California High-Speed Train Project

TECHNICAL MEMORANDUM / POLICY

Station Program Design Guidelines
TM 2.2.2

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for the California High-Speed Rail Authority

System Level Technical and Integration Reviews

The purpose of the review is to ensure:

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

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

System Level Technical Reviews by Subsystem:

Systems:	*Signed document on file* Print Name: Eric Scotson	25 Sep 08 Date
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ABSTRACT

This technical memorandum identifies the facilities, designated spaces, design elements, and service amenities to be provided at passenger stations for the California High-Speed Train Project (CHSTP). This document presents design guidance for the programming and functional requirements of high-speed train stations in order to advance design so that the station's facilities and functionality can be fully considered during the project-level environmental assessment and through the 15% Design level. This document does not define requirements for platform geometries or station sites. These issues are considered in other technical memoranda.

High-speed train passenger stations fulfill multiple roles. Stations must provide the required functional services for the high-speed train system, accommodate the needs of passengers, and support the administrative requirements for train operations. Safe, secure, and comfortable stations that are of high quality promote and encourage ridership are essential.

The placement and flow between the specific elements and amenities that make up a station shall lead to logical internal movement and minimization of conflicts. Standardization of certain design elements for stations throughout the line is important in order to simplify design, procurement, and maintenance. Certain stations will additionally require distinct facilities and amenities to reflect the type of station (intermediate or terminal), location and category of station, anticipated patron ridership, and the surrounding environment.

The following elements are considered in this memorandum:

- Station Design Considerations, including design principles and factors leading to variation between stations
- Station Program Requirements, including public areas, controlled areas, circulation spaces and support areas
- Station Amenities, including furniture, signage and communication and fare collection equipment
- Station Systems, including building and systems that interface with trains

Station programs for the currently operating high-speed train and conventional passenger rail services were considered in developing these standards and guidelines. Where appropriate, this memorandum presents the current design practices in European and Asian systems for reference. The quantitative guidance in this document is based on the currently available information. It is recognized that the guidance in this document will require refinement during subsequent design phases as more current information becomes available.

This document does not define specific layouts or prescribe architectural design. While code and safety requirements are cited, actual design will require more thorough code assessment and application. Definition of the aesthetic requirements for high-speed train passenger stations will be presented in a separate document.

1.0 INTRODUCTION

1.1 PURPOSE OF TECHNICAL MEMORANDUM

The purpose of this technical memo is to set forth design guidelines and standards for passenger stations that promote safe, efficient, and high quality operations for high-speed train service. This memorandum presents information relating to functional space requirements, building amenities, station performance, circulation, connection, and safety of the patrons and employees of the high-speed train system. Where available, this information is based on present practices used worldwide and on current U.S. Federal, State, and Transit Agency standards, guidelines and practices. Document searches were conducted to identify and present practices for existing or planned European and Asian station facilities and this information was used to define the CHSTP guidance that is included in this memorandum.

It is the intent of the Authority for these standards and guidelines to be followed in the design of passenger station sites and related facilities. Since the stations will be located in multiple municipal jurisdictions, state rights-of-way, and/or unincorporated jurisdictions, the CHSTP standards and guidelines may differ from local jurisdictions' codes and standards. The designer's use of jurisdictions' codes and standards, rather than the Authority's standards requires approval.

1.2 STATEMENT OF TECHNICAL ISSUE

This document presents design guidance for the programming and functional requirements of high-speed train stations in order to advance design so that the station's facilities and functionality can be fully considered during the project-level environmental assessment and through the 15% Design level. This document does not define requirements for platform geometries, specific site layouts or prescribe architectural or aesthetic design requirements. These issues are considered in other technical memorandums.

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.

Accessibility	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, including wheelchair users.
Alignment	The horizontal and vertical route of a transportation corridor or path.
Americans with Disabilities Act (ADA)	Federal regulation establishing legal requirements for accessibility.
At Grade	At ground surface level; used to describe roadways, river crossings, and track alignments.
Authority	California High-Speed Rail Authority
Back-of-House Area	Area dedicated to station operational and support functions, with access restricted to station employees.
Concourse	Large open space for the gathering or passage of patrons
Connectivity	Describes the degree of "connectedness" of a transportation system such as a transit network, and the ease with which passengers can move from one point to another within the network, or points outside the network.

Controlled Area	Areas on the platform side of the fare-paid line where possession of a valid CHST ticket is required.
Dedicated Corridor	Segment along the high-speed train alignment where high-speed trains operate on tracks that are exclusive of other passenger or freight railroads with the exception of other HST-compatible equipment used for long distance commuter service or high-speed freight
Design Guidelines	Provide a preferred but not necessarily required direction for a particular design feature.
Design Standards	Indicate a required direction for a particular design feature.
Fare Gate Array	Physical barrier which requires a valid CHST ticket to pass.
Fare Gates	Device for ticket processing.
Feasible	Capable of being implemented.
Free Area	Areas within the station which are open to the general public.
Footprint	Area of the ground surface covered by a facility, or affected by construction activities.
Grade-Separated	At different elevations; on separate levels.
Headway	The time between buses, trains, or other transit vehicles at a given point. For example, a 15-minute headway means that one bus arrives every 15 minutes.
High-Speed Train	Refers to a train designed to operate safely and reliably at speeds near 220 mph (350 kph).
Intermediate Station	Any station between two terminal stations. Intermediate HST stations will include additional tracks to allow for through running express services.
Island Platform	Passenger platform in-between two station tracks, with vertical circulation, seating, and other furniture concentrated along the central axis of the platform
Level of Service (LOS)	A rating using qualitative measures that characterize operational conditions within a traffic stream and their perception by motorists, passengers, and pedestrians.
Outboard Platforms	Side boarding platforms located directly opposite one another, each serving one track.
Peak Period	Time period during the day with the greatest volume of CHST patrons
Platform	Station area adjacent to tracks where trains stop to allow passengers to board and alight.
Queuing Area	Station area where passengers can wait in a line without disrupting other passenger flow. Also, area provided to accommodate peak passenger surges.
Ridership	Number of passengers using CHST over a certain period of time
Shared Corridor	A high-speed train alignment where high-speed trains operate adjacent to other passenger railroads (e.g., Caltrain, Metrolink, and Amtrak).
Shared Track	Segment along the CHSTP alignment where rail operations are conducted by high-speed trains and another railroad on common track.
Side Platforms	See Outboard Platforms.
Station	All areas within station building envelope.

Terminal Station	A station located at the end of a line.
Trainset	A complete unit of rolling stock that makes up a single train.

Acronyms

ADA	Americans with Disabilities Act
ADAAG	ADA Accessibility Guidelines for Buildings and Facilities
ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
Authority	California High-Speed Rail Authority
CBC	California Building Code
CCR	California Code of Regulations
CCTV	Closed Circuit Television
CES	Customer Emergency Stations
CHST	California High-Speed Train
CHSTP	California High-Speed Train Project
CFR	Code of Federal Regulations
CPUC	California Public Utilities Commission
DSA	Division of the State Architect
EIR	Environmental Impact Report (CEQA)
EIS	Environmental Impact Statement (NEPA)
FRA	Federal Railroad Administration
HST	High Speed Train
IBC	International Building Code
LOS	Level of Service
LRT	Light Rail Transit
NFPA	National Fire Protection Association
PCJPB	Peninsula Joint Powers Board
SCRRA	Southern California Regional Rail Authority
SNCF	Société Nationale des Chemins de fer Français (French National Railway Company)
TGV	Train à Grande Vitesse
THSR	Taiwan High Speed Rail
TM	Technical Memorandum
TSI	Technical Specifications for Interoperability
TVM	Ticket Vending Machine
UBC	Uniform Building Code
UFC	Uniform Fire Code

1.3.2 Units

The California High-Speed Train Project is based on U.S. Customary Units consistent with guidelines prepared by the California Department of Transportation and defined by the National Institute of Standards and Technology (NIST). U.S. Customary Units are officially used in the United States, and are also known in the U.S. as “English” or “Imperial” units. In order to avoid confusion, all formal references to units of measure shall be made in terms of U.S. Customary Units.

Guidance for units of measure terminology, values, and conversions can be found in the Caltrans Metric Program Transitional Plan, Appendice B U.S. Customary General Primer (http://www.dot.ca.gov/hq/oppd/metric/TransitionPlan/Appendice-B-US-Customary-General-Primer.pdf). Caltrans Metric Program Transitional Plan, Appendice B can also be found as an attachment to the CHSTP Mapping and Survey Technical Memorandum.

2.0 DESIGN STANDARDS AND GUIDELINES

2.1 GENERAL

This document provides initial guidance on elements of high-speed train passenger station design in order to establish a station footprint for environmental assessment and develop station plans to the 15% Design level. It is based on currently available information on other rail transportation services and common standards.

Site design guidelines and associated design elements will be developed in subsequent stages of design.

2.2 LAWS AND CODES

Design criteria for the CHSTP are under development. When completed, a CHSTP Design Manual will present design standards and guidelines specifically for the construction and operation of high-speed railways based on international best practices. Initial high-speed rail design criteria will be issued in technical memoranda that provide guidance and procedures to advance the design of project-specific elements. Criteria for design elements not specific to high-speed train operations will be governed by existing applicable standards, laws, and codes. Since the stations will be located within multiple municipal jurisdictions, state rights-of-way, and/or unincorporated jurisdictions, local building, planning, and zoning codes and laws must be considered.

The CHSTP design standards and guidelines may differ from local jurisdictions' codes and standards. Because the Authority is an agency of the state government, development of facilities within the state's right-of-way should fall under the jurisdiction of the Division of the State Architect (DSA) and the State Fire Marshall along with input and coordination with local jurisdictions. In the case of differing values on work outside of the state-owned right-of-way, conflicts in the various requirements for design, or discrepancies in application of the design standards, the criteria followed shall be that which results in the highest level of satisfaction for all requirements or that is deemed as the most appropriate by the California High-Speed Rail Authority (Authority). The standard shall be followed as required for securing regulatory approval. Approvals may also be required from the Army Corps of Engineers, Division of the State Architect, Office of the State Fire Marshall, California Coastal Commission, Caltrans, and other agencies and authorities at specific locations.

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

- ADA and ADAAG: ADA Guidelines for Buildings and Facilities
- ANSI 117.1 – American National Standards Institute standard for accessible design for persons with disabilities
- NFPA 130: National Fire Protection Association's fire protection and life safety requirements for underground, surface and elevated fixed guideway transit systems
- NFPA 101: National Fire Protection Association's life safety code and Part IV DOT, 49 CFR Parts 27, 37 and 38,
- IBC: International Building Code
- UBC: Uniform Building Code
- California Code of Regulations, Title 24 or California Building Standards Code
- CPUC: California Public Utilities Commission
- SCRRA Engineering Standards
- Peninsula Corridor Joint Powers Board (PCJPB) Design Standards
- Local Building, Planning and Zoning Codes
- FRA 49CFR: Code of Federal Regulations

- AREMA
- TSI: Technical Specifications for Interoperability. for the Trans-European Transport Network. Although existing TSIs do not directly address station functionality, they may indirectly.

The Technical Specifications for Interoperability (TSI) are a set of standards required of all railroad systems in the European Union. The TSI are defined and published by subject matter, described as "subsystems". The TSI that is primarily relevant to this technical memorandum is that for the Infrastructure Subsystem, current version dated 19 March 2008 based on a Commission Decision of 20 December 2007. The Infrastructure TSI does not directly address station program requirements.

2.3 APPLICABILITY TO FEDERAL REGULATIONS

To follow.

2.4 POLICY CONSIDERATIONS

Policy considerations can significantly influence the size and functionality of high-speed train stations. In developing this document, design assumptions were made that will require confirmation based on Authority policy. In order to advance the design of stations and determine square footage requirements, several key policy issues must be confirmed. Potential approaches to addressing these issues are summarized in the following sections. Appendix A: Policy-Related Station Elements in Other Systems presents how these issues were addressed by other applicable rail systems. In order to advance other elements of station functional design, assumptions about policy considerations were necessary. Each policy assumption is cited below and liable to change. Assumptions are based upon characteristics of international high-speed rail systems as outlined in Appendix A.

2.4.1 Fare Control

Fare control may be pursued in several ways:

1. Proof-of-payment: No physical barrier is established between the "free" and "fare paid" zones. Patrons in a "fare paid" zone without a ticket are subject to fine.
2. Fare gates: Fare gate arrays separate the "free" and the controlled or "fare paid" station areas. Passengers must insert, slide or scan their ticket to gain passage through the fare gate.
3. Human ticket control: Patrons are required to present tickets for inspection in order to enter the "fare paid" area.

For the purpose of this document, it is assumed that proof-of-payment is the method that will be used. However, station facilities should be designed with sufficient flexibility to allow for possible introduction of fare gates in the future.

The areas where a paid ticket is required for admittance and how this area is controlled must be determined. There are several options for establishing the "free/fare paid" line:

- Inside of the station: A ticket is required to access areas of the station closer to the platform, additional waiting spaces, and other station services. Some support services may be necessary on both sides of the barrier, such as waiting areas and restrooms.
- Entrance to platform: Areas of the station are open to the public with the exception of the platform.
- Boarding train: All parts of the station area are accessible to the public. This would allow for ticketing facilities to be located along the platform. This could prevent duplication of some patron support services but could lead to higher platform loads in the form of "meeters and greeters".
- On the train: In this scenario, passengers would be able to board the train with or without a ticket and purchase one from a conductor on-board.

For the purpose of this document, it is assumed that passengers will be required to obtain valid tickets prior to accessing the platform.

2.4.2 Ticket Purchase and Distribution

The number and type of ticketing transactions will influence station space requirements. There are three main ways that tickets could be purchased:

- Ticket booth: A person-to-person interaction. Space is required for the ticket booth, queuing space and supporting administrative space for the ticketing attendants. A ticket booth may provide services in addition to ticketing such as information and security.
- Ticket vending machine (TVM): Tickets are purchased at the station using a machine. Space is needed for machine, corresponding queue and machine maintenance.
- Pre-purchase: Tickets may be bought online or by phone prior to arrival at the station. Patrons receive tickets prior to travel or obtain them via will call at a ticket booth or a TVM.

All three options will be offered. However, one particular ticketing method may be promoted over others by providing more or less of one type of ticket purchasing facility. For example, many ticket booths and few TVMs would encourage more in-person ticketing. If the majority of tickets are to be purchased and received prior to arrival at the station, ticketing facilities at the stations may correspondingly shrink. The following document assumes the provision of all three types of ticketing.

2.4.3 Baggage Handling

Baggage handling facilities require significant area to accommodate the movement of baggage between the ticketing area, the baggage "make-up" area, and trains; and from the trains to disembarking passengers. Facilities may be manual, automated, or a combination of methods depending upon the distance and quantity of baggage to be accommodated. Baggage handling facilities, if provided, need to be sized for the following activities:

- Receipt and checking of outbound baggage
- Receipt of inbound baggage from the train and dispensing these items to passengers (baggage claim)
- Storage of unclaimed and connecting baggage
- Storage of baggage tractors and carts
- Storage of cleaning and maintenance supplies

In most operating high-speed train systems, passengers carry and store their own luggage in luggage racks (of varying sizes) that are provided on the trains. In some systems, porters and luggage carts are provided to assist with luggage movement. For the purpose of this document, it is assumed that CHST will not have baggage handling capabilities. Passengers will board the train with their luggage. Stations may have luggage storage facilities for users to temporarily leave belongings at a station. These may consist of a staffed luggage check room and/or storage lockers.

Stations could be designed to preserve the future ability to handle checked baggage on high-speed trains. If so, allowances will need to be made in the design for these potential future facilities.

2.4.4 Concessions

The level of commercial and privately operated services provided at a station could vary widely from a vending machine to extensive shopping malls and influence the design of "free areas", "controlled areas", or potentially both. Commercial services for station patrons may include food (ranging from a coffee cart to full-service restaurants), travel services (such as rental car agency offices, travel agencies, or visitor bureau offices), ATMs or banks, and postal services. The Authority's *Adopted HST Station Development Policies* (May 14, 2008) (see Appendix C) encourages a high density of population, jobs, commercial activities, entertainment and other

activities around stations which will influence the facilities provided in and around stations. As concessions are not a requirement for high-speed train operations, this technical memorandum will not issue parameters for the sizing of such spaces. However, guidelines are provided for the interaction of concessionary space with required station spaces.

2.4.5 Platform Edge Doors

In addition to platform safety rails and platform edge markings, platform edge doors may be provided if they are deemed necessary to protect passengers, particularly from trains passing platforms at high-speed. Doors can serve multiple purposes, including accident reduction - especially where high-speed trains will operate non-stop through the station - for skip stop service, platform climate control, and improved security by limiting access to tracks. Platform doors are most common in subways and airport transit systems but fairly uncommon in train stations. Options for platform doors include:

- Platform screen doors. Full height barriers between the station floor and ceiling.
- Platform edge doors. Full height but do not reach the ceiling.
- Platform safety gates or platform gate doors. Gates are approximately 3 feet high and are used at some Shinkansen stations in Japan.
- Platform safety rails. No gates but safety railings between boarding areas.
- No doors. Only signage and tactile warning strip at edge of platform. This will decrease maintenance and operating costs.

For the purpose of this document, it is assumed that platform edge doors are not implemented in stations. At intermediate stations, platform tracks will be separate from tracks used by non-stop trains. At the major terminal stations, all trains will be assumed to stop.

Should physical, operational, or budgetary constraints result in a condition at a station where tracks adjacent to a platform may be used by high-speed, non-stop trains, then the platforms will need to be equipped with appropriate equipment and infrastructure to ensure safety by keeping passengers away from the platform edge when a non-stop train is passing through. The solution at these locations could entail platform doors or barriers, visual and/or audible warning systems, and/or operational procedures such as restrictions on passenger access to platforms except when needed for boarding of stopping trains.

The types of train movements occurring at each station will be driven by the operating plan, which will be developed and refined as the planning and design process progresses. Station planners and designers should keep apprised of the current operating plans for the Phase 1 and Full Build conditions, to understand the operating requirements at specific stations.

2.4.6 Sustainability

Station design and programming standards may require some sustainability measures be implemented including obtaining a certain level of LEED certification (Certified, Silver, Gold or Platinum). This may require changes to functional design which lead to increases in water efficiency, reductions in energy use and other factors. This document assumes all stations should be at least LEED certified.

2.4.7 Sharing of Facilities with Other Rail Operators

A majority of the cities that will be served by the CHST system are also served by other intercity and/or commuter rail operators, including Caltrain, Metrolink and the Amtrak Capitol Corridor, San Joaquin and Pacific Surfliner services. Though the system will develop new station facilities, the stations may be located immediately adjacent to or serve as extensions of existing stations at some locations.

The CHST system is expected to be well-connected to the existing passenger rail services. Ridership forecasts include assumptions about passengers transferring between high-speed trains and other train services. The passenger experience at stations should be as seamless and convenient as possible. Pedestrian transfer connections from train to train should be intuitive, short and direct.

Initial analysis of station requirements are based on the assumption that high-speed trains utilize dedicated platforms at stations and have a dedicated controlled area within which access can be limited to ticketed high-speed train passengers, and which can be protected by a fare control array and security screening cordon, if such facilities are deemed appropriate.

The differentiation of public concourse facilities within the "free area" is less clear-cut. Stations could have a single public concourse providing access to platforms used by multiple rail operators, or it may be more practical to provide public concourse areas for each operator, interconnected by pedestrian walkways.

There may be significant benefits to integrating or co-locating facilities for the various rail operators, including operating cost savings, ease of passenger transfers between services, and improved customer orientation and convenience. The opportunities and possible physical configurations depend upon the relative orientation and location of the tracks and platforms used by the different rail operators, such as side-by-side tracks and platforms, or different vertical levels for the high-speed and other trains.

For purposes of this document and initial station planning, stations will be planned as stand-alone facilities providing sufficient space and facilities to accommodate the requirements of high-speed train patrons. As design progresses, opportunities can be explored for sharing some functions and facilities among rail operators at stations that will be served by more than one operator. Examples of possible shared functions include ticketing, information dissemination, security, cleaning, and facility maintenance.

2.4.8 Bicycle Access

Some rail services in California permit passengers to carry bicycles directly on-board trains, either on a reserved, unreserved or first-come, first-served basis. Other rail services permit bicycles to be boxed and carried aboard as hand luggage. The policy that is established with respect to passengers carrying bicycles on-board trains will influence the circulation, access, and temporary storage facilities that will be needed at stations.

Design of the platforms, vertical circulation elements and passenger circulation, waiting and queuing areas should take into account requirements for passengers with bicycles.

For the purpose of this document, it is assumed bicycles are allowed on-board certain trains. Details of bicycle service will be outlined in the system operations plan.

2.4.9 Small Package Express Service

High-speed trains may prove to be a convenient, timely and reliable way of delivering small packages (unaccompanied by passengers) between cities served by the CHST system – and might prove to be profitable for the system operator. Should a decision be made to provide such a service, facilities will need to be provided at stations for the receipt, collection and processing of these packages. The capability of handling such packages would need to be built into the design of the high-speed trainset. Special equipment would facilitate station operations, such as carts with special storage containers for these packages, and operating procedures would need to be carefully crafted to ensure that the off-loading and loading of these small package containers could occur without lengthening train dwell times. Alternatively, a small package service could utilize dedicated trains and load, unload and distribution facilities.

Station designs should be sufficiently flexible to accommodate the future introduction of such service, should it prove to be workable. If small package express service is provided, system requirements will need to be defined.

3.0 ASSESSMENT / ANALYSIS

3.1 BACKGROUND

Design standards and guidelines for international high-speed train systems were reviewed along with Caltrain, Metrolink, and Amtrak criteria. Several stations will be served by both high-speed trains and conventional passenger trains making these standards and guidelines important. It is recognized that there will be a high degree of variability between stations due to different station locations, ridership demands, potential intermodal connections, different trip purposes, and local land use and building codes. The following sections identify design elements to be considered at all stations. The prescribed design criteria are considered to be a minimum and local and unique circumstances should be considered in each station's design.

3.2 STATION DESIGN CONSIDERATIONS

3.2.1 General Considerations

These considerations are meant to assist designers in the design and configuration of spaces within the station envelope. Major stations' areas and facilities are described. Design and sizing of stations should consider:

- The prescribed design criteria are considered a minimum. The design of each station should reflect local and unique circumstances.
- Safety of station patrons, train passengers, and operating personnel should be the first priority in station design.
- Stations should be sized to accommodate expected ridership in the Full Build (2035) or projected Phase I ridership, whichever is higher, under estimated peak period and emergency conditions. The Design Life for passenger stations is addressed in the Design Life Technical Memorandum.
- Shared-use stations require that station design serves both high-speed and conventional rail services.
- Station plans should have clarity and simplicity of organization. Interdependent passenger spaces must have clarity of organization. Space sequence and architectural treatment should be simple and reinforce building pathways, destinations, and functions. Circulation routes should be clear and unobstructed by people or architectural elements.
- Station design should consider future extension and expansion as well as ridership growth as far as feasible. This could include increase in system reach, increase in frequencies, increase in train length, and increase in number of tracks.
- Stations design should consider a "not to preclude" approach and provide sufficient flexibility to accommodate future updates to the programmatic requirements, within reason.

3.2.2 Functional Consistency

Station configuration should be functionally consistent in order to allow for system identity and to simplify orientation for system passengers. Some common station elements can lead to reduced capital, operations, and maintenance costs through reduced design and construction variation, economies of scale, and simplification of operations and maintenance procedures. However, unique and recognizable stations will improve the passenger experience and encourage fulfilment of the Authority's *Adopted HST Station Development Policies* (Appendix C). Functionally consistent elements include but are not limited to:

- Signage and graphics, including informational and directional signage
- Passenger Information Systems, including dynamic and static visual displays and public address systems
- Ticket sales office location and configuration

- Fare collection and train boarding process
- Finishes and hardware
- Escalators and elevators
- Fare collection equipment
- Communications systems
- Platform minimum width and length
- Platform surface and edge paving

One key to accomplishing the functional consistency station facilities will be the development of station-operating and passenger-handling procedures. These procedures will be a function of the overall high-speed train operating plan, which will be developed as the planning and design process progresses.

3.2.3 Peak Period Passengers

Public station areas are generally sized based on peak expected use, which is derived from estimates of peak train loads or peak period ridership. Ridership forecasts are approximate and will change over the duration of the project, requiring station requirements to be refined. The following methodology for temporarily distributing station patrons was developed in lieu of a more sophisticated approach, until more precise estimates are available at a later stage of the planning and design process. It is an approximation derived from a compendium of other ridership estimates.

Peak period ridership is determined using the following parameters:

- **Daily Boardings:** Average daily boardings at stations as well as a peak day boarding will be provided by the Authority. The peak day boarding will take into account seasonal and day-of-week peaking as well as possible changes in HST level of service which could impact station ridership.. Design should be based on the peak day boarding.
- **Peak 6-hour Boardings (P_{360B}):** Ridership peaking factors to convert peak day boardings to peak 6-hour boardings are provided in Technical Memorandum 4.2 Phase 1 Service Plan.
- **Peak Hour Boardings (P_{60B}):** Ridership peaking factors to convert peak day boardings to peak hour boardings are provided in Technical Memorandum 4.2 Phase 1 Service Plan.
- **Peak 30-minute Boardings (P_{30B}):** Half of all the peak hour boardings, multiplied by a system surge factor of 1.2.
- **Peak 15-minute Boardings (P_{15B}):** A quarter of the peak hour boardings, multiplied by a system surge factor of 1.3.
- **Peak 5-minute Boardings (P_{5B}):** Peak hour boardings divided by 12 and multiplied by a system surge factor of 1.4.
- **Peak minute Boardings (P_{1B}):** Peak hour boardings divided by 60 and multiplied by a system surge factor of 1.5.

As these figures are only represent for people boarding the trains, approximations were made to ensure that stations are sized to accommodate alighting passengers. A factor of 1.75 is applied to boardings to determine total boardings and alightings (P_{360}, P_{60}, P_{30}, P_{15}, P_5, P_1). Boardings are shown using a subscript "B" (P_B), and alightings are shown using a subscript "A" (P_A).

It is expected that some high-speed train passengers will have people dropping them off or picking them up at the station. Peak "meeters-and-greeters" are estimated to be one-tenth of the total boardings and alightings. Total station occupancy also includes station staff which varies based on operating conditions and station type.

Certain station facility requirements will be based on estimated passenger trainloads, rather than peak period passenger volumes factored from estimated daily demand. High-speed trainsets are planned to be approximately 650 feet in length capable of coupling to provide approximately 1300-foot long train sets during peak operating conditions. A 650 foot train will accommodate approximately 450 passengers; a 900 foot trainset will hold 900 passengers. The terminal stations will need to be sized to accommodate surge loads of up to 900 passengers either boarding or alighting from a fully-loaded train. Intermediate stations will need to be able to safely hold and evacuate full trainloads of passengers in the event of a mechanical failure or emergency condition.

- **Peak Boarding Load (P_{Bpeak}):** Estimated volume of boarding passengers for the peak train on the design day, assuming normal on-time operations
- **Maximum Boarding Load (P_{Bmax}):** Estimated volume of boarding passengers for the peak train on the design day, assuming perturbed operating conditions, such as one cancelled train or moderate service delays.

Similar estimates of peak and maximum alighting train loads should be developed.

Station facilities also will need to be able to accommodate the additional passengers that will accumulate within the station when a train is cancelled or seriously delayed for some reason. Estimates will need to be developed for the expected concentrations of passengers that will accumulate within station facilities under various delay and service disruption scenarios. The methodology to be used to analyze passenger movement dynamics and potential delay conditions will be developed as the planning process progresses.

In order to ensure that stations are designed to accommodate peak flows as the system is built, ridership estimates for both the full build out and Phase 1 must be considered. Station sizing should be based on the scenario that has higher ridership for that station.

The Phase 1 and Full Build ridership figures for each station will be provided by the Authority.

Note: It is recognized that ridership forecasts will be updated throughout CHSTP development. It is the responsibility of the designer to ensure that station design is based on the current available ridership figures.

3.2.4 Station Types

Elements of station functionality and design vary based on overarching differences in station type. The most significant of these are outlined in the following sections.

3.2.4.1 Intermediate Stations

Station design must acknowledge the operating conditions at intermediate (non-terminal) stations since most trains will dwell at these platforms for less than two minutes. Passengers will need to be on the platform prior to the train's arrival. In the event that boarding passengers are assigned to specific seats or cars, then they will need to be provided with information about where to wait at the platform, so that they can quickly board the proper car when the train arrives. The platform and waiting facilities should encourage distribution of passengers along the platform. The platform should be a comfortable environment in which patrons can wait.

Sufficient platform area must be provided to allow alighting passengers to exit the train without being blocked by boarding passenger queues – and without causing boarding passengers to crowd near the platform edge.

3.2.4.2 Terminal Stations

Terminal stations typically will have island platforms serving multiple tracks, since trains will occupy the station tracks for longer periods of time than will be the case at intermediate stations.

Terminal stations are expected to have additional ancillary facilities to prepare the trains for a return trip in the opposite direction. Activities occurring on or utilizing terminal station platforms include re-stocking and provisioning the on-board food service facility, light interior cleaning of the train and trash removal, train crew circulation to and from the train, and mechanical inspection of the train in-between trips.

Requirements for passenger-handling will depend upon layover time, a function of the system operating plan. When layover times are sufficiently long, passenger boarding will begin only once all alighting passengers have exited the arriving train and the train has been cleaned, inspected, serviced and provisioned. Departing passengers would be held within the concourse areas until the start of the boarding process.

There may be instances at a terminal station when trains will need to make relatively rapid turns at the platform. In these cases, it may be desirable or necessary to allow the departing passengers to occupy the platform prior to an incoming train's arrival, in which case the platform will need to have sufficient area to accommodate the boarding and alighting passenger loads simultaneously without creating undue congestion or hazardous conditions.

3.2.4.3 Intermediate Stations with Turnback Service

Operating plans, which have not yet been developed in detail, may indicate the need for selected trains to originate and terminate at intermediate stations along the route – to balance the supply and demand for rail system service and capacity and to ensure effective utilization of the high-speed train fleet. These stations also may require some of the elements of a terminal station, even if relatively few trains turn there. Each of the locations in this category will need to be considered individually as a special case.

3.3 STATION PROGRAM REQUIREMENTS

Station programming includes determination of required capacities, floor areas, adjacencies of uses and functional connections between spaces. This section describes the types of spaces required in a high-speed train station, corresponding areas for those spaces, basic area functions and characteristics, and how different areas interact. These standards and guidelines reflect only the needs of CHSTP, not those of any additional, adjacent transportation facilities or systems.

3.3.1 Goals

The main goals in planning station spaces are as follows:

- Assure the safety and security of passengers and station occupants
- Avoid congestion and meet peak level of service objectives
- Resilience to accommodate surges in demand or disruptions in train service
- Capacity for emergency evacuation
- Hierarchy of function based on spatial relationships
- Simplified flow between origins and destinations
- Ease of access for mobility-impaired passengers
- Architectural statement of civic purpose
- Flexibility to accommodate increases in ridership and changes in facilities and operating procedures.

3.3.2 Station Planning Zones and Patron Flows

Patron flows in a high-speed train station vary significantly based on the policy decisions outlined in Section 2.4 – Policy Considerations. Assumptions cited in that section were used to develop a standard passenger progression through the station. In order to simplify station planning and passenger movement, stations are divided into station planning zones based on hierarchy of functions and sequence. Flows are outlined below:

- Passengers pass through the entrance and into the concourse/ticket hall where information, ticketing, and basic services are easy to locate.
- Upon obtaining tickets and up-to-date train information, departing passengers will either proceed to a waiting area or make use of station amenities within the concourse. Depending upon the station configuration and passenger-handling procedures that are being employed, departing passengers may use dedicated waiting space within the public concourse free area or proceed to the fare paid area.

- Before the train's expected departure time, passengers will be instructed by announcements and dynamic signage to proceed to the appropriate platform (and to a specific spot on the platform if the system employs reserved seats or cars) to prepare for boarding the train.
- When the train arrives, the arriving passengers alight, and then the departing passengers board the train.
- Arriving passengers move from the platform, through the circulation space and concourse, and out the entrance. Services for departing passengers are included in the public concourse, including travel and transportation services and "meet and greet" space. To the extent possible, arriving passenger flows should be segregated from boarding passenger flows in order to minimize congestion and passenger confusion.

The primary performance measure that will be used to determine the adequacy of pedestrian circulation facilities within the station will be peak Level of Service (LOS), as defined by Fruin[1], which describes the peak degree of congestion, based on density, at key locations within the train station. This methodology is used throughout architecture, planning and engineering to size spaces for pedestrians and is not specific to types of facilities but instead general corridors, stairways and queues. Further explanation of the Fruin LOS performance measure is provided in *Appendix B: Level of Service Standards*.

3.3.3 Public Concourse Zone/Ticket Hall/Free Area

This area is the gateway to the station and includes public space where public information and ticketing facilities are located.

3.3.3.1 Entrances

Entrances provide a gateway to the station building and the rest of the station area site and surrounding community. As such, they should be clearly indicated to allow for easy entrance and exit by patrons. Exterior entrances should provide wind and rain protection if required in the area. Entrances should be visible from various locations around the site and building shell should make entrance locations intuitive. Where possible, stations entrances should be visible from areas external to the station site.

Stations are required to have multiple entrances (2 minimum) to ensure that a clear pathway for emergency exiting is always available. The minimum width of all combined entrances should be:

$[(P_1 \times 1.1) \div 15]$ ft or $[(P_1 \times 1.1) \div 50]$ m

The minimum width of each entrance is 10 ft (3m). Floors directly adjacent to entrances should be level for at least 10 ft (3 m) inside and outside of the entrance. For rail passengers, especially those carrying luggage, automated sliding or swinging doors are preferable to revolving doors and provide a higher capacity for passenger flow. Entrances must have a mechanism that allows the station to be closed, such as rolling or shuttered security gates.

3.3.3.2 Outer Concourse

The "fare free" concourse area contains circulation paths for passengers travelling from station entrances. It should be laid out to encourage movement through the station from the entrance to the "fare paid" area or other pre-boarding areas. Ticket sales, passenger information, public toilets, and waiting areas are located right off the main circulation path. The concourse area has signage and Passenger Information System displays, including a prominent timetable screen showing train arrivals and departures and a large-scale clock.

This area can be sized as follows:

P_{15} x 30 sf/person (Fruin LOS B) x 300ft (average travel path) @ 200 ft/minute

P_{15} = Peak 15 minute boardings and alightings

[1] Pedestrian Planning and Design. John J Fruin, Ph.D. 1987.

3.3.3.3 Public Waiting Areas

General public waiting areas provide a place for passengers and those accompanying or waiting for them to wait prior to entering the controlled area or leaving the station. Seating, information screens, and waste receptacles are located in this area. These areas should be located so they are easily accessible but do not impede the principal travel path to ticketing facilities or from the ticketing facilities to the platform. This both improves circulation and minimizes disturbance to waiting passengers.

Waiting areas in this zone should have a minimum area of:

$\{[(P_{30B}-P_{15B}) \times 1.1] + (P_{15A} \times 0.1)\} \times 14ft^2$

$[\{[(P_{30B}-P_{15B}) \times 1.1] + (P_{15A} \times 0.1)\} \times 1.3m^2]$

P_{30B} = Peak 30 minute boardings

P_{15B} = Peak 15 minute boardings

P_{15A} = Peak 15 minute alightings

As some of this space is dedicated for "meet and greet" or persons meeting arriving passengers, at least some of it is to be located near to where arriving passengers will emerge. Spaces should be organized so that those waiting do not impede flows for others going to and from the platforms.

3.3.3.4 Ticketing and Station Information

These spaces are located adjacent to the Public Concourse. Each has queuing areas which must be considered when planning circulation space and station sizing. Station designs should be able to accommodate either individual queues at each ticket/information window or a bank-style ordered queue. Space requirements and standards are discussed in Section 3.3.6.1 – Passenger Service Areas.

3.3.3.5 Public Restrooms

Provide male and female public restrooms that are consistent with ADA requirements. Facilities should be sized in accordance with local codes, ordinances, and regulations. The minimum occupant load for the facility should be based on 15 minute peak station patrons ($\mathbf{P_{15}}$) and applicable code requirements.

3.3.3.6 Commercial Spaces

Allocations for commercial space are not dictated by this document as such spaces are not necessary for high-speed train operation. However station design shall reflect the Authority's *Adopted HST Station Development Policies* (Appendix C) which encourages a high density of population, jobs, commercial activities, entertainment and other activities around stations. If commercial space is provided in the outer public concourse area, it should be located adjacent to major passenger circulation areas and not adjacent to the outer concourse. Commercial spaces and the patrons they attract must not impede high-speed train passenger flow. Additional guidelines for commercial development are outlined in Section 3.3.7 – Commercial Areas.

3.3.4 Controlled / "Fare Paid" Area

Access to the Controlled Area requires a paid fare and possession of a valid ticket. It is assumed that a proof-of-payment line is located at the entrance to platforms or at the entrance to a concourse leading to platforms. Spaces include, the Controlled Concourse, waiting areas, platforms, and restrooms. Total area for the Controlled Area should be sufficient to hold two fully loaded trains with an effective area[2] $7ft^2$ ($0.65m^2$) per person (under emergency conditions), equivalent to LOS C/D.

Extensive signage and Passenger Information should be displayed throughout the Controlled Area. The controlled area will have minimal amenities with nearly all services located in the "Free Area." This allows for the maximum utilization of these amenities and services.

[2] Effective area equals total area, less any area occupied by obstructions such as structural columns or furniture, and subtracting an allowance for edge conditions.

3.3.4.1 Controlled Concourse

The Controlled Concourse includes circulation space inside the Controlled Area, providing routes between the Public Concourse Zone and the platforms. Direct movement between these spaces should be facilitated through clear sight lines and logical configuration. Connections to the platform may require vertical circulation including stairs, escalators, and elevators (Vertical Circulation is discussed in Section 3.3.5). Restrooms, commercial spaces, and waiting spaces should be located immediately adjacent to the Controlled Concourse but should not impede major circulation routes.

Space requirements will be a function of the specific station operating plan and layout. However, for initial planning purposes, an area allowance for this space may be derived as follows:

P_{15} x 25 sf/person (Fruin LOS C) x 300ft (average travel path) @ 200 ft/minute

P_{15} = Peak 15 minute boardings and alightings

Area for the controlled concourse will be a function of the necessary circulation elements - corridors, stairs, escalators – and an element's effective width will be one which accommodates the maximum of the P_{15} volume at LOS B/C or the peak trainload surge volume at LOS C/D.

3.3.4.2 Waiting Areas

Waiting areas within the Controlled Area are provided on the platforms except where the total required waiting area exceeds the available platform area, or where passenger-handling procedures call for passenger waiting to occur in the controlled concourse area. In these cases, additional waiting areas should be provided adjacent to the platforms or the vertical circulation that leads to platforms. Waiting areas should not impede circulation between the free area and the platform. The area, whether adjacent to the platform or on the platform itself, should include sufficient seating for waiting passengers, waste receptacles and public telephones.

The minimum waiting area to be provided, inclusive of waiting area provided on the platforms, should be the maximum of:

P_{15B} x 14 ft^2 (P_{15B} x 1.3 m^2)

P_{Bpeak} x 14 ft^2 or (P_{Bpeak} x 1.3 m^2)

P_{Bmax} x 10 ft^2 or (P_{Bmax} x 0.9 m^2)

Platform area allocated for waiting must not impede circulation along platform and provides for buffers along the platform edge, walls and platform obstructions.

3.3.4.3 Business Center / Lounge

Some stations may include a business center of lounge to cater to business travellers and "frequent rider" customers. The facility would provide business services and/or premium amenities – such as those found at airline clubs, airport business centers or Amtrak's ClubAcela. The facility could include computers, printers, fax, wired internet, conference rooms, ticketing, passenger services and concierge services. Operations could be based on either a subscription basis as a for-profit enterprise or as a frequent traveller prerequisite (or both).

3.3.4.4 Platforms

Passenger Platforms

The primary function of station platforms is the boarding and alighting of trains. Platform geometry is discussed in the CHSTP Station Platform Geometric Design Technical Memorandum. Criteria will differ depending upon whether the platforms are in a side (outboard) versus island (center) configuration, are at an intermediate or a terminal station, and are exclusively used by high-speed trains or shared with other intercity or commuter rail services.

In addition to these general operating dimensions, platforms must conform to ADA and NFPA 130 standards. Under emergency conditions platforms should be able to hold a fully loaded train stopping at the station and the peak 15 minutes of waiting passengers. A safety zone along the platform edge and a buffer zone along walls must be discounted from this figure. Platforms should be sized to allow for complete clearing of the platform of:

- A peak arriving trainload prior to the next train's arrival, and
- The peak occupant load on the platform in 4.0 minutes or less (NFPA 130)

Platforms should be laid out in order to encourage separation of uses between waiting and queuing, circulation, and platform edge safety zone. Travel distance along the platform should be minimized. Long platforms will likely require multiple entry points from the Controlled Concourse. The minimum distance to the nearest egress point from any point along a platform is 300 ft. (NFPA 130). An egress point can be a vertical circulation element (stair or escalator) or a horizontal exit with an appropriate fire-rated doorway (along side platforms or at the ends of island platforms if a refuge zone is provided of the end of the platform).

Weather protection, including canopies and windscreens, should be provided along the entire length of the platform and should be oriented longitudinally along the platform and designed to maximize sightlines for station patrons, station operators, and train engineers.

Seating and information should be distributed along the length of the platform in order to discourage bunching and locate passengers near the car they will be boarding. Seating should be provided out of the main circulation and face the tracks. Seating and other furniture should be located at the widest points on the platform (for platforms that vary in width) and should be grouped in "furniture clusters." Car identification signs inform patrons of where they will be boarding. Information provided should include: clocks, system maps, timetables, and real time train arrival and departure information.

There must be at least 8.2 ft (2.5 m) of clear space between the edge of the platform and any obstructions, including but not limited to stairs, elevators, columns, sign posts, and other furniture. When point obstructions that are less than a meter long, clear width can be reduced to 6.6 ft (2 m). This provides safety for passengers on the platform and minimizes obstructions to the train operator's view.

Some operations and maintenance spaces will be necessary on the platform or adjacent to it. These spaces should be sited in order to minimize disruption to circulation flow and obstruction of clear lines of sight.

A clear refuge space should be provided under the platform edge at the track level. Exits from this space should be provided at the platform ends.

Under platform space may be used to house machine chambers, cables and other mechanical and electrical systems. These spaces should be divided into sections separated by 2-hour rated firewalls.

3.3.4.5 Commercial Spaces

Allocations for commercial space are not dictated by this document as such spaces are not necessary for high-speed train operation. However station design shall reflect the Authority's *Adopted HST Station Development Policies* (Appendix C) which encourages a high density of population, jobs, commercial activities, entertainment and other activities around stations. If commercial space is provided in the Controlled Area, it should be located adjacent to major passenger circulation areas. Commercial spaces and the patrons they attract must not impede high-speed train passenger flow. Additional guidelines for commercial development are outlined in Section 3.3.7 – Commercial Areas.

3.3.5 Station Corridors and Circulation Spaces

Station corridors and circulation spaces include passenger walkways, elevators, escalators, stairs, and ramps as well as emergency routes and non-public corridors. Access and circulation should be simple, obvious, and comfortable.

Circulation patterns should be laid out in order to:

- Avoid unnecessary cross flows, turns, and dead ends.
- Avoid cross circulation, especially at decision points, instead creating right hand circulation.
- Minimize travel distances and provide direct routes.

Allocation for access and circulation space should consider:

- Sufficient width to accommodate varying patron walking speeds.
- Space adjacent to circulation route for waiting passengers.
- Additional room needed per person due to luggage, strollers, bicycles, etc.
- Surge and queuing at decision points, barriers, and changes in direction or speed.
- Different routes for the public and the non-public.

Overall, station corridors and circulation spaces should be designed to a peak Fruin LOS B or better for walkways and concourse spaces and be in compliance with NFPA 130 requirements.

Where space is constrained by physical conditions that cannot be mitigated cost-effectively, high-speed train facilities should be designed for a peak LOS C.

3.3.5.1 Horizontal Circulation/Walkways

Horizontal walkways must be wide enough for peak flow while accommodating the variety of patron walking speeds. Changes in level and stairs should be minimized while maximizing sight lines. Obstructions, such as signs, structural supports, or furniture should not be placed in walkways. Minimum width for public circulation space is 7.9 ft (2.4 m). Specific minimum circulation width should be calculated as follows:

Total peak hour pedestrian volume should be assigned among all walking paths in the station. Corridor width should be based on avg. flow during peak 5-minute interval (P_{5C}). At locations without train-generated passenger surges, the station average can be used to derive flows in individual corridors. Corridors leading directly to/from platforms should be sized to accommodate the expected surge loadings of boarding and/or alighting passengers.

General locations: Width = $[P_{5C} \div 15) \div M1] \times F + B$

Passenger surge locations: Width = $[P_{Bpeak} \div M2] \times F + B$

P_{5C} = Peak passenger load in circulation space based on distribution throughout station, sum of all P_{5C} should be equal to P_5.

M1 = Passenger circulation rate for general flows, assumed to be 10 people/min per foot of effective width, or 32.8 people/min per meter of effective width [LOS B/C threshold]

M2 = Passenger circulation rate for surge flows, assumed to be 25 people/m/min [LOS C/D threshold is 15 people/min per foot of effective width, or 49.2 people/min per meter of effective width]

F = Friction factor (equals 1.0 for one-way or evenly balanced flows; ranges up to 1.2 for unbalanced flows)

B = Buffer Zone: 1.6 ft (0.5 m) for walls and railings, 4.9 ft (1.5 m) along commercial space, 3.3 ft (1 m) at platform edge

Non-public circulation spaces should be sized according to local codes.

All sizing should comply with NFPA 130 which takes precedence over other guidance.

3.3.5.2 Vertical Circulation

Changes of grade within the station should be minimized. However, vertical circulation will be necessary in stations in order to reach platforms and may be warranted in other cases.

3.3.5.2.1 Stairs

Stairs are necessary in places with significant changes in grade. Stair width is determined based on satisfying level of service standards for expected peak flow conditions, as well as NFPA 130 emergency egress calculations. Other stair requirements are based on local codes and regulations.

Width = $[(P_{5C} \div 5) \div M] \times F + B$

P_{5C} = Peak passenger load in circulation space based on distribution throughout station, sum of all P_{5C} should be equal to P_5.

M = Passenger circulation rate for general flows, assumed to be 7 people/min per foot of effective width, or 23 people/min per meter of effective width [LOS B/C threshold]

F = Friction factor (equals 1.0 for one-way or evenly balanced flows; ranges up to 1.2 for unbalanced flows)

B = Buffer Zone: 1.0 ft (0.3 m) for stair railings.

3.3.5.2.2 Ramps

Ramps can be utilized where there are small changes in elevation that cannot be avoided. Ramp width follows horizontal circulation requirements. Ramp gradient requirements are outlined in Section 4.8.2 of the ADA Accessibility Guidelines. Where such a ramp requires turns, a ramp and stairs must be provided.

3.3.5.2.3 Escalators

Escalators should be provided between station levels or other places where there will be high passenger flows and relatively large vertical changes. The number of escalators varies by station and demand. At least one extra escalator should be provided between levels in order to provide a back up in case of maintenance. All escalators should be full two-lane models with a 40 in (1 m) tread width and should be of the heavy-duty, reversible type. Escalators should be capable of operating at speeds of 90 ft. / min. and 120 ft. / min. The maximum throughput rate for a 40 inch tread-width escalator operating at 90 ft. / min. is defined to be 70 people per minute.

3.3.5.2.4 Elevators

Elevators should be provided for disabled patrons, patrons for luggage which is unsafe to carry on escalators, and the movement of supplies. Elevators should be designed and sized for use for individuals with disabilities, luggage, or bicycles. Elevators require adjacent machine rooms.

If access to the platform requires a change of level, two elevators are required. This provides redundancy in the case of maintenance.

Passenger elevators should be separate from service elevators. There shall be one service elevator per platform, with a service corridor either beneath or above track level connected to the back-of-house zone of the station.

Elevators will not be used in the calculation of platform egress capacity and will not be assumed to contribute significant capacity for pedestrian movements within the station concourse levels. Sizing and configuration of vertical circulation points should comply with NFPA 130, which takes precedence over other guidance.

3.3.5.3 Queuing Spaces

Queuing spaces must be provided throughout the station and should not overlap with areas allocated to circulation or other spaces. Specific minimum requirements for queuing are as follows:

Landing area at top and bottom of public stairs: 14.8 ft (4.5 m)

Landing area at top and bottom of escalator: 19.7 ft (6 m)

Entrance to elevator: 5.9 ft (1.8 m)

In front of TVM: 16.4 ft (5 m)

In front of Ticket Sales Office: 19.7 ft (6 m)

Actual requirements should be determined at each location based on estimated peak passenger volumes, passenger handling procedures, and queuing analysis. At ticket sales offices, the public queuing space should be kept free of intermediate columns and should be sized to accommodate either individual queues at each window or a single ordered queue with stanchions.

3.3.6 Station Support Areas

This area includes all semi- or non-public (back-of-the-house) areas of the station that are required for the operation of the station and the system. These include passenger service areas, station operation offices, and other ancillary spaces. Design of these spaces should be purely functional.

3.3.6.1 Passenger Service Areas

These spaces provide functions directly to station patrons. As such, they must be adjacent to public areas. The design of many of these spaces will be uniform throughout the system in order to provide continuity to passengers. The following is a non-exhaustive list of these spaces.

3.3.6.1.1 Ticket Sales Office

At ticket sales offices, passengers are able to procure tickets directly from station staff. Other ticketing transactions may also be conducted including refunds, ticket adjustments, or retrieval of reserved tickets. These offices are located adjacent to the Public Concourse and are easily visible from station entrances.

Ticket windows should be provided to meet peak passenger demand as follows:

Ticket windows = $(P_{60B} \times A) \div (B \times C)$

A = Percentage of P_{60B} making ticket window transactions (assume 15%)

B = Tickets sold in each ticketing transaction (assume 1.5)

C = Hourly rate at which transactions are processed per ticket window (assume 60)

The number of windows should be rounded up to the nearest whole number and a spare window may be included to accommodate ticket clerk shift changes.

Spacing between each window should be at least 6.0 ft (1.8 m). Queuing space requirements are outlined in Section 3.3.5.3.

Each ticket window position should be a minimum of 75 square feet.

Ticket Vending Machines (TVMs) should be located near to the Ticket Sales office and within view of the ticket office queuing area. Requirements for TVMs are outlined in Section 3.4.3.1. Ticket sales administrative offices and other ticketing-related offices should be adjacent to these facilities.

3.3.6.1.2 Station Information Office

The Station Information Office provides information to station patrons about the use of the high-speed train network. They should be located adjacent to the Public Concourse and easily visible from station entrances. An information office should have counter space and space for the agent to work. An office should be a minimum of 100 square feet but may be significantly larger in some stations. Queuing space with a minimum depth of 15 feet is required to be outside of the Public Concourse's direct circulation. If stations have sufficiently low ridership projections, these functions may be combined with the Ticket Sales Office.

In addition to the information office, the public concourse shall have information kiosks and racks for train timetables and other pertinent information for passengers. The kiosks can help reduce the peak demand for information clerks and would provide information about high-speed train service, including train schedules, fares and policies. These or other kiosks also could provide information about the local city and connecting modes of transportation available at the station.

3.3.6.1.3 Passenger Services Office

The "information office" function should be limited to the dispensing of train information, with short transaction times and short passenger queues. The passenger services function encompasses a broader array of interactions with passengers and typically longer transaction times. This relieves ticket and information clerks from handling complex passenger queries not directly related to tickets or train information. This facility typically consists of a small waiting room/lobby with a counter and adjoining office. It can be integrated with the station agent office. The passenger services office shall have a minimum area of 160 ft^2 (15 m^2).

3.3.6.1.4 Lost and Found

This function consists of a small store room with a counter fronting on the public concourse. It can be integrated with passenger services, temporary baggage storage and/or the station agent function. The store room shall have a minimum area of 43 ft^2 (4 m^2).

3.3.6.1.5 Station Agent Office

This serves as the office for the station manager. It should be adjacent to the Public Concourse and connected to other station offices and should have a minimum area of 270 ft^2 (25 m^2).

3.3.6.1.6 Baggage Storage

Temporary storage for luggage may be provided for system patrons at some stations. Evaluation of demand luggage storage and potential security risks must be completed before space is included in the station design. Such storage would typically be a staffed store room with a counter fronting on the public concourse. These may be supplemented with self-service storage lockers. This storage may be integrated with lost and found.

3.3.6.2 Station Operation Offices

These back-of-house areas are offices and other spaces which have no public contact. They should be arranged according to function and have non-public access. The following is a partial list of these spaces.

3.3.6.2.1 Station Administration Office

Administrative tasks are performed in this space. It should be adjacent to the Station Manager's office. Minimum size should be as follows:

{(65 ft^2x Staff with assigned workspace) + (43 ft^2 x Staff with shared workspace)} x 1.25

[{(6 m^2x Staff with assigned workspace) + (4 m^2 x Staff with shared workspace)} x 1.25]

3.3.6.2.2 Station Staff Training and Meeting Room

This room will be included in some stations and is used for staff meetings, staff training and emergency command. The minimum area for this room is (20 ft^2 x maximum number of staff during one shift x 1.25) or (2 m^2 x maximum number of staff during one shift x 1.25).

3.3.6.2.3 Station Control Room

The Station Control Room is where movements in the station and with the train are monitored and some are controlled. For the station, this includes passenger circulation, fare control, security, and building service operations. For the train, this includes the option of local train operation, traction power, signalling, and communication. However, it is likely that most of these functions will be controlled at the Central Control Facility (CCF). Station designers need to be familiar with the operating plan and coordinate their efforts with the systems designers to determine the appropriate location and configuration of any such facilities at CHST stations.

The Station Control Room shall also function as an incident response command center. This will be the place where first responders would coordinate activities with station personnel in the event of an emergency or security incident.

For initial planning purposes, this function is assumed to have a minimum area of 1,080 ft^2 (100 m^2).

3.3.6.2.4 Station Computer Room

The station computer room houses the servers that are needed in order to operate the ticketing and station operation systems. This area should have controlled heat and humidity and a link to the Uninterrupted Power Supply (UPS). Area is generally 520 ft^2 (48 m^2).

3.3.6.2.5 Platform Operation Room

This space is used to monitor passenger circulation as trains arrive and depart. Public address capabilities, and control of the in-station dynamic signage, should be integrated into this space and it should be located near the middle of the platform length. Co-location of this function with the station control room is desirable. This facility requires a good communications link with the station control room and the Central Control Facility, to facilitate timely and accurate dissemination of train information to the public. Its location should allow for visual surveillance which is supplemented by CCTVs. Total area should be a minimum of 160 ft^2 (15 m^2).

3.3.6.2.6 Ticket Administration Office

This space will be used for administrative functions required for ticketing. Also, cash and ticket storage will be here. The room should be secured and have a secured access to allow for transferring of cash. Minimum area should be 160 ft^2 (15 m^2).

3.3.6.2.7 Security Office

This is the office for security personnel. The office will have video screens showing the station area CCTV. In addition, direct access to the public concourse should be provided. Consideration shall be given to the placement of this office within the public concourse to provide security presence within the public space. Direct access to the public concourse will be provided. Minimum area should be 160 ft^2 (15 m^2).

3.3.6.2.8 Police Office

Some stations may have an office for police responsible for station area security. It should be located adjacent to the security office and near the station entrance. Minimum area should be 160 ft^2 (15 m^2). Some stations may require holding cells and/or canine support facilities as well.

3.3.6.2.9 Facility Maintenance Office

Administration and basic maintenance space for building service staff should have a minimum size of 325 ft^2 (30 m^2).

3.3.6.2.10 Operation Maintenance Office

Administration work and parts/equipment storage space for the high-speed train system operations and engineering staff should have a minimum size of 1,080 ft^2 (100 m^2).

3.3.6.2.11 Transportation Agency Offices

Transportation agencies may be interested in having offices within a high-speed train station. Inclusion and sizing of this space would vary by station.

3.3.6.2.12 Staff Restrooms

Male and female staff restrooms should be provided in addition to public ones and in line with the building code. Sizing to be determined by code.

3.3.6.2.13 Staff Locker Room

Male and female locker rooms should be provided for staff including room for personal storage during shift and showers. Sizing to be determined by code.

3.3.6.2.14 Staff Break Room

Station staff break room will have basic kitchen facilities and room for staff on break. The minimum size should be as follows:

20 ft^2 x 0.25 x Maximum staff per shift x 1.25

(2 m^2 x 0.25 x Maximum staff per shift x 1.25)

3.3.6.2.15 Refuse Storage Room

Provide space to store recycling and waste according to station production and pick up rate. Refuse storage should be located where collection trucks can drop-off and collect and away from public areas. Minimum area should be 54 ft^2 (5 m^2).

3.3.6.2.16 Cleaning Facility Rooms

These spaces will provide storage space for cleaning supplies. Each will have a janitor's sink and a minimum size of 108 ft^2 (10 m^2). They should be located adjacent to the Public Concourse, the Controlled Concourse and the Station Platform.

3.3.6.2.17 Station Storage Rooms

General storage will be provided adjacent to the Public Concourse, the Controlled Concourse, and the Station Platform. Minimum area should be 130 ft^2 (12 m^2).

3.3.6.2.18 Landscape Maintenance Storage Room

This room will have space for landscaping tools and supplies and basic work. It should have direct access to outdoors.

3.3.6.2.19 End-of-Line Operations Area

Provide space to support the cleaning, re-stocking, provisioning and preparation of trains prior to turning at terminal stations or other stations based on the operations plan. This may also include additional area for train crews, on-board security staff, and mechanical crews (including break rooms, locker rooms, ready room, train crew sleeping quarters, and/or ticket receiver's office).

3.3.6.2.20 Porters' Office

This function provides back-of-house support space, including cart storage, for the porters (a.k.a. "red caps") who will assist passengers with their luggage while within the station. This service will be provided at some stations. The facility should be conveniently accessible to the public concourse. Minimum area shall be 200 ft^2 (18.6 m^2).

3.3.6.3 Station Building Service and HST System Equipment Rooms

Facilities needed for building services are addressed in building codes and other technical memorandums, respectively. Potential systems to consider include but are not limited to: HVAC, electrical, fire protection, traction power, rail infrastructure maintenance, and telecommunications. Station design shall accommodate the systems and operational requirements and meet the requirements of applicable codes.

Also include elevator/escalator maintenance, storage for luggage or servicing carts, battery storage/charging for any such carts.

3.3.6.4 Service Corridors, Platform Access and Loading Dock

Some stations will require contiguous service access to all platforms, the back-of-house areas of the station, and the station loading dock. Ideally, these access pathways should not cross pedestrian flow routes within the station. These corridors will be used by station staff and maintenance personnel and will not be accessible to the public.

Elevators separate from the passenger elevators should be provided to each platform, connecting with a service corridor that passes above or below the platforms and provides direct non-public

access to the station's back-of-house facilities. It will be desirable to standardize the location of these service elevators at all high-speed train stations (i.e., at the north end or south end of the platforms), to facilitate train provisioning and servicing. This will require coordination with the trainset design and the developers of the overall operating plan.

Certain station-related service corridors, such as the ones linking the ticket office with the loading dock, which will be used for handling ticket revenue, should be kept separate from service corridors serving the retail and commercial zones of the station.

The station loading dock and service entrance should be sized to accommodate station-related deliveries, ticket revenue handling, trash compacting and collection for the entire station, delivery of on-board services supplies (at terminal stations), police and security-related access, and deliveries to retail concessions within the station.

3.3.7 Commercial Areas

This zone includes all areas of the station that contain commercial development. Allocations for commercial space are not dictated by this document as such spaces are not necessary for high-speed train operation. However, station design shall reflect the Authority's *Adopted HST Station Development Policies* (Appendix C) which encourages a high density of population, jobs, commercial activities, entertainment and other activities around stations. If commercial space is provided, it should be located adjacent to major passenger circulation areas. Any concessions which are in operation should not interfere with operation of the station or passenger circulation. This includes separation of routing for goods and materials.

3.4 STATION AMENITIES

3.4.1 Furniture

Station furniture should be sited outside of circulation areas and avoid blocking logical flows. Furniture should be secured and vandal-resistant. Where possible, furniture elements should be grouped together along with system information. Furniture is not limited to that described in the following sections.

3.4.1.1 Seating and Benches

Seating and benches should be designed to discourage sleeping and generally be in areas protected from the weather.

Minimum number of seats to be provided as follows:

Controlled Concourse Waiting Area: $P_{15} \times 0.25$

Public Concourse Waiting Area: $\{[(P_{30B}-P_{15B}) \times 1.1] + (P_{15A} \times 0.1)\} \times 0.05$

P_{30B} = Peak 30 minute boardings

P_{15B} = Peak 15 minute boardings

P_{15A} = Peak 15 minute alightings

3.4.1.2 Waste and Recycling Receptacles

Receptacles should be located so they are accessible for station patrons and maintenance crews. Weather exposure should be minimized and trash receptacles should be blast-resistant. The locations for such receptacles should be configured so as to avoid blocking pedestrian flows or restricting the effective widths or circulation routes.

3.4.1.3 Public Telephones

Design guidance for public telephones will be developed at a later date.

3.4.1.4 Water Fountains

Design guidance for water fountains will be developed at a later date.

3.4.2 Signage and Communication

Signage should be provided throughout stations to improve way-finding and safety as well as providing general information. Signage should be visibly and logically placed to maximize

effectiveness. Other transportation systems and modes should be integrated into the signage plan. Specific signage and information to be considered include: Way-finding signs, variable message signs, warning signs, maps, schedules, clocks, arrival and departure information boards, and public address systems.

In addition, waiting areas should include power outlets for laptops, Wi-Fi and television monitors.

Additional information will be developed at a later time.

3.4.3 Fare Collection Equipment

3.4.3.1 Ticket Vending Machines (TVMs)

Ticket Vending Machines should be located in the Public Concourse near to Ticketing Booth(s) and adjacent to the main circulation routes from entrances to the Controlled Concourse and Platforms. The machines and corresponding queue space (outlined in Section 3.3.5.3) must be located outside of patron circulation space. Machines should be grouped into clusters. Depending on the scale of the station and the number of TVMs, multiple clusters may be appropriate. There should be sufficient TVM redundancy in the case of machine maintenance.

TVMs should be provided to meet peak passenger demand as follows:

$$TVMs = (P_{60B} \times A) \div (B \times C)$$

A = Percentage of P_{60B} making TVM transactions (assume 40%)

B = Tickets sold in each ticketing transaction (assume 1.5)

C = Hourly rate at which transactions are processed per ticket window (assume 60)

3.4.3.2 Ticket Validating Machine

Design guidance for ticket validating machines will be developed at a later date.

3.4.3.3 Fare Adjustment Machine

Design guidance for fare adjustment machines will be developed at a later date.

3.5 STATION SYSTEMS

Building systems are functional requirements of a station in order to ensure safe and effective building operations. Sizing standards of building systems will generally be dictated by local building codes.

3.5.1 Security

Station security is provided with the goal of protecting the station, the high-speed train system and station, and system patrons. Specific security spaces included in station facilities include a security office and a police office. Other facilities which may contribute to station security include the station control and communications room, the platform operation room and the station agent office. Staff support facilities will be shared between security and other station personnel.

3.5.2 Electrical

Electrical systems include power supplies (high, low voltage, and emergency), normal and emergency lighting, and grounding. Space and facilities to support electrical operation of the station may include standby generators, switchboards, uninterrupted power systems, and electrical distribution facilities.

3.5.3 Plumbing and Drainage

Plumbing and drainage systems include general water supply, storm water drainage, sewer and waste water drainage, and fire protection water supply.

3.5.4 Fire Detection and Protection

Station design must comply with NFPA 130 which stipulates fire compartmentalization requirements, station exit capacities, and evacuation times. Firemen's stairs should be provided as dictated by local requirements. Ancillary space exit travel distances should comply with CBC. Automatic smoke detectors, fire detectors, and manual pull stations should be provided for detection. Fire protection systems should include at least portable fire extinguishers, manual

standpipe and hose stations, and automatic sprinklers. A separate water supply with pump should be provided for fire suppression purposes. Additional space requirements for fire detection and protection may include control, pump, and valve rooms.

3.5.5 Acoustic, Noise and Vibration Minimization

Noise and vibration generated by the train, patrons, external sources, and building systems should be minimized through station design. Appropriate mitigations should be considered both inside of the station and in adjacent areas.

3.5.6 HVAC

Heating, ventilation, and air conditioning (HVAC) requirements will vary based on station type, station area weather, and other factors. Level of service will also vary within the building based on specific room requirements. HVAC space requirements may include chiller, air handling, control room, and ventilation among other spaces.

3.5.7 Telecommunications and Signaling

Telecommunications and signalling facilities may include radio, battery, cable distribution, and signal equipment rooms.

4.0 SUMMARY AND RECOMMENDATIONS

The recommended station program requirements to be provided at stations are presented in Section 6.0.

5.0 SOURCE INFORMATION AND REFERENCES

1. The Manual for Railway Engineering of the American Railway Engineering and Maintenance-of-Way Association (AREMA Manual)
2. FTA /FRA 49CFR
3. California Public Utilities Commission General Order 26-D
4. CHSRA Adopted HST Station Development Policies. May 14, 2008.
5. CHSTP Design Basis Document – California High-Speed Rail Program – High-Speed Rail System Design Comparison
6. CHSTP Basis of Design Policy – California High-Speed Train Project – January 2008.
7. CHSTP Technical Memorandum TM 1.1.6 – Alignment Standards for Shared Use Corridors – Specific to LA to Anaheim
8. CHSTP Technical Memorandum TM 2.2.4 – Station Platform Geometric Design
9. CHSTP Design Criteria Draft (2004)
10. Nash, Andrew. Best Practices in Shared-Use High-Speed Rail Systems. Mineta Transportation Institute. June 2003.
11. Taiwan High-Speed Rail Station Design Criteria. December 2000.
12. Fruin, John J. Pedestrian Planning and Design. Elevator World, Inc. 1987.
13. Caltrain Design Criteria. Chapter 3 – Station and Facilities. April 15, 2007.
14. Denver Regional Transit District (RTD) Design Guidelines & Criteria. Light Rail Design Criteria. Section 5 – Station Design. November 2005.
15. Federal Aviation Administration (FAA) Terminal Design Guidelines. April 1988.
16. Long Beach Airport Terminal Space Recommendations. April 17, 2007. HOK Architects.
17. CHSTP EIR/EIS Task 1.11 Engineering Criteria Report.
18. SCRRA Design Criteria Manual. January 2003.
19. Sound Transit. Design Standards and Guidelines for Sound Transit Projects: Sounder & ST Express Passenger Facilities. January 22, 2007.
20. Singapore Land Transport Authority. Marina Line Transit Stations. Architectural Design Criteria. May 1999.
21. Amtrak Station Program & Planning Standards and Guidelines, Ver. 2.2
22. Benz, Gregory P., *Pedestrian Time-Space Concept*, W. B Parsons Fellowship Monograph, Rev. 1992.
23. NFPA 130 Emergency Egress Standards and Analytic Methodology

6.0 DESIGN MANUAL CRITERIA

6.1 STATION DESIGN CONSIDERATIONS

6.1.1 General Considerations

These considerations are meant to assist designers in the design and configuration of spaces within the station envelope. Major stations' areas and facilities are described. Design and sizing of stations shall consider:

- The prescribed design criteria are considered a minimum. The design of each station shall reflect local and unique circumstances.
- Safety of station patrons, train passengers, and operating personnel shall be the first priority in station design.
- Stations shall be sized to accommodate expected ridership in the Full Build (2035) or projected Phase I ridership, whichever is higher, under estimated peak period and emergency conditions. The Design Life for passenger stations is addressed in TM 1.1.2 - Design Life Technical Memorandum.
- Shared-use stations require that station design serves both high-speed and conventional rail services.
- Station plans shall have clarity and simplicity of organization. Interdependent passenger spaces must have clarity of organization. Space sequence and architectural treatment should be simple and reinforce building pathways, destinations, and functions. Circulation routes shall be clear and unobstructed by people or architectural elements.
- Station design shall consider future extension and expansion as well as ridership growth as far as feasible. This could include increase in system reach, increase in frequencies, increase in train length, and increase in number of tracks.
- Stations design should consider a "not to preclude" approach and provide sufficient flexibility to accommodate future updates to the programmatic requirements, within reason.

6.1.2 Functional Consistency

Station configuration should be functionally consistent in order to allow for system identity and to simplify orientation for system passengers. Some common station elements can lead to reduced capital, operations, and maintenance costs through reduced design and construction variation, economies of scale, and simplification of operations and maintenance procedures. However, unique and recognizable stations will improve the passenger experience and encourage fulfilment of the Authority's *Adopted HST Station Development*. Functionally consistent elements include but are not limited to:

- Signage and graphics, including informational and directional signage
- Passenger Information Systems, including dynamic and static visual displays and public address systems
- Ticket sales office location and configuration
- Fare collection and train boarding process
- Finishes and hardware
- Escalators and elevators
- Fare collection equipment
- Communications systems
- Platform minimum width and length
- Platform surface and edge paving

One key to accomplishing the functional consistency station facilities will be the development of station-operating and passenger-handling procedures. These procedures will be a function of the overall high-speed train operating plan, which will be developed as the planning and design process progresses.

6.1.3 Peak Period Passengers

Public station areas are generally sized based on peak expected use, which is derived from estimates of peak train loads or peak period ridership. Ridership forecasts are approximate and will change over the duration of the project, requiring station requirements to be refined. The following methodology for temporarily distributing station patrons was developed in lieu of a more sophisticated approach, until more precise estimates are available at a later stage of the planning and design process. It is an approximation derived from a compendium of other ridership estimates.

Peak period ridership is determined using the following parameters:

- **Daily Boardings:** Average daily boardings at stations as well as a peak day boarding will be provided by the Authority. The peak day boarding will take into account seasonal and day-of-week peaking as well as possible changes in HST level of service which could impact station ridership. Design shall be based on the peak day boarding.
- **Peak 6-hour Boardings (P_{360B}):** Ridership peaking factors to convert peak day boardings to peak 6-hour boardings are provided in Technical Memorandum 4.2 Phase 1 Service Plan.
- **Peak Hour Boardings (P_{60B}):** Ridership peaking factors to convert peak day boardings to peak hour boardings are provided in Technical Memorandum 4.2 Phase 1 Service Plan.
- **Peak 30-minute Boardings (P_{30B}):** Half of all the peak hour boardings, multiplied by a system surge factor of 1.2.
- **Peak 15-minute Boardings (P_{15B}):** A quarter of the peak hour boardings, multiplied by a system surge factor of 1.3.
- **Peak 5-minute Boardings (P_{5B}):** Peak hour boardings divided by 12 and multiplied by a system surge factor of 1.4.
- **Peak minute Boardings (P_{1B}):** Peak hour boardings divided by 60 and multiplied by a system surge factor of 1.5.

As these figures are only represent for people boarding the trains, approximations were made to ensure that stations are sized to accommodate alighting passengers. A factor of 1.75 is applied to boardings to determine total boardings and alightings (P_{360}, P_{60}, P_{30}, P_{15}, P_5, P_1). Boardings are shown using a subscript "B" (P_B), and alightings are shown using a subscript "A" (P_A).

It is expected that some high-speed train passengers will have people dropping them off or picking them up at the station. Peak "meeters-and-greeters" are estimated to be one-tenth of the total boardings and alightings. Total station occupancy also includes station staff which varies based on operating conditions and station type.

Certain station facility requirements will be based on estimated passenger trainloads, rather than peak period passenger volumes factored from estimated daily demand. High-speed trainsets are planned to be approximately 650 feet in length capable of coupling to provide approximately 1300-foot long train sets during peak operating conditions. A 650 foot train will accommodate approximately 450 passengers; a 900 foot trainset will hold 900 passengers. The terminal stations will need to be sized to accommodate surge loads of up to 900 passengers either boarding or alighting from a fully-loaded train. Intermediate stations will need to be able to safely hold and evacuate full trainloads of passengers in the event of a mechanical failure or emergency condition.

- **Peak Boarding Load (P_{Bpeak}):** Estimated volume of boarding passengers for the peak train on the design day, assuming normal on-time operations

- **Maximum Boarding Load (P_{Bmax}):** Estimated volume of boarding passengers for the peak train on the design day, assuming perturbed operating conditions, such as one cancelled train or moderate service delays.

Similar estimates of peak and maximum alighting train loads shall be developed.

Station facilities also will need to be able to accommodate the additional passengers that will accumulate within the station when a train is cancelled or seriously delayed for some reason. Estimates will need to be developed for the expected concentrations of passengers that will accumulate within station facilities under various delay and service disruption scenarios. The methodology to be used to analyze passenger movement dynamics and potential delay conditions will be developed as the planning process progresses.

In order to ensure that stations are designed to accommodate peak flows as the system is built, ridership estimates for both the full build out and Phase 1 must be considered. Station sizing shall be based on the scenario that has higher ridership for that station.

The Phase 1 and Full Build ridership figures for each station will be provided by the Authority.

Note: It is recognized that ridership forecasts will be updated throughout CHSTP development. It is the responsibility of the designer to ensure that station design is based on the current available ridership figures.

6.1.4 Station Types

Elements of station functionality and design vary based on overarching differences in station type. The most significant of these are outlined in the following sections.

6.1.4.1 Intermediate Stations

Station design must acknowledge the operating conditions at intermediate (non-terminal) stations since most trains will dwell at these platforms for less than two minutes. Passengers will need to be on the platform prior to the train's arrival. In the event that boarding passengers are assigned to specific seats or cars, then they will need to be provided with information about where to wait at the platform, so that they can quickly board the proper car when the train arrives. The platform and waiting facilities shall encourage distribution of passengers along the platform. The platform shall be a comfortable environment in which patrons can wait.

Sufficient platform area must be provided to allow alighting passengers to exit the train without being blocked by boarding passenger queues – and without causing boarding passengers to crowd near the platform edge.

6.1.4.2 Terminal Stations

Terminal stations typically will have island platforms serving multiple tracks, since trains will occupy the station tracks for longer periods of time than will be the case at intermediate stations.

Terminal stations are expected to have additional ancillary facilities to prepare the trains for a return trip in the opposite direction. Activities occurring on or utilizing terminal station platforms include re-stocking and provisioning the on-board food service facility, light interior cleaning of the train and trash removal, train crew circulation to and from the train, and mechanical inspection of the train in-between trips.

Requirements for passenger-handling will depend upon layover time, a function of the system operating plan. When layover times are sufficiently long, passenger boarding will begin only once all alighting passengers have exited the arriving train and the train has been cleaned, inspected, serviced and provisioned. Departing passengers would be held within the concourse areas until the start of the boarding process.

There may be instances at a terminal station when trains will need to make relatively rapid turns at the platform. In these cases, it may be desirable or necessary to allow the departing passengers to occupy the platform prior to an incoming train's arrival, in which case the platform will need to have sufficient area to accommodate the boarding and alighting passenger loads simultaneously without creating undue congestion or hazardous conditions.

6.1.4.3 Intermediate Stations with Turnback Service

Operating plans, which have not yet been developed in detail, may indicate the need for selected trains to originate and terminate at intermediate stations along the route – to balance the supply and demand for rail system service and capacity and to ensure effective utilization of the high-speed train fleet. These stations also may require some of the elements of a terminal station, even if relatively few trains turn there. Each of the locations in this category will need to be considered individually as a special case.

6.2 STATION PROGRAM REQUIREMENTS

Station programming includes determination of required capacities, floor areas, adjacencies of uses and functional connections between spaces. This section describes the types of spaces required in a high-speed train station, corresponding areas for those spaces, basic area functions and characteristics, and how different areas interact. These standards and guidelines reflect only the needs of CHSTP, not those of any additional, adjacent transportation facilities or systems.

6.2.1 Goals

The main goals in planning station spaces are as follows:

- Assure the safety and security of passengers and station occupants
- Avoid congestion and meet peak level of service objectives
- Resilience to accommodate surges in demand or disruptions in train service
- Capacity for emergency evacuation
- Hierarchy of function based on spatial relationships
- Simplified flow between origins and destinations
- Ease of access for mobility-impaired passengers
- Architectural statement of civic purpose
- Flexibility to accommodate increases in ridership and changes in facilities and operating procedures.

6.2.2 Station Planning Zones and Patron Flows

Patron flows in a high-speed train station vary significantly based on the policy decisions outlined in Section 2.4 – Policy Considerations. Assumptions cited in that section were used to develop a standard passenger progression through the station. In order to simplify station planning and passenger movement, stations are divided into station planning zones based on hierarchy of functions and sequence. Flows are outlined below:

- Passengers pass through the entrance and into the concourse/ticket hall where information, ticketing, and basic services are easy to locate.
- Upon obtaining tickets and up-to-date train information, departing passengers will either proceed to a waiting area or make use of station amenities within the concourse. Depending upon the station configuration and passenger-handling procedures that are being employed, departing passengers may use dedicated waiting space within the public concourse free area or proceed to the fare paid area.
- Before the train's expected departure time, passengers will be instructed by announcements and dynamic signage to proceed to the appropriate platform (and to a specific spot on the platform if the system employs reserved seats or cars) to prepare for boarding the train.
- When the train arrives, the arriving passengers alight, and then the departing passengers board the train.
- Arriving passengers move from the platform, through the circulation space and concourse, and out the entrance. Services for departing passengers are included in the public concourse, including travel and transportation services and "meet and greet" space. To the extent possible, arriving passenger flows shall be segregated from boarding passenger flows in order to minimize congestion and passenger confusion.

The primary performance measure that will be used to determine the adequacy of pedestrian circulation facilities within the station will be peak Level of Service (LOS), as defined by Fruin[3], which describes the peak degree of congestion, based on density, at key locations within the train station. This methodology is used throughout architecture, planning and engineering to size spaces for pedestrians and is not specific to types of facilities but instead general corridors, stairways and queues.

6.2.3 Public Concourse Zone/Ticket Hall/Free Area

This area is the gateway to the station and includes public space where public information and ticketing facilities are located.

6.2.3.1 Entrances

Entrances provide a gateway to the station building and the rest of the station area site and surrounding community. As such, these shall be clearly indicated to allow for easy entrance and exit by patrons. Exterior entrances shall provide wind and rain protection if required in the area. Entrances shall be visible from various locations around the site and building shell shall make entrance locations intuitive. Where practical, stations entrances shall be visible from areas external to the station site.

Stations are required to have multiple entrances (2 minimum) to ensure that a clear pathway for emergency exiting is always available. The minimum width of all combined entrances shall be:

$[(P_1 \times 1.1) \div 15]$ ft

The minimum width of each entrance is 10 ft. Floors directly adjacent to entrances shall be level for at least 10 ft inside and outside of the entrance. For rail passengers, especially those carrying luggage, automated sliding or swinging doors are preferable to revolving doors and provide a higher capacity for passenger flow. Entrances must have a mechanism that allows the station to be closed, such as rolling or shuttered security gates.

6.2.3.2 Outer Concourse

The “fare free” concourse area contains circulation paths for passengers travelling from station entrances. It shall be laid out to encourage movement through the station from the entrance to the “fare paid” area or other pre-boarding areas. Ticket sales, passenger information, public toilets, and waiting areas are located right off the main circulation path. The concourse area has signage and Passenger Information System displays, including a prominent timetable screen showing train arrivals and departures and a large-scale clock.

This area can be sized as follows:

P_{15} x 30 sf/person (Fruin LOS B) x 300ft (average travel path) @ 200 ft/minute

P_{15} = Peak 15 minute boardings and alightings

6.2.3.3 Public Waiting Areas

General public waiting areas provide a place for passengers and those accompanying or waiting for them to wait prior to entering the controlled area or leaving the station. Seating, information screens, and waste receptacles are located in this area. These areas shall be located so they are easily accessible but do not impede the principal travel path to ticketing facilities or from the ticketing facilities to the platform. This both improves circulation and minimizes disturbance to waiting passengers.

Waiting areas in this zone shall have a minimum area of:

$\{[(P_{30B}-P_{15B}) \times 1.1] + (P_{15A} \times 0.1)\} \times 14ft^2$

P_{30B} = Peak 30 minute boardings

P_{15B} = Peak 15 minute boardings

P_{15A} = Peak 15 minute alightings

[3] Pedestrian Planning and Design. John J Fruin, Ph.D. 1987.

As some of this space is dedicated for "meet and greet" or persons meeting arriving passengers, at least some of it is to be located near to where arriving passengers will emerge. Spaces shall be organized so that those waiting do not impede flows for others going to and from the platforms.

6.2.3.4 Ticketing and Station Information

These spaces are located adjacent to the Public Concourse. Each has queuing areas which must be considered when planning circulation space and station sizing. Station designs shall be able to accommodate either individual queues at each ticket/information window or a bank-style ordered queue. Space requirements and standards are discussed in Section 6.2.6.1 – Passenger Service Areas.

6.2.3.5 Public Restrooms

Provide male and female public restrooms that are consistent with ADA requirements. Facilities shall be sized in accordance with local codes, ordinances, and regulations. The minimum occupant load for the facility shall be based on 15 minute peak station patrons ($\mathbf{P_{15}}$) and applicable code requirements.

6.2.3.6 Commercial Spaces

Allocations for commercial space are not dictated by this document as such spaces are not necessary for high-speed train operation. However station design shall reflect the Authority's *Adopted HST Station Development Policies* which encourages a high density of population, jobs, commercial activities, entertainment and other activities around stations. If commercial space is provided in the outer public concourse area, it should be located adjacent to major passenger circulation areas and not adjacent to the outer concourse. Commercial spaces and the patrons they attract must not impede high-speed train passenger flow. Additional guidelines for commercial development are outlined in Section 6.2.7 – Commercial Areas.

6.2.4 Controlled / "Fare Paid" Area

Access to the Controlled Area requires a paid fare and possession of a valid ticket. It is assumed that a proof-of-payment line is located at the entrance to platforms or at the entrance to a concourse leading to platforms. Spaces include, the Controlled Concourse, waiting areas, platforms, and restrooms. Total area for the Controlled Area shall be sufficient to hold two fully loaded trains with an effective area[4] 7ft^2 per person (under emergency conditions), equivalent to LOS C/D.

Extensive signage and Passenger Information shall be displayed throughout the Controlled Area. The controlled area will have minimal amenities with nearly all services located in the "Free Area." This allows for the maximum utilization of these amenities and services.

6.2.4.1 Controlled Concourse

The Controlled Concourse includes circulation space inside the Controlled Area, providing routes between the Public Concourse Zone and the platforms. Direct movement between these spaces shall be facilitated through clear sight lines and logical configuration. Connections to the platform may require vertical circulation including stairs, escalators, and elevators (Vertical Circulation is discussed in Section 6.2.5). Restrooms, commercial spaces, and waiting spaces shall be located immediately adjacent to the Controlled Concourse but shall not impede major circulation routes.

Space requirements will be a function of the specific station operating plan and layout. However, for initial planning purposes, an area allowance for this space may be derived as follows:

P_{15} x 25 sf/person (Fruin LOS C) x 300ft (average travel path) @ 200 ft/minute

P_{15} = Peak 15 minute boardings and alightings

[4] Effective area equals total area, less any area occupied by obstructions such as structural columns or furniture, and subtracting an allowance for edge conditions.

Area for the controlled concourse will be a function of the necessary circulation elements - corridors, stairs, escalators – and an element's effective width will be one which accommodates the maximum of the P_{15} volume at LOS B/C or the peak trainload surge volume at LOS C/D.

6.2.4.2 Waiting Areas

Waiting areas within the Controlled Area are provided on the platforms except where the total required waiting area exceeds the available platform area, or where passenger-handling procedures call for passenger waiting to occur in the controlled concourse area. In these cases, additional waiting areas shall be provided adjacent to the platforms or the vertical circulation that leads to platforms. Waiting areas shall not impede circulation between the free area and the platform. The area, whether adjacent to the platform or on the platform itself, shall include sufficient seating for waiting passengers, waste receptacles and public telephones.

The minimum waiting area to be provided, inclusive of waiting area provided on the platforms, shall be the maximum of:

P_{15B} x 14 ft^2

P_{Bpeak} x 14 ft^2

P_{Bmax} x 10 ft^2

Platform area allocated for waiting must not impede circulation along platform and provides for buffers along the platform edge, walls and platform obstructions.

6.2.4.3 Business Center / Lounge

Some stations may include a business center of lounge to cater to business travellers and "frequent rider" customers. The facility would provide business services and/or premium amenities – such as those found at airline clubs, airport business centers or Amtrak's ClubAcela. The facility could include computers, printers, fax, wired internet, conference rooms, ticketing, passenger services and concierge services. Operations could be based on either a subscription basis as a for-profit enterprise or as a frequent traveller prerequisite (or both).

6.2.4.4 Platforms

Passenger Platforms

The primary function of station platforms is the boarding and alighting of trains. Platform geometry is discussed in CHSTP TM 2.2.3 - Station Platform Geometric Design Technical Memorandum. Criteria will differ depending upon whether the platforms are in a side (outboard) versus island (center) configuration, are at an intermediate or a terminal station, and are exclusively used by high-speed trains or shared with other intercity or commuter rail services.

In addition to these general operating dimensions, platforms must conform to ADA and NFPA 130 standards. Under emergency conditions platforms shall be able to hold a fully loaded train stopping at the station and the peak 15 minutes of waiting passengers. A safety zone along the platform edge and a buffer zone along walls must be discounted from this figure. Platforms shall be sized to allow for complete clearing of the platform of:

- A peak arriving trainload prior to the next train's arrival, and
- The peak occupant load on the platform in 4.0 minutes or less (NFPA 130)

Platforms shall be laid out in order to encourage separation of uses between waiting and queuing, circulation, and platform edge safety zone. Travel distance along the platform shall be minimized. Long platforms will likely require multiple entry points from the Controlled Concourse. The minimum distance to the nearest egress point from any point along a platform is 300 ft. (NFPA 130). An egress point can be a vertical circulation element (stair or escalator) or a horizontal exit with an appropriate fire-rated doorway (along side platforms or at the ends of island platforms if a refuge zone is provided of the end of the platform).

Weather protection, including canopies and windscreens, shall be provided along the entire length of the platform and shall be oriented longitudinally along the platform and designed to maximize sightlines for station patrons, station operators, and train engineers.

Seating and information shall be distributed along the length of the platform in order to discourage bunching and locate passengers near the car they will be boarding. Seating shall be provided out of the main circulation and face the tracks. Seating and other furniture shall be located at the widest points on the platform (for platforms that vary in width) and shall be grouped in "furniture clusters." Car identification signs inform patrons of where they will be boarding. Information provided shall include: clocks, system maps, timetables, and real time train arrival and departure information.

There shall be at least 8.2 ft of clear space between the edge of the platform and any obstructions, including but not limited to stairs, elevators, columns, sign posts, and other furniture. When point obstructions that are less than a meter long, clear width can be reduced to 6.6 ft. This provides safety for passengers on the platform and minimizes obstructions to the train operator's view.

Some operations and maintenance spaces will be necessary on the platform or adjacent to it. These spaces shall be sited in order to minimize disruption to circulation flow and obstruction of clear lines of sight.

A clear refuge space shall be provided under the platform edge at the track level. Exits from this space should be provided at the platform ends.

Under platform space may be used to house machine chambers, cables and other mechanical and electrical systems. These spaces shall be divided into sections separated by 2-hour rated firewalls.

6.2.4.5 Commercial Spaces

Allocations for commercial space are not dictated by this document as such spaces are not necessary for high-speed train operation. However station design shall reflect the Authority's *Adopted HST Station Development Policies* which encourages a high density of population, jobs, commercial activities, entertainment and other activities around stations. If commercial space is provided in the Controlled Area, it should be located adjacent to major passenger circulation areas. Commercial spaces and the patrons they attract must not impede high-speed train passenger flow. Additional guidelines for commercial development are outlined in Section 6.2.7– Commercial Areas.

6.2.5 Station Corridors and Circulation Spaces

Station corridors and circulation spaces include passenger walkways, elevators, escalators, stairs, and ramps as well as emergency routes and non-public corridors. Access and circulation should be simple, obvious, and comfortable.

Circulation patterns shall be laid out in order to:

- Avoid unnecessary cross flows, turns, and dead ends.
- Avoid cross circulation, especially at decision points, instead creating right hand circulation.
- Minimize travel distances and provide direct routes.

Allocation for access and circulation space shall consider:

- Sufficient width to accommodate varying patron walking speeds.
- Space adjacent to circulation route for waiting passengers.
- Additional room needed per person due to luggage, strollers, bicycles, etc.
- Surge and queuing at decision points, barriers, and changes in direction or speed.
- Different routes for the public and the non-public.

Overall, station corridors and circulation spaces shall be designed to a peak Fruin LOS B or better for walkways and concourse spaces and be in compliance with NFPA 130 requirements.

Where space is constrained by physical conditions that cannot be mitigated cost-effectively, high-speed train facilities shall be designed for a peak LOS C.

6.2.5.1 Horizontal Circulation/Walkways

Horizontal walkways must be wide enough for peak flow while accommodating the variety of patron walking speeds. Changes in level and stairs shall be minimized while maximizing sight lines. Obstructions, such as signs, structural supports, or furniture shall not be placed in walkways. Minimum width for public circulation space is 7.9 ft. Specific minimum circulation width shall be calculated as follows:

Total peak hour pedestrian volume shall be assigned among all walking paths in the station. Corridor width shall be based on avg. flow during peak 5-minute interval (P_{5C}). At locations without train-generated passenger surges, the station average can be used to derive flows in individual corridors. Corridors leading directly to/from platforms shall be sized to accommodate the expected surge loadings of boarding and/or alighting passengers.

General locations: Width = $[P_{5C} \div 15) \div M1] \times F + B$

Passenger surge locations: Width = $[P_{Bpeak} \div M2] \times F + B$

P_{5C} = Peak passenger load in circulation space based on distribution throughout station, sum of all P_{5C} shall be equal to P_5.

M1 = Passenger circulation rate for general flows, assumed to be 10 people/min per foot of effective width, [LOS B/C threshold]

M2 = Passenger circulation rate for surge flows, assumed to be 25 people/m/min [LOS C/D threshold is 15 people/min per foot of effective width]

F = Friction factor (equals 1.0 for one-way or evenly balanced flows; ranges up to 1.2 for unbalanced flows)

B = Buffer Zone: 1.6 ft (0.5 m) for walls and railings, 4.9 ft along commercial space, 3.3 ft at platform edge

Non-public circulation spaces shall be sized according to local codes.

All sizing shall comply with NFPA 130 which takes precedence over other guidance.

6.2.5.2 Vertical Circulation

Changes of grade within the station shall be minimized. However, vertical circulation will be necessary in stations in order to reach platforms and may be warranted in other cases.

6.2.5.2.1 Stairs

Stairs are necessary in places with significant changes in grade. Stair width is determined based on satisfying level of service standards for expected peak flow conditions, as well as NFPA 130 emergency egress calculations. Other stair requirements are based on local codes and regulations.

Width = $[(P_{5C} \div 5) \div M] \times F + B$

P_{5C} = Peak passenger load in circulation space based on distribution throughout station, sum of all P_{5C} shall be equal to P_5.

M = Passenger circulation rate for general flows, assumed to be 7 people/min per foot of effective width [LOS B/C threshold]

F = Friction factor (equals 1.0 for one-way or evenly balanced flows; ranges up to 1.2 for unbalanced flows)

B = Buffer Zone: 1.0 ft for stair railings.

6.2.5.2.2 Ramps

Ramps can be utilized where there are small changes in elevation that cannot be avoided. Ramp width follows horizontal circulation requirements. Ramp gradient requirements are outlined in Section 4.8.2 of the ADA Accessibility Guidelines. Where such a ramp requires turns, a ramp and stairs must be provided.

6.2.5.2.3 Escalators

Escalators shall be provided between station levels or other places where there will be high passenger flows and relatively large vertical changes. The number of escalators varies by station and demand. At least one extra escalator shall be provided between

levels in order to provide a back up in case of maintenance. All escalators shall be full two-lane models with a 40 inch tread width and shall be of the heavy-duty, reversible type. Escalators shall be capable of operating at speeds of 90 ft. / min. and 120 ft. / min. The maximum throughput rate for a 40 inch tread-width escalator operating at 90 ft. / min. is defined to be 70 people per minute.

6.2.5.2.4 Elevators

Elevators shall be provided for disabled patrons, patrons for luggage which is unsafe to carry on escalators, and the movement of supplies. Elevators shall be designed and sized for use for individuals with disabilities, luggage, or bicycles. Elevators require adjacent machine rooms.

If access to the platform requires a change of level, two elevators are required. This provides redundancy in the case of maintenance.

Passenger elevators shall be separate from service elevators. There shall be one service elevator per platform, with a service corridor either beneath or above track level connected to the back-of-house zone of the station.

Elevators will not be used in the calculation of platform egress capacity and will not be assumed to contribute significant capacity for pedestrian movements within the station concourse levels. Sizing and configuration of vertical circulation points shall comply with NFPA 130, which takes precedence over other guidance.

6.2.5.3 Queuing Spaces

Queuing spaces must be provided throughout the station and shall not overlap with areas allocated to circulation or other spaces. Specific minimum requirements for queuing are as follows:

Landing area at top and bottom of public stairs: 14.8 ft

Landing area at top and bottom of escalator: 19.7 ft

Entrance to elevator: 5.9 ft

In front of TVM: 16.4 ft

In front of Ticket Sales Office: 19.7 ft

Actual requirements shall be determined at each location based on estimated peak passenger volumes, passenger handling procedures, and queuing analysis. At ticket sales offices, the public queuing space should be kept free of intermediate columns and shall be sized to accommodate either individual queues at each window or a single ordered queue with stanchions.

6.2.6 Station Support Areas

This area includes all semi- or non-public (back-of-the-house) areas of the station that are required for the operation of the station and the system. These include passenger service areas, station operation offices, and other ancillary spaces. Design of these spaces shall be purely functional.

6.2.6.1 Passenger Service Areas

These spaces provide functions directly to station patrons. As such, they must be adjacent to public areas. The design of many of these spaces will be uniform throughout the system in order to provide continuity to passengers. The following is a non-exhaustive list of these spaces.

6.2.6.1.1 Ticket Sales Office

At ticket sales offices, passengers are able to procure tickets directly from station staff. Other ticketing transactions may also be conducted including refunds, ticket adjustments, or retrieval of reserved tickets. These offices are located adjacent to the Public Concourse and are easily visible from station entrances.

Ticket windows shall be provided to meet peak passenger demand as follows:

Ticket windows = $(P_{60B} \times A) \div (B \times C)$

A = Percentage of P_{60B} making ticket window transactions (assume 15%)

B = Tickets sold in each ticketing transaction (assume 1.5)

C = Hourly rate at which transactions are processed per ticket window (assume 60)

The number of windows shall be rounded up to the nearest whole number and a spare window may be included to accommodate ticket clerk shift changes.

Spacing between each window shall be at least 6.0 ft. Queuing space requirements are outlined in Section 6.2.5.3.

Each ticket window position shall be a minimum of 75 square feet.

Ticket Vending Machines (TVMs) shall be located near to the Ticket Sales office and within view of the ticket office queuing area. Requirements for TVMs are outlined in Section 6.3.3.1. Ticket sales administrative offices and other ticketing-related offices shall be adjacent to these facilities.

6.2.6.1.2 Station Information Office

The Station Information Office provides information to station patrons about the use of the high-speed train network. They should be located adjacent to the Public Concourse and easily visible from station entrances. An information office shall have counter space and space for the agent to work. An office shall be a minimum of 100 square feet but may be significantly larger in some stations. Queuing space with a minimum depth of 15 feet is required to be outside of the Public Concourse's direct circulation. If stations have sufficiently low ridership projections, these functions may be combined with the Ticket Sales Office.

In addition to the information office, the public concourse shall have information kiosks and racks for train timetables and other pertinent information for passengers. The kiosks can help reduce the peak demand for information clerks and would provide information about high-speed train service, including train schedules, fares and policies. These or other kiosks also could provide information about the local city and connecting modes of transportation available at the station.

6.2.6.1.3 Passenger Services Office

The "information office" function shall be limited to the dispensing of train information, with short transaction times and short passenger queues. The passenger services function encompasses a broader array of interactions with passengers and typically longer transaction times. This relieves ticket and information clerks from handling complex passenger queries not directly related to tickets or train information. This facility typically consists of a small waiting room/lobby with a counter and adjoining office. It can be integrated with the station agent office. The passenger services office shall have a minimum area of 160 ft^2.

6.2.6.1.4 Lost and Found

This function consists of a small store room with a counter fronting on the public concourse. It can be integrated with passenger services, temporary baggage storage and/or the station agent function. The store room shall have a minimum area of 43 ft^2.

6.2.6.1.5 Station Agent Office

This serves as the office for the station manager. It should be adjacent to the Public Concourse and connected to other station offices and shall have a minimum area of 270 ft^2.

6.2.6.1.6 Baggage Storage

Temporary storage for luggage may be provided for system patrons at some stations. Evaluation of demand luggage storage and potential security risks must be completed before space is included in the station design. Such storage would typically be a staffed store room with a counter fronting on the public concourse. These may be supplemented with self-service storage lockers. This storage may be integrated with lost and found.

6.2.6.2 Station Operation Offices

These back-of-house areas are offices and other spaces which have no public contact. They shall be arranged according to function and have non-public access. The following is a partial list of these spaces.

6.2.6.2.1 Station Administration Office

Administrative tasks are performed in this space. It should be adjacent to the Station Manager's office. Minimum size shall be as follows:

{(65 ft^2x Staff with assigned workspace) + (43 ft^2 x Staff with shared workspace)} x 1.25

6.2.6.2.2 Station Staff Training and Meeting Room

This room will be included in some stations and is used for staff meetings, staff training and emergency command. The minimum area for this room is (20 ft^2 x maximum number of staff during one shift x 1.25).

6.2.6.2.3 Station Control Room

The Station Control Room is where movements in the station and with the train are monitored and some are controlled. For the station, this includes passenger circulation, fare control, security, and building service operations. For the train, this includes the option of local train operation, traction power, signalling, and communication. However, it is likely that most of these functions will be controlled at the Central Control Facility (CCF). Station designers need to be familiar with the operating plan and coordinate their efforts with the systems designers to determine the appropriate location and configuration of any such facilities at HST stations.

The Station Control Room shall also function as an incident response command center. This will be the place where first responders would coordinate activities with station personnel in the event of an emergency or security incident.

For initial planning, this function is assumed to have a minimum area of 1,080 ft^2.

6.2.6.2.4 Station Computer Room

The station computer room houses the servers that are needed to operate the ticketing and station operation systems. This area shall have controlled heat and humidity and a link to the Uninterrupted Power Supply (UPS). Area is approximately 520 ft^2.

6.2.6.2.5 Platform Operation Room

This space is used to monitor passenger circulation as trains arrive and depart. Public address capabilities, and control of the in-station dynamic signage, shall be integrated into this space and it should be located near the middle of the platform length. Co-location of this function with the station control room is desirable. This facility requires a good communications link with the station control room and the Central Control Facility, to facilitate timely and accurate dissemination of train information to the public. Its location shall allow for visual surveillance which is supplemented by CCTVs. Total area shall be a minimum of 160 ft^2.

6.2.6.2.6 Ticket Administration Office

This space will be used for administrative functions required for ticketing. Also, cash and ticket storage will be here. The room shall be secured and have a secured access to allow for transferring of cash. Minimum area shall be 160 ft^2.

6.2.6.2.7 Security Office

This is the office for security personnel. The office will have video screens showing the station area CCTV. In addition, direct access to the public concourse shall be provided. Consideration shall be given to the placement of this office within the public concourse to provide security presence within the public space. Direct access to the public concourse will be provided. Minimum area shall be 160 ft^2.

6.2.6.2.8 Police Office

Some stations may have an office for police responsible for station area security. It should be located adjacent to the security office and near the station entrance. Minimum area shall be 160 ft^2. Some stations may require holding cells and/or canine support facilities as well.

6.2.6.2.9 Facility Maintenance Office

Administration and basic maintenance space for building service staff shall have a minimum size of 325 ft^2.

6.2.6.2.10 Operation Maintenance Office

Administration work and parts/equipment storage space for the high-speed train system operations and engineering staff shall have a minimum size of 1,080 ft^2.

6.2.6.2.11 Transportation Agency Offices

Transportation agencies may be interested in having offices within a high-speed train station. Inclusion and sizing of this space would vary by station.

6.2.6.2.12 Staff Restrooms

Male and female staff restrooms shall be provided in addition to public ones and in line with the building code. Size shall be determined by code.

6.2.6.2.13 Staff Locker Room

Male and female locker rooms shall be provided for staff including room for personal storage during shift and showers. Size shall be determined by code.

6.2.6.2.14 Staff Break Room

Station staff break room will have basic kitchen facilities and room for staff on break. The minimum size shall be as follows:

20 ft^2 x 0.25 x Maximum staff per shift x 1.25

6.2.6.2.15 Refuse Storage Room

Provide space to store recycling and waste according to station production and pick up rate. Refuse storage should be located where collection trucks can drop-off and collect and away from public areas. Minimum area shall be 54 ft^2.

6.2.6.2.16 Cleaning Facility Rooms

These spaces will provide storage space for cleaning supplies. Each will have a janitor's sink and a minimum size of 108 ft^2. They should be located adjacent to the Public Concourse, the Controlled Concourse and the Station Platform.

6.2.6.2.17 Station Storage Rooms

General storage will be provided adjacent to the Public Concourse, the Controlled Concourse, and the Station Platform. Minimum area shall be 130 ft^2.

6.2.6.2.18 Landscape Maintenance Storage Room

This room will have space for landscaping tools and supplies and basic work. It shall have direct access to outdoors.

6.2.6.2.19 End-of-Line Operations Area

Provide space to support the cleaning, re-stocking, provisioning and preparation of trains prior to turning at terminal stations or other stations based on the operations plan. This may also include additional area for train crews, on-board security staff, and mechanical crews (including break rooms, locker rooms, ready room, train crew sleeping quarters, and/or ticket receiver's office).

6.2.6.2.20 Porters' Office

This function provides back-of-house support space, including cart storage, for the porters (a.k.a. "red caps") who will assist passengers with their luggage while within the station. This service will be provided at some stations. The facility shall be conveniently accessible to the public concourse. Minimum area shall be 200 ft^2.

6.2.6.3 Station Building Service and HST System Equipment Rooms

Facilities needed for building services are addressed in building codes and other technical memorandums, respectively. Potential systems to consider include but are not limited to: HVAC, electrical, fire protection, traction power, rail infrastructure maintenance, and telecommunications. Station design shall accommodate the systems and operational requirements and meet the requirements of applicable codes.

Also include elevator/escalator maintenance, storage for luggage or servicing carts, battery storage/charging for any such carts.

6.2.6.4 Service Corridors, Platform Access and Loading Dock

Some stations will require contiguous service access to all platforms, the back-of-house areas of the station, and the station loading dock. Ideally, these access pathways should not cross pedestrian flow routes within the station. These corridors will be used by station staff and maintenance personnel and will not be accessible to the public.

Elevators separate from the passenger elevators shall be provided to each platform, connecting with a service corridor that passes above or below the platforms and provides direct non-public access to the station's back-of-house facilities. It will be desirable to standardize the location of these service elevators at all high-speed train stations (i.e., at the north end or south end of the platforms), to facilitate train provisioning and servicing. This will require coordination with the trainset design and the developers of the overall operating plan.

Certain station-related service corridors, such as the ones linking the ticket office with the loading dock, which will be used for handling ticket revenue, should be kept separate from service corridors serving the retail and commercial zones of the station.

The station loading dock and service entrance shall be sized to accommodate station-related deliveries, ticket revenue handling, trash compacting and collection for the entire station, delivery of on-board services supplies (at terminal stations), police and security-related access, and deliveries to retail concessions within the station.

6.2.7 Commercial Areas

This zone includes all areas of the station that contain commercial development. Allocations for commercial space are not dictated by this document as such spaces are not necessary for high-speed train operation. However, station design shall reflect the Authority's *Adopted HST Station Development Policies* which encourages a high density of population, jobs, commercial activities, entertainment and other activities around stations. If commercial space is provided, it should be

located adjacent to major passenger circulation areas. Any concessions which are in operation should not interfere with operation of the station or passenger circulation. This includes separation of routing for goods and materials.

6.3 STATION AMENITIES

6.3.1 Furniture

Station furniture should be sited outside of circulation areas and avoid blocking logical flows. Furniture shall be secured and vandal-resistant. Where possible, furniture elements shall be grouped together along with system information. Furniture is not limited to that described in the following sections.

6.3.1.1 Seating and Benches

Seating and benches shall be designed to discourage sleeping and generally be in areas protected from the weather.

Minimum number of seats to be provided as follows:

Controlled Concourse Waiting Area: $P_{15} \times 0.25$

Public Concourse Waiting Area: $\{[(P_{30B}-P_{15B}) \times 1.1] + (P_{15A} \times 0.1)\} \times 0.05$

P_{30B} = Peak 30 minute boardings

P_{15B} = Peak 15 minute boardings

P_{15A} = Peak 15 minute alightings

6.3.1.2 Waste and Recycling Receptacles

Receptacles shall be located so they are accessible for station patrons and maintenance crews. Weather exposure shall be minimized and trash receptacles shall be blast-resistant. The locations for such receptacles shall be configured so as to avoid blocking pedestrian flows or restricting the effective widths or circulation routes.

6.3.1.3 Public Telephones

Design guidance for public telephones will be developed at a later date.

6.3.1.4 Water Fountains

Design guidance for water fountains will be developed at a later date.

6.3.2 Signage and Communication

Signage shall be provided throughout stations to improve way-finding and safety as well as providing general information. Signage shall be visibly and logically placed to maximize effectiveness. Other transportation systems and modes shall be integrated into the signage plan. Specific signage and information to be considered include: Way-finding signs, variable message signs, warning signs, maps, schedules, clocks, arrival and departure information boards, and public address systems.

In addition, waiting areas shall include power outlets for laptops, Wi-Fi and television monitors.

Additional information will be developed at a later time.

6.3.3 Fare Collection Equipment

6.3.3.1 Ticket Vending Machines (TVMs)

Ticket Vending Machines shall be located in the Public Concourse near to Ticketing Booth(s) and adjacent to the main circulation routes from entrances to the Controlled Concourse and Platforms. The machines and corresponding queue space (outlined in Section 6.2.5.3) must be located outside of patron circulation space. Machines shall be grouped into clusters. Depending on the scale of the station and the number of TVMs, multiple clusters may be appropriate. There shall be sufficient TVM redundancy in the case of machine maintenance.

TVMs shall be provided to meet peak passenger demand as follows:

$$TVMs = (P_{60B} \times A) \div (B \times C)$$

A = Percentage of P_{60B} making TVM transactions (assume 40%)

B = Tickets sold in each ticketing transaction (assume 1.5)

C = Hourly rate at which transactions are processed per ticket window (assume 60)

6.3.3.2 Ticket Validating Machine

Design guidance for ticket validating machines will be developed at a later date.

6.3.3.3 Fare Adjustment Machine

Design guidance for fare adjustment machines will be developed at a later date.

6.4 STATION SYSTEMS

Building systems are functional requirements of a station in order to ensure safe and effective building operations. Sizing standards of building systems will generally be dictated by local building codes.

6.4.1 Security

Station security is provided with the goal of protecting the station, the high-speed train system and station, and system patrons. Specific security spaces included in station facilities include a security office and a police office. Other facilities which may contribute to station security include the station control and communications room, the platform operation room and the station agent office. Staff support facilities will be shared between security and other station personnel.

6.4.2 Electrical

Electrical systems include power supplies (high, low voltage, and emergency), normal and emergency lighting, and grounding. Space and facilities to support electrical operation of the station may include standby generators, switchboards, uninterrupted power systems, and electrical distribution facilities.

6.4.3 Plumbing and Drainage

Plumbing and drainage systems include general water supply, storm water drainage, sewer and waste water drainage, and fire protection water supply.

6.4.4 Fire Detection and Protection

Station design must comply with NFPA 130 which stipulates fire compartmentalization requirements, station exit capacities, and evacuation times. Firemen's stairs shall be provided as dictated by local requirements. Ancillary space exit travel distances shall comply with CBC. Automatic smoke detectors, fire detectors, and manual pull stations shall be provided for detection. Fire protection systems shall include at least portable fire extinguishers, manual standpipe and hose stations, and automatic sprinklers. A separate water supply with pump shall be provided for fire suppression purposes. Additional space requirements for fire detection and protection may include control, pump, and valve rooms.

6.4.5 Acoustic, Noise and Vibration Minimization

Noise and vibration generated by the train, patrons, external sources, and building systems shall be minimized through station design. Appropriate mitigations shall be considered both inside of the station and in adjacent areas.

6.4.6 HVAC

Heating, ventilation, and air conditioning (HVAC) requirements will vary based on station type, station area weather, and other factors. Level of service will also vary within the building based on specific room requirements. HVAC space requirements may include chiller, air handling, control room, and ventilation among other spaces.

6.4.7 Telecommunications and Signaling

Telecommunications and signalling facilities may include radio, battery, cable distribution, and signal equipment rooms.

6.5 STATION PROGRAM REQUIREMENTS

In order to define station footprints, station elements are listed below along with either a standard size or a formula to determine sizing based on station ridership. These are gross estimates and are provided in order to develop order of magnitude station sizing estimates. The configuration of each station facility is dependent on specific land uses and local codes, conditions, and policies.

Operational considerations and train operation support systems will vary by station due to track alignment and site constraints.

In order to determine overall square footage, apply a 1.4 factor to the total spaces in order to account for building area that are not included in the larger usable spaces such as walls, ducts, and similar spaces.

Table 6.1: Required Station Spaces and Corresponding Approximate Areas

Area	Standard or Formula
Public Concourse Zone	
Entrance (width)	[(P_1 x 1.1) ÷ 15] ft
Outer Concourse	P_{15} x 30 sf/person (Fruin LOS B) x 300 ft (average travel path) @ 200 ft/minute
Public Waiting Area	{[(P_{30B}-P_{15B}) x 1.1] + (P_{15A} x 0.1)} x 14 ft^2
Restrooms (occupancy)	P_{15}
Ticket Vending Machines (inc. queue)	[(0.4 x P_{60B}) ÷ (1.5 x 60)] x 100 ft^2
Ticket Window Queue	[(P_{60B} x 0.15) ÷ (1.5 x 60)] x 145 ft^2
Controlled Area	
Controlled Concourse	P_{15} x 30 sf/person (Fruin LOS B) x 300 ft (average travel path) @ 200 ft/minute
Controlled Waiting Areas	P_{15B} x 14 ft^2 or P_{Bmax} x 10 ft^2 or P_{Bmax} x 10 ft^2
Business Center/Lounge	Station-by-station inclusion and sizing
Platforms – Island	1380 ft x 30 ft or (P_{15B} x+ 1800) x 7 ft^2
Platforms – Side	1380 ft x 20 ft or (P_{15B} x+ 900) x 7 ft^2
Corridors and Circulation	
Walkways	Based on station layout, codes
Vertical Circulation	Based on station layout, codes
Station Support Areas	
Passenger Service Areas	
Ticket Sales Offices	{[(P_{60B} x 0.15) ÷ (1.5 x 60)] x 75} ft^2
Station Information Office (inc. queue)	{100 + (15 x width)} ft^2
Passenger Services Office	160 ft^2
Lost and Found	43 ft^2
Station Agent Office	270 ft^2
Baggage Storage	Inclusion varies by station
Station Operation Offices	
Station Administration Office	{(65 ft^2x Staff with own workspace) + (43 ft^2 x Staff with shared workspace)} x 1.25
Training and Meeting Room	(20 ft^2 x max staff per shift x 1.25)
Station Control and Communications Room	1080 ft^2
Station Computer Room	520 ft^2

Area	Standard or Formula
Station Support Areas, cont.	
Platform Operation Room	160 ft^2
Ticket Administration Office	160 ft^2
Security Office	160 ft^2
Police Office	160 ft^2
Facility Maintenance Office	325 ft^2
Operation Maintenance Office	1080 ft^2
Transportation Offices	Based on demand
Staff Restrooms	Local codes
Staff Locker Room	Local codes
Staff Break Room	(20 ft^2 x 0.25 x Max staff per shift x 1.25)
Refuse Storage Room	54 ft^2
Janitor's Rooms	110 ft^2 x 3
Station Storage Rooms	130 ft^2 x 3
Landscape Maintenance Storage Room	-
End-of-Line Operations Area	-
Porters' Office	200 ft^2
HVAC Rooms: Ex. Chiller, Air Handling, Control Room, Ventilation, etc	
Electrical Rooms: Ex. Standby Generator, Switchboard, Uninterrupted Power System, Electrical Distribution, etc	
Fire Protection Rooms: Ex. Control Room, Pump Room, Valve Room, etc	
Telecommunications Rooms: Ex. Radio Rooms, Battery Rooms, etc.	
Signaling System Rooms: Ex. Cable Distribution Room, Signal Equipment Room, Battery Room, etc.	
Plumbing Rooms	
Commercial Spaces - Not determined by the Authority	

Note: It is recognized that ridership forecasts will be updated throughout high-speed train project development. It is the responsibility of the designer to ensure that station design is based on the current available ridership figures.

Appendix A: Policy-Related Station Elements in Other Systems

x – System includes this Station Element
o – System does not include Station Element

Country System	Japan Shinkansen	France TGV	Taiwan THSR	Korea KTX	Germany ICE	Belgium Thalys	England Eurostar
Platform Doors	some	o	o	o	o	o	o
Fare Control							
Fare Gates	x	o	x	x	o	o	x
Proof-of-Payment	o	x	o	o	x	x	o
Human Ticket Control	o	o	o	o	o	o	o
Ticket Purchase							
Ticket Booth	x	x	x	x	x	x	x
Ticket Vending Machine	x	x	x	x	x	x	x
Pre-purchase	x	x	x	x	x	x	x
On Board	o	o	o	o	x	x	o
Reserved Seating	x	x		x	x	x	x
Unreserved Seating	x	o		o	o	o	o
Baggage Handling*	o	o	o	o	o	o	x**
Security							
Security Screening	o	o	o	o	o	o	x
Concessions							
Basic Services		x	x		x		o
Focus on Retail/Development			x		x		x

* Baggage handling refers to the checking of luggage when checking in for the train, trains may have freight options or luggage carts (for passengers to move luggage to their coach) but this is still not considered "baggage handling"

** Not necessarily on the same train, only at some stations, extra charges, http://www.eurostar.com/UK/uk/leisure/travel_information/at_the_station/baggage.jsp

Appendix B: LEVEL OF SERVICE STANDARDS

The primary performance measure that will be used to determine the adequacy of pedestrian circulation facilities within the station will be peak Level of Service (LOS), as defined by Fruin, which describes the peak degree of congestion at key locations. The general characteristics of the six levels of service defined by Fruin for stairways, corridors, and passageways are described below. The difference between each of the six levels is the freedom to choose walking speed, the ability to bypass slower moving pedestrians, and ease of contraflow movements at pedestrian traffic concentrations. Brief descriptions of each LOS are described below and examples of LOS thresholds are presented in Table B.1:

- LOS A and B, there is sufficient area to allow pedestrians to freely select walking speed and bypass slower moving pedestrians. When cross flow and reverse flow movement exists, minor conflicts may occur. There are no severe peak concentrations. V/C rations for LOS A range from 0.00 to 0.45, while for LOS B these range from 0.45 to 0.70.
- LOS C pedestrian movement is fluid although somewhat restricted. It provides sufficient room for standing without personal contact. Circulation through queuing areas, however, will require adjustment to walking speed. V/C ratios range from 0.70 to 1.00.
- LOS D walking speed is restricted and reduced. Reverse flow and cross flow movement is severely restricted due to congestion and difficulty in bypassing slower moving pedestrians. These conditions are common in many Manhattan locations during peak periods and represent somewhat congested conditions with V/C ratios ranging from 1.00 to 1.33.
- LOS E and F represent severe congestion with LOS E V/C ratios ranging from 1.33 to 1.67. Walking speed is restricted and there is insufficient area to bypass others and contraflow movement is difficult. LOS F is “bumper to bumper” pedestrian flow, with forward progress achievable only through shuffling, with queues forming.

Table B.1 Pedestrian Level of Service Standards

	Flow Rates/ Occupancies	Volume/ Capacity Ratio
Corridors and Ramps		
LOS A (Unrestricted)	≤7 p/m/ft	≤0.47
LOS B (Slightly restricted)	7-10 p/m/ft	0.47 – 0.67
LOS C (Restricted, but fluid)	10-15 p/m/ft	0.67 – 1.00
LOS D (Restricted, necessary to continually alter walking speed)	15-20 p/m/ft	1.00 – 1.33
LOS E (Severely restricted)	20-25 p/m/ft	1.33 – 1.67
LOS F (Forward progress only by shuffling, no reverse movement possible)	≥25 p/m/ft	≥1.67
Stairways		
LOS A (Unrestricted)	≤5 p/m/ft	≤0.50
LOS B (Slightly restricted, no impact on speed)	5-7 p/m/ft	0.50 – 0.70
LOS C (Speeds reduced, difficult to pass)	7-10 p/m/ft	0.70 – 1.00
LOS D (Restricted, reverse flow conflicts)	10-13 p/m/ft	1.00 – 1.30
LOS E (Severely restricted)	13-17 p/m/ft	1.30 – 1.70
LOS F (Many stoppages, no discernable flow)	≥17 p/m/ft	≥1.70

Queuing		
LOS A (Free circulation)	≤8 p/100sf	≤0.57
LOS B (Restricted circulation without affecting queues)	8 -10 p/100sf	0.57 – 0.70
LOS C (Restricted circulation affecting people in queue)	10 - 14 p/100sf	0.70 – 1.00
LOS D (Severely restricted circul., no personal contact)	14 - 33 p/100sf	1.00 – 2.36
LOS E (No circulation, personal contact unavoidable)	33 - 50 p/100sf	2.36 – 3.57
LOS F (Close physical contact, unsustainable)	≥50 p/100sf	≥3.57

Note: For purposes of calculating the volume-to-capacity ratio, capacity (V/C=1.0) is defined to be the threshold between Levels of Service C and D; the ratio is calculated by dividing the flow rate or occupancy level by the corresponding Level of Service C/D threshold value.

Source: John J. Fruin, *Pedestrian Planning and Design, Revised Edition*, Elevator World, Inc., 1987

The design of facilities within the station will be based on achieving a level of service of B/C or better during the weekday peak five minute period.

APPENDIX C: Station Development Policies

HST Station Development Policies

The Authority is proposing to build a high-speed train system to provide intercity and interregional mobility to the California residents that will inhabit the state in 2020 and for decades thereafter. For the high-speed train to be more useful and yield the most benefit, it is important that the stations be placed where there will be a high density of population, jobs, commercial activities, entertainment and other activities that generate personal trips. The success of HST is highly dependent on land use patterns that also reduce urban sprawl, reduce conversion of farm land to development, reduce vehicle miles traveled by automobiles, and encourage high-density development in and around the HST station.

As part of the statewide program EIR/EIS process preferred HST station locations have been selected, and as part of the Bay Area to Central Valley Program EIR/EIS process, preferred HST station locations have been identified. HST station locations were selected based in part on their ability to provide linkage with local and regional transit, airports, and highways – each station would be a multi-modal transportation hub. Most of the potential stations identified for further evaluation are located in the heart of or near the downtown/central city areas of California's major cities. By eliminating potential *greenfield* sites[1], the Authority has selected a proposed HST system that meets the objectives of minimizing potential impacts on the environment and maximizing connectivity with other modes.

The Authority's objectives for station location and development around stations are similar to those who advocate for more transit-oriented development and higher density urban cores around the train station. This offers an opportunity for the Authority to work cooperatively with local governments, environmental and public interest groups, developers and others to pursue these common development objectives.

In pursuing a profitable and successful HST system, the Authority will utilize its resources, both financial and otherwise, to encourage the characteristics listed below for land use development in and around its station. The Authority recognizes that the actual land use decisions will be made by local communities and the real estate market. HST stations, by their nature will be the most effective and powerful tool to create the market conditions that attract basic sector jobs to the station areas and will encourage the following development patterns:

- Higher density development in relation to the existing pattern of development in the surrounding area, along with minimum requirements for density.
- A mix of land uses (e.g., retail, office, hotels, entertainment, residential) and a mix of housing types to meet the needs of the local community.
- A grid street pattern and compact pedestrian-oriented design that promotes a walking, bicycle and transit access with streetscapes that include landscaping, small parks, and pedestrian spaces.
- Context-sensitive building design that considers the continuity of the building sizes and that coordinates the street-level and upper-level architectural detailing, roof forms, and

[1] Sites in rural areas with very limited or no existing infrastructure.

the rhythm of windows and doors should be provided. New buildings should be designed in relation to public spaces, such as streets, plazas, other open space areas, and public parking structures.

- Limits on the amount of parking for new development and a preference that parking be placed in structures. TOD areas typically have reduced parking requirements for retail, office, and residential uses due to their transit and bicycle access and walkability. Sufficient train passenger parking would be essential to the system viability, but this should, as appropriate, be offered at market rates (not free) to encourage the use of access by transit and other modes.