot be met, a site-specific hazard analysis shall be conducted to determine the requirements for a physical barrier to avert intrusion. The barrier may consist of metal beam guard rails or concrete barriers and shall meet the requirements of Caltrans Traffic Manual, Chapter 7 and CHSTS Technical Memorandum 2.1.7.

Technical Memorandum 2.1.7 *Rolling Stock and Vehicle Intrusion Protection* identifies in greater detail the infrastructure elements required for rail and highway vehicle intrusion protection.

6.6.2 Fire and Smoke Prevention and Mitigation

Fire Prevention and Mitigation – The prevention of fire is achieved through the use of non-flammable materials in the construction of infrastructure and rail vehicles. The effects of a fire, should one occur, can be mitigated through the installation of: on-board fire suppression systems in the high-speed trains; compartmentation in the design of the trains and interior spaces of infrastructure such as tunnels, stations, maintenance facilities, employee facilities, and traction-power facilities; standpipe systems in tunnel and sub-grade (trench) alignments; ventilation



systems in tunnels greater than 1000 feet in length; and access/egress points at nominal 2.5 mile intervals for above-ground alignments and at 800 feet intervals for twin bore single-track tunnel structures and single bore double-track tunnels equipped with center walls. Egress from single bore two-track tunnels not equipped with center walls shall be provided by lateral or vertical exits to the surface every 2500 feet.

Smoke Removal – In the event of a fire, a smoke removal system in enclosed spaces, such as tunnels, underground stations, station concourses, and other confined environments, is critical for the safe and efficient passage of passengers and employees to a place of safe refuge. A mechanical ventilation system shall be provided in tunnels greater than 1000 feet in length where supported by Fire Hazard Analysis. Smoke removal equipment shall be located away from high risk areas, protected and connected to emergency power. Separate smoke removal systems for different areas of a facility may be considered. Smoke removal equipment shall have the ability to be controlled by both the OCC/RCC and local control panels in case the remote connection is lost.

Reliability – Fire protection water systems shall have redundancies in order to overcome a local failure and be encased, buried and otherwise protected from potential damage. Where appropriate a dual fire pump arrangement shall be considered with one electric pump and one diesel pump.

6.6.3 Station Platforms

Station platforms provide the passengers with direct interface with the high-speed trains and present safety hazards not found in other parts of the CHSTS. Special consideration must be made for the hazards peculiar to station platforms including platform configuration, walking surfaces and markings, platform edge treatment, the effects of passing trains, Americans with Disabilities Act (ADA) requirements, and other mitigations for platform hazards.

Platform configuration will be site-specific but conforming to certain safety guidelines including minimum widths of 30 feet for two-track platforms and 20 feet for single-track platforms, height that allows for level boarding to the CHSTS equipment (when selected), cross-slope away from the track, longitudinal slope in conformance to the rail alignment and tangent in alignment.

The platform edge shall be established 5.75 feet from the center line of the nearest track. When a final rail vehicle configuration is selected this measurement shall be adjusted accordingly. The gap between the platform edge and train sill door shall be no greater than 3 inches horizontally and plus/minus 5/8 inches vertically. Platform edges shall be identified for the visually impaired and marked with an appropriate setback for passengers when trains are passing. Under-platform refuge areas shall be constructed in order to provide a place of refuge should a person fall from the platform in front of a train.

Platform obstructions shall be assessed on a site-specific basis to ensure that they do not present visual or physical barriers to passengers, train operators, or law enforcement personnel.

OCS support poles shall be located away from the platform areas where possible. If an energized conductor has to be located above a station platform, the wire height shall be set to meet the minimum clearance requirements specified in Technical Memorandum 3.2.6 - *Traction Electrification System Requirements for Grounding and Bonding and Protection against Electric Shock*. TM 3.2.6 also provides details pertaining to grounding requirements for platforms.

Inter track screen walls shall be installed to mitigate the effects of trains passing through the station facility on the center tracks at maximum authorized speed and to prevent people from crossing the tracks. The inter track screen walls are described in greater detail in Technical Memorandum 2.8.2 *Access Control for HSR ROW and Facilities*.

Safety and security design requirements for station facilities are addressed in Section 6.2.6, Section 6.3.1, and Section 6.5.2 of this document and in conformance with Technical Memorandum 2.2.2 *Station Program Design Guidelines*, and Technical Memorandum 2.2.4 *Station Platform Geometric Design, and System Requirements*. Technical Memorandum 2.2.2 addresses platform load (under both normal and emergency conditions), emergency evacuation,



platform edge safety measures, platform ends, the Platform Agent Booth, weather protection, and CCTV systems. Technical Memorandum 2.2.4 *HST Station Platform Geometric Design* addresses in greater detail platform configuration, platforms adjacent to through tracks, setback to obstructions from the platform edge, and under-platform refuge area, and other platform design requirements.

6.6.4 Lighting

Lighting is an important element in the development of safety and security requirements. Lighting allows for walkway hazards and other obstructions to be seen more clearly, provides guidance for appropriate pathways, and enhances security sight lines by improving natural surveillance. Lighting shall complement CCTV systems to ensure CCTVs are an effective tool for surveillance and investigation. Lighting shall be installed in vandal-resistant coverings. Designers shall reference the Illuminating Engineering Society of North America (IESNA) for recommended safety and security lighting practices.

Stations and station sites, including parking facilities, roadways, and walkways, shall have adequate interior and exterior lighting as defined in TMs 2.2.2 and 2.2.3.

Other CHSTS facilities shall be illuminated to provide emergency egress for passengers and access for employees and emergency responders. Facilities include access/egress points, emergency vehicle assembly areas, walkways in tunnels, tunnel portal facilities, traction power facilities, and maintenance facilities.

6.6.5 Protection against Hydrology/Hydraulics Hazards

The CHSTS trainway shall be designed so as to mitigate the effects of water, considering the hydrology of the surrounding environment and the hydraulic requirements for drainage that preserves the safe operating conditions of the trainway. Hydrologic studies shall identify the ambient flood plain and determine the required mitigations; including raising the trainway above the flood plain or the installation of barriers to prevent intrusion of flood waters into the trainway. Hydraulic studies shall identify the potential runoff and determine the required mitigations, including drainage system requirements and outflow.

Technical Memorandum 2.6.5 *Hydraulics and Hydrology Design Guidelines* identifies in greater detail the assessment processes and infrastructure elements required for addressing hydraulic and hydrologic issues.

6.6.6 Utilities

The construction of the CHSTS trainway will result in interfaces with existing or new utilities (underground, overhead, and above-ground facilities). The strategy for addressing utility issues includes identification of existing utilities, evaluation of potential utility impacts, adjustment and protection of existing utilities within the CHSTS right-of-way, and abandonment of utilities where practicable.

Consideration must be given to the impact of and on utilities in both the Construction and Operational phases of the CHSTS.

Technical Memorandum 2.7.5 *Utilities Requirements* identifies in greater detail the assessment processes and infrastructure elements required for relocating and protecting existing and new utilities.

6.6.7 Facilities Power

The electrical system is essential to safe and secure operation of the high-speed train system. The system is drawn from the local utility grid and provides power for communication, lighting, essential building services and many other functions.

Distributed Emergency Power – Emergency power infrastructure shall be installed separately, and as far apart as possible, from normal electrical infrastructure. This includes electric panels, conduits and switchgear as well as electric distribution.



Normal and Emergency Fuel Storage – Fuel storage shall be access restricted and protected. Main fuel storage shall be located away from loading docks, entrances and parking. Emergency fuel storage shall be sized based on the facility it is supporting. Emergency batteries or UPS may replace or supplement emergency generators at some sites.

Emergency Power – An emergency generator shall be located away from the station building itself, loading docks, entrances, parking, and areas prone to flooding. The facility housing the generator shall be secured. Conduit and cabling shall be installed outside of a facility where practicable to enable mobile generator support of the facility's electrical system.

Grounding and Bonding – Grounding and bonding of the high-speed train traction electrification system is necessary for protection against electric shock. Technical Memorandum 3.2.6 *Traction Electrification System Requirements for Grounding and Bonding and Protection against Electric Shock* defines grounding and bonding requirements generally, for traction power facilities, the overhead contact system, for passenger station platforms, for structures, and for overhead bridges. Additionally, the TM defines the requirements for protection against electric shock from induced voltage and lightning strikes.

6.6.8 Traction Power Facilities

The traction power system will be fed directly from the public utility grid at nominally 115kV/220kV, stepped down to 25kV at traction power substations. Traction power facilities shall be provided at the following nominal intervals along the CHSTS trainway: traction power substations (30 miles), switching stations (15 miles), and paralleling stations (5 miles). The facilities shall share vehicle access roadways with access/egress points as described in Section 6.2. Access control measures shall be provided as described in Section 6.5.3. Design of fire suppression systems and other fire and life safety elements of traction power facilities shall be in compliance with the requirements of California Code of Regulations, Title 24, Part 9 *California Fire Code*.

Technical Memorandum 3.1.1.3 *Traction Power Facilities General Standardization Requirements* identifies in greater detail the fire and life safety infrastructure elements associated with traction power facilities.

6.6.9 Overhead Contact System

The overhead contact system (OCS) supplies the 25kV traction power to the trains. The operation of the OCS shall be controlled from the Operations Control Center (OCC) but shall have the ability to be isolated from the Operations Control Center or other remote locations. Generally grounding of the conductors must be done locally by qualified railroad employees. Emergency responders will be required to confirm isolation and grounding of the OCS prior to commencing operations that might interfere with or otherwise bring them into contact with the OCS.

The use of grounding switches is becoming a common safe practice to provide the ability to remotely isolate and ground the OCS in a confined area where people may be trapped. This allows a positive indication of the grounded OCS to be given to the emergency responders without having to wait for the qualified employee to arrive. The use of grounding switches can be studied in conjunction with the OCS design and their applicability determined on a site-specific basis for underground stations and tunnels.

Special considerations for the OCS system shall be included in the development of emergency response plans for all infrastructure elements. OCS poles shall be located outside of the dynamic train envelope and the walkway envelope.

Technical Memorandum 3.2.1 *OCS Requirements* identifies in greater detail the operation of and design requirements of the OCS system.



6.6.10 Radio Communication Sites

Stand-alone radio sites will be located along the CHSTS trainway at nominal 2.5 mile intervals, co-located with traction power or train control sites where possible. The facilities shall share vehicle access roadways with access/egress points as described in Section 6.2. Access control measures shall be provided as described in Section 6.5.3.

Collapsible radio towers will be designed so as to collapse away from the CHSTS operating envelope for maintenance or other purposes.

6.6.11 Grounding and Bonding

Grounding and bonding of the high-speed train traction electrification system is necessary for protection against electric shock. Technical Memorandum 3.2.6 – *Traction Electrification System Requirements for Grounding and Bonding and Protection against Electric Shock* defines grounding and bonding requirements generally, for traction power facilities, the overhead contact system, for passenger station platforms, for structures, and for overhead bridges. Additionally, the TM defines the requirements for protection against electric shock from induced voltage and lightning strikes.

6.6.12 Structures

Structure, Walls and Windows – Glazing and strength requirements are to be developed.

Progressive Collapse – Building and structure designs shall not be vulnerable to progressive collapse. A structure shall have adequate redundant load paths. Local damage to a structure shall not lead to complete collapse or failure.

Building Materials – Building materials which have inherent ductility and are better able to respond to load reversals shall be given special consideration

Air Intakes – Air intakes, especially those for tunnels, shall be monitored and access controlled. A security zone shall be established around the intake, which is access controlled with fencing, gate and appropriate signage. The distance from the edge of the security zone to the intakes shall be based on a standoff distance from possible explosive detonations. Intakes shall be installed as high as practical from the ground with a minimum of 12 feet from ground level. If this is not feasible, the intake shall be covered with a vertical duct. The duct opening shall not be located at the height of the structure or at a point where it is easily accessible from the structure. Duct openings can be curved at the top but shall be angled and covered with a screen.

Air intakes design shall prevent recirculation of smoke into structures or tunnels. Air intakes on buildings shall be located on the roof or as high as possible as appropriate. Vent structures and buildings shall be nondescript and blend into the surrounding community.

Protecting Incoming Utilities – Overhead utility systems shall be located at least 50 feet from loading docks, main entrances or parking areas. Incoming systems shall be concealed and properly protected, including possible burial or encasement.

6.6.13 Communications

Public Address – Speakers and amplifiers shall provide coverage to all public areas.

Redundant Communications – Multiple forms of communication shall be utilized in order to maintain communications in case of incident.

Alarm and Information Systems – Alarm and information systems shall not be mounted in a single conduit or co-located.

Emergency Alarms and Telephones – Emergency call buttons, alarms, or telephones shall be installed in stations, on station sites, in tunnels, on viaducts and bridges, and in other select places along the alignment.



Technical Memorandum 3.4.2 *Communications Site Requirements* addresses in greater detail the platform configuration, platforms adjacent to through tracks, setback to obstructions from the platform edge, and under-platform refuge area, and other platform design requirements.

6.6.14 Signage and Wayfinding

Appropriate safety and security signage shall be used throughout the system to ensure safety for passengers, staff, and the public. Confusing, inconsistent or non-existent signage can reduce site safety and security. Where applicable, signage shall cite California laws. Signage shall reflect general signage and wayfinding standards which are to be developed. Safety signage, such as those pertaining to warnings, trespassing, danger, and loitering, shall be used in stations, at bridges and overpasses, at right-of-way edges, on and around trainways, and around and inside tunnels. Unless required for safety reasons or by other standards, signs shall not identify sensitive areas.

Signage shall be consistent with System Requirement INF 3-48, and shall follow ADA, CPUC, NFPA 130, and CFR Title 29, Part 1910 standards and guidance.

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

6.6.15 Landscaping

Landscaping can improve or hinder safety and security. Soft and hardscape can direct circulation and limit access. Landscaping that could allow for concealment or reduce sightlines shall be avoided.

Trees should have, at a minimum, a six foot (6') canopy; hedges should not be taller than two feet (2'). Perimeter fencing and walls shall have a minimum ten foot (10') clearance from the nearest planting, allowing for easy observation of potential trespassers or weapons concealment.

6.6.16 Wind Turbine Adjacency

The safety hazard associated with the location of the CHSTS trainway adjacent to a wind farm is a physical one resulting from the intrusion into the CHSTS trainway of debris that has become disengaged from the wind turbine: ice throw, rotor failure, or structural collapse.

Setback Requirements – Horizontal separation between the CHSTS trainway and any wind turbine shall be no less than one and one-half (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).

Notifications and Operational Response – Mitigation for this hazard is the development of a protocol for the notification by the wind turbine operator to the CHSTS Operations Control Center of an adjacent wind turbine operating in an unsafe condition (overspeed, excessive winds, ice buildup, etc.). The CHSTS Operations Control Center can then implement an appropriate response. The Operations response shall include a range of responses, from continued monitoring to stopping of trains, appropriate to the proximity and specific conditions of the wind turbine.

6.7 HAZARD DETECTION SYSTEMS

6.7.1 Seismic

The California High-Speed Train system shall employ a dedicated Earthquake Early Warning (EEW) system for CHSTS operations. EEW monitoring stations shall be installed at regular intervals along the CHSTS, and at locations where the trainway crosses known earthquake faults. The EEW system may be supplemented with information from the California Integrated Seismic Network (CISN) and other seismic data sources.

Additionally, monitoring systems shall be used near portals and other trackway locations to detect falling rocks and landslides associated with ground movement.



6.7.2 Climatic

Climatic conditions, including rain, wind, and snow can affect high-speed train operation. Monitoring of climatic conditions will include temperature, wind, precipitation, humidity and other factors. Guidelines for climatic monitoring will be developed. Thresholds for automatic or manual operational response are under development.

High Water / Flood Detectors shall be installed where necessary taking into account drainage, culverts, bridges, overpasses, underpasses and flood plains. The system shall notify the ATC system and the OCC of any location where an accumulation of water exists in the right-of-way which may be a risk to the right-of-way, in-service equipment, or passenger equipment.

Slide Detectors shall be installed at locations of potential landslides onto the CHSTS trainway, where supported by site-specific hazard analysis. Slide detectors shall transmit information to the OCC and directly to the train control system when certain hazard thresholds are achieved.

Cross Wind Detectors shall be installed where necessary based on area wind and weather patterns, topography (particularly mountain passes), and proximity to bodies of water. Wind speed data shall be transmitted continuously to the OCC.

Temperature Detectors shall be installed where necessary based on changing average temperatures along the corridor. Temperature data shall be transmitted continuously to the OCC.

6.7.3 Intrusion

Intrusion Detection shall be located along the right-of-way and at CHSTS facilities identified as high risk locations. Intrusion detection shall detect access to elevated trackways, air intakes, cross passages, subsurface to surface access locations, ATC interlocking houses, communications houses, traction power facilities, station platform edges, tunnel portals, and other critical infrastructure areas. Intrusion detection shall be employed at high risk locations for theft, vandalism, accidental and intentional entry or other types of intrusion where required by site-specific hazard or threat/vulnerability analysis. The intrusion detection system will not be contiguous for the whole of the route. Intrusion detection systems shall report to the OCC and appropriate RCC as well as local administrative and/or security offices depending on the location.

Fall Intrusion Detectors shall be located at overpasses and underpasses used by highway vehicles, animals, and non-CHSTS equipment. These will utilize detection systems appropriate to the specific site and application. Data output from the fall intrusion detectors shall be fed to the ATC system and available to railroad operations personnel.

Rock Fall Intrusion Detectors shall be located at tunnel portals and in areas adjacent to retained embankments and cut slopes that are prone to rock falls or other landslides. These will utilize detection systems appropriate to the specific site and application. Data output from the fall intrusion detectors shall be fed to the ATC system and available to railroad operations personnel.

Wayside Intrusion Detectors shall be installed in the fencing along the CHSTS right-of-way to detect intrusion to the maximum extent practical. This system shall be installed in all areas where intrusion may occur, as supported by site-specific hazard analysis or threat/vulnerability assessment. These detectors shall be connected to the ATC system and to the OCC and shall alert the OCC when intrusion occurs.

Closed Circuit Television (CCTV) will be used throughout the system at high-risk locations as identified in a site-specific TVA or hazard analysis to monitor and record activities. Possible locations include but are not limited to station buildings, platforms, station sites, parking facilities, trainways, bridges, overpasses, tunnel portal entrances, tunnel emergency entrances, tunnel portal crossovers, maintenance facility entrances, air intakes, and air intake cross passageways. CCTV will focus on points of access. CCTV feeds will be accessible from the OCC and local security facilities and be integrated with access control and intrusion detection equipment. Facility specific information about CCTVs is provided in other technical memoranda. Station CCTV is addressed in TM 2.2.2 *Station Program Design Guidelines*.



In spaces where lighting is inappropriate due to environmental impacts, infrared receptors with infrared cameras or other appropriate technologies may be used.

6.7.4 Equipment Detection

On-Board Diagnostic Systems shall be installed to monitor the CHSTS vehicles for performance and to detect the presence of hazards such as fire and smoke. Information from the on-board diagnostic systems shall be transmitted to the train operator, Operations Control Center, and vehicle maintenance facilities.

Dragging Equipment Detectors shall be installed at locations where underframe repair or maintenance is performed and other locations as deemed necessary. The detector shall transmit data to the OCC.

6.7.5 Other Hazards

Ambient Gas Detectors shall be installed in tunnels, trenches, underground stations, and other below-grade locations identified by site-specific hazard analysis, and at locations adjacent to solid-waste disposal sites regulated by California Code of Regulations Title 27, Chapter 6, Section 20921 and as supported by site-specific hazard analysis.

Explosive, chemical, biological and radiological detection equipment shall be installed at high-risk locations as identified in a site-specific TVA. Locations may include but are not limited to stations, tunnels, and air vent locations.

