

California High-Speed Train Project



TECHNICAL MEMORANDUM / POLICY

Station Program Design Guidelines TM 2.2.2

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System Level Technical and Integration Reviews

The purpose of the review is to ensure:

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

System level reviews are required for all technical 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.

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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.

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 fulfillment 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 Fruin³, 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:

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

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:

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

$$P_{15} = \text{Peak 15 minute boardings and alightings}$$

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:

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

$$P_{30B} = \text{Peak 30 minute boardings}$$

$$P_{15B} = \text{Peak 15 minute boardings}$$

$$P_{15A} = \text{Peak 15 minute alightings}$$

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 (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 area⁴ 7ft² 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:

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

$$P_{15} = \text{Peak 15 minute boardings and alightings}$$

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:

$$P_{15B} \times 14 \text{ ft}^2$$

$$P_{Bpeak} \times 14 \text{ ft}^2$$

$$P_{Bmax} \times 10 \text{ ft}^2$$

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 or 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:

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

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 ft².

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 ft².

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 ft².

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:

$$\{(65 \text{ ft}^2 \times \text{Staff with assigned workspace}) + (43 \text{ ft}^2 \times \text{Staff with shared workspace})\} \times 1.25$$

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 $(20 \text{ ft}^2 \times \text{maximum number of staff during one shift} \times 1.25)$.

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 ft².

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 ft².

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 ft².

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 ft².

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 ft².

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 ft². 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 ft².

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 ft².

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:

$$20 \text{ ft}^2 \times 0.25 \times \text{Maximum staff per shift} \times 1.25$$

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 ft².

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 ft². 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 ft².

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 ft².

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:

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

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)	$[(P_1 \times 1.1) \div 15]$ ft
Outer Concourse	$P_{15} \times 30$ sf/person (Fruin LOS B) x 300 ft (average travel path) @ 200 ft/minute
Public Waiting Area	$\{[(P_{30B} - P_{15B}) \times 1.1] + (P_{15A} \times 0.1)\} \times 14$ ft ²
Restrooms (occupancy)	P_{15}
Ticket Vending Machines (inc. queue)	$[(0.4 \times P_{60B}) \div (1.5 \times 60)] \times 100$ ft ²
Ticket Window Queue	$[(P_{60B} \times 0.15) \div (1.5 \times 60)] \times 145$ ft ²
Controlled Area	
Controlled Concourse	$P_{15} \times 30$ sf/person (Fruin LOS B) x 300 ft (average travel path) @ 200 ft/minute
Controlled Waiting Areas	$P_{15B} \times 14$ ft ² or $P_{Bmax} \times 10$ ft ² or $P_{Bmax} \times 10$ ft ²
Business Center/Lounge	Station-by-station inclusion and sizing
Platforms – Island	1380 ft x 30 ft or $(P_{15B} \times + 1800) \times 7$ ft ²
Platforms – Side	1380 ft x 20 ft or $(P_{15B} \times + 900) \times 7$ ft ²
Corridors and Circulation	
Walkways	Based on station layout, codes
Vertical Circulation	Based on station layout, codes
Station Support Areas	
<i>Passenger Service Areas</i>	
Ticket Sales Offices	$\{[(P_{60B} \times 0.15) \div (1.5 \times 60)] \times 75\}$ ft ²
Station Information Office (inc. queue)	$\{100 + (15 \times \text{width})\}$ 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
<i>Station Operation Offices</i>	
Station Administration Office	$\{(65 \text{ ft}^2 \times \text{Staff with own workspace}) + (43 \text{ ft}^2 \times \text{Staff with shared workspace})\} \times 1.25$
Training and Meeting Room	$(20 \text{ ft}^2 \times \text{max staff per shift} \times 1.25)$
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
<i>HVAC Rooms: Ex. Chiller, Air Handling, Control Room, Ventilation, etc</i>	
<i>Electrical Rooms: Ex. Standby Generator, Switchboard, Uninterrupted Power System, Electrical Distribution, etc</i>	
<i>Fire Protection Rooms: Ex. Control Room, Pump Room, Valve Room, etc</i>	
<i>Telecommunications Rooms: Ex. Radio Rooms, Battery Rooms, etc.</i>	
<i>Signaling System Rooms: Ex. Cable Distribution Room, Signal Equipment Room, Battery Room, etc.</i>	
<i>Plumbing Rooms</i>	
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.