APPENDIX 2-D: APPLICABLE DESIGN STANDARDS

CAHSR FJ
TYPICAL SECTION DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED) | BLENDED CRITERIA /DEDICATED CALTRAIN CRITERIA (BLE) | MATHEMATIZED BLENDED CRITERIA (MAT) | COMMON CRITERIA (COM)

AT GRADE TYPICAL SECTION DESIGN

DESIGN ELEMENT	PCEP D/B FEIR dated Jan 2015 (Fig 2-6, Fig 2-8)	HST (TM1.1.10) (TM1.1.21-B)	CALTRAIN DESIGN STANDARD (SD-2151) (SD-9001)	PCEP D/B IFP (W3011, W4101, W4102)	DEDICATED HST CRITERIA	BLENDED CRITERIA (JPB CTC) (Mathematized Alignment)
Center of track to Center of OCS Pole	(BLE) 18"	(DED) 10.67'	n/a	(BLE) 9'-3", actual pole offsets may vary	(DED) 10.67'	(BLE) 10' added pole width
Center of track to Face of OCS Pole	9'-11'	n/a	n/a	(BLE) 9'-3", actual pole offsets may vary	n/a	(BLE) 9'-3"
Pole Width	(BLE) 18"	n/a	n/a	n/a	n/a	(BLE) 18"
Face of OCS to Structure Clearance	(DED) 6'	n/a	n/a	n/a	(DED) 6'	n/a
Face of OCS to Vegetation Clearance	(DED) 10'	n/a	n/a	n/a	(DED) 10'	n/a
Embankment Slope	n/a	(DED) 2:1 min	(BLE) 2:1	n/a	(DED) 2:1 min	(BLE) 2:1
Excavation Slope	n/a	(DED) 2:1 min	(BLE) 2:1	n/a	(DED) 2:1 min	(BLE) 2:1
OCS Pole Foundation Width	3.5'	3'	n/a	(COM) 42" Diameter for standard poles at track area 30" or 36" at stations and sidewalks	(COM) 3'	(COM) 3'
Walkway Width	n/a	(DED) Desirable 3' Minimum 3' Exceptional 2.5'	(BLE) Minimum 2' CPUC	n/a	(DED) 3'	(MAT) 2.5' (NFPA 130)
Ditch	n/a	Open drainage (ditch): A 10-foot wide area shall be reserved on both sides of a two track and single track formation for drainage purposes. Closed drainage (pipe culvert): A minimum culvert diameter for trunk drains located on both sides of two track and single track formations and culvert crossings under the track shall be 36 inches. Closed drainage (underdrain): A 2-foot wide area, the edge of which is located approximately 5-feet – 6 inches (min.) from the OCS pole centerline shall be reserved on both sides of a two track formation or on one side of a single track formation for drainage purposes. V-Ditch: 6' min	(COM) Ditch 9'	n/a	(COM) Ditch 9'	(COM) Ditch 9'
Drainage Ditch Depth		1' minimum	(COM) 2'		(COM) 2'	(COM) 2'
Ditch Foreslope/backslope		(COM) 2:1	2:1		(COM) 2:1	(COM) 2:1
Ditch Bottom Width		0'	(COM) 1'		(COM) 1'	(COM 1'
Edge of Walkway to Ditch Hinge Point	n/a	n/a	n/a	n/a	(COM) 1'	(COM) 1'
Utility Easement	(BLE) 5'	n/a	n/a	n/a	n/a	(BLE) 5'
Maintenance Access	(BLE) 10' is required within JPB ROW, where available	(DED) 15' 20' for cut slopes higher than 20 feet.	n/a	n/a	(DED) 15'	(BLE) 10' is required within JPB ROW, where available (no Building acquisitions required)

CAHSR FJ
TYPICAL SECTION DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)		BLENDED CRITERIA /DEDICATED CALTRAIN CRITERIA (BLE)		MATHEMATIZED BLENDED CRITERIA (MAT)		COMMON CRITERIA (COM)	
Fence Foundation Width	n/a	1.5'	(COM) Line Post 1' Terminal Posts 1.5'	n/a	(COM) 1.5'	(COM) 1.5'	
Ditch hinge point to centerline of fence	n/a	n/a	n/a	n/a	(COM) 1'	(COM) 1'	
Centerline of Fence to Proposed ROW	n/a	(DED) AR(Access Restriction) Fence is located 1 foot inside from Authority's ROW.	(BLE) 9" to Terminal Post		(DED) 1'	(BLE) 9" to Terminal Post	

RETAINING WALL/BALLAST RETAINER TYPICAL SECTION DESIGN

DESIGN ELEMENT	PCEP D/B FEIR dated Jan 2015 (Fig 2-6, Fig 2-8)	HST (TM1.1.10) (TM1.1.21-B)	CALTRAIN DESIGN STANDARD (SD-2151) (SD-9001)	PCEP D/B IFP (W3011, W4101, W4102)	DEDICATED HST CRITERIA	BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA
Center of track to Center of OCS Pole	(BLE) 18"	(DED) 10.67'	n/a	(BLE) 9'-3", actual pole offsets may vary	(DED) 10.67'	(BLE) 10' added pole width
Center of track to Face of OCS Pole	9'-11'	n/a	n/a	(BLE) 9'-3", actual pole offsets may vary	n/a	(BLE) 9'-3"
Pole Width	(BLE) 18"	n/a	n/a	n/a	n/a	(BLE) 18"
Face of OCS to Structure Clearance	(COM) 6'	n/a	n/a	n/a	(COM) 6'	(COM) 6'
Face of OCS to Vegetation Clearance	(COM) 10'	n/a	n/a	n/a	(COM) 10'	(COM) 10'
OCS Pole Foundation Width	3.5'	3'	n/a	(COM) 42" Diameter for standard poles at track area 30" or 36" at stations and sidewalks	(COM) 3.00	(COM) 3.00
Walkway Width	n/a	(DED) Desirable 3' Minimum 3' Exceptional 2.5'	(BLE) Minimum 2' CPUC	n/a	(DED) 3'	(MAT) 2.5' (NFPA 130)
Centerline of track to face of MSE Wall	n/a	(DED) 20' for structure higher than 9' 18' for structure less than 9'	n/a	n/a	(DED) 20' for Cut 18' for Fill	n/a
Maintenance Access	(BLE) 10' is required within JPB ROW, where available	(DED) 15' 20' for cut slopes higher than 20 feet.	n/a	n/a	(DED) 15' Desirable both sides 10' Min both sides (no variance required) 10' Min One sided (variances required) <10' Variance Required	(BLE) 10' is required within JPB ROW, where available (no Building acquisitions required)

AERIAL STRUCTURE TYPICAL SECTION DESIGN

(DED) Note: Aerial structure is only for HST tracks in Diridon Station area.

DESIGN ELEMENT	PCEP D/B FEIR dated Jan 2015 (Fig 2-8)	HST (TM2.3.3) (1.1.21-B) (1.1.21-D) (TM3.2.1-C) (1.1.2-G)	CALTRAIN DESIGN STANDARD	PCEP D/B IFP (W3011, W4101, W4102)	DEDICATED HST CRITERIA
Center of track to Center of OCS Pole	9.75' - 11.75'	(DED) 10.67'	n/a	n/a	(DED) 10.67'

CAHSR FJ
TYPICAL SECTION DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)		BLENDED CRITERIA /DEDICATED CALTRAIN CRITERIA (BLE)		MATHEMATIZED BLENDED CRITERIA (MAT)	
Center of OCS Pole to Edge of Structure	6.75'	(DED) 9'	n/a	Face of pole to CL Track 9'-3", actual pole offsets may vary	(DED) 9'
OCS Pole Foundation Width	3.5'	(DED) 3'	n/a	42" including casing at track area 30" or 36" including casing at stations and sidewalks	(DED) 3'
Walkway Width (On top of Ductbank) (See TM1.1.10 for Details)	n/a	(DED) Desirable 3' Minimum 3' Exceptional 2.5'	n/a		(MAT) 2.5' (NFPA 130)
Edge of Structure to Proposed ROW	n/a	(DED) 15'	n/a		(DED) 15' 10 feet if tight 5 feet at minimum
Utility Easement	n/a	n/a	n/a	n/a	n/a
Maintenance Access	10' is required within JPB ROW, where available	(DED) 15'	n/a	n/a	(DED) 15'

COMMON CRITERIA (COM)

AT GRADE STATION PLATFORM TYPICAL SECTION DESIGN

DESIGN ELEMENT	PCEP D/B FEIR dated Jan 2015 (Fig 2-8)	HST (TM2.2.4-B) (TM2.2.4-C)	CALTRAIN DESIGN STANDARD (SD-3051) (SD 3052)	PCEP D/B IFP (W3011, W4101, W4102)	DEDICATED HST CRITERIA	BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA
Center of track to edge of platform	n/a	(DED) 5.75'	(BLE) 5.33'	n/a	(DED) 5.75'	(BLE) Caltrain Platforms: 5'-4" Shared-use platforms: 6'-0"
Platform Width	n/a	**(DED)** **Center island platform** Minimum 30' Exceptional 25' **Outboard platform** Minimum 20' Exceptional 18'	**(BLE)** **Center island platform** Preferred 32' Minimum 28' **Outboard platform** Preferred 20' Minimum 16'	n/a	**(DED)** **Center island platform** Minimum 30' Exceptional 25' **Outboard platform** Minimum 20' Exceptional 18'	**(BLE)** **Center island platform** Preferred 32' Minimum 28' **Outboard platform** Preferred 20' Minimum 16'
Shelter Width	n/a	**(DED)** **Center island platform** n/a **Outboard platform** Use Platform Canopy Foundation pole minimum 7' from face of platform	**(BLE)** **Passenger Shelter** Minimum 6' Maximum 7' for both center and outboard platform **TVM Shelter** Minimum 6' Maximum 7' for both center and outboard platform	n/a	**(DED)** **Center island platform** n/a **Outboard platform** Use Platform Canopy Foundation pole minimum 7' from face of platform	**(BLE)** **Passenger Shelter** Minimum 6' Maximum 7' for both center and outboard platform **TVM Shelter** Minimum 6' Maximum 7' for both center and outboard platform

CAHSR FJ
HORIZONTAL DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED

BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)

MATHEMATIZED BLENDED CRITERIA (MAT)

COMMON CRITERIA (COM)

NOTE: Caltrain Design Standard is valid for Maximum Authorized Speed of 90mph and FRA Track Class 5 standard. The same standard applies for alignment design where speed is over 90mph and for Track Class 6.

DESIGN ELEMENT	HST TM 2.1.2	CALTRAIN DESIGN STANDARD (Chapter 2 - TRACK)	AMTRAK SPECIFICATION NO. 63	CFR Title 49, Subtitle B, Chapter II, Part 213	Don't Spill Your Coffee: The Importance of Spiral Design for Passenger Comfort Thomas W. Williams, P.E., Senior Project Manager, Transit Planning Group, Wight & Company	DEDICATED HST CRITERIA	BLENDED CRITERIA (JPB CTC) (Mathematized Alignment)	COMMENTS
SPEED	(DED) V_{min} (MPH) 125	V_{min} (MPH) 90	$V_{max} = ((Ea + Eu) / (0.0007D))^{0.5}$		V_{max} (MPH) 70	(DED) V_{min} (MPH) 125	(MAT) V_{min} (MPH) 110	
TRACK CLASS		Track Class 5	Track Class 5 Max Speed 90 MPH (COM) Track Class 6 Max Speed 110 MPH Track Class 7 Max Speed 125 MPH	Class 5 Track The maximum allowable operating speed for passenger trains 90 MPH (COM) Class 6 Track The maximum allowable operating speed for passenger trains 110 MPH Class 7 Track The maximum allowable operating speed for passenger trains 125 MPH			(COM) Class Track 6 The maximum allowable operating speed for passenger trains 110 MPH	See note at top of page regarding MAS and Track Class.
ANGLE POINTS			Angle points between two tangents must not be used unless the use of a properly-designed curve is impossible. Track Class 5 Max Angle 0°-5'-30" Track Class 6 Max Angle 0°-4'-00" Track Class 7 Max Angle 0°-3'-00"					
CHANGES IN DIRECTION	(DED) Over four changes in direction per mile shall constitute an Exceptional condition.					(DED) Over four changes in direction per mile shall constitute an Exceptional condition.		
CURVE LENGTH	(DED) For V < 186 MPH, o Desirable attenuation time: not less than 2.4 seconds o Minimum attenuation time: not less than 1.8 seconds o Exceptional attenuation time: not less than 1.5 seconds - An attenuation time of 1.0 seconds on the diverging route in curves adjacent to or between turnouts Minimum segment length : $L_{FEET} = V_{MPH} \times 44/30 \times T_{sec}$ Where alignment segments overlap, each change shall be treated as a separate alignment element for the purpose of calculating minimum segment lengths.	(BLE) MINIMUM (FT) 100'				(DED) For V < 186 MPH, o Desirable attenuation time: not less than 2.4 seconds o Minimum attenuation time: not less than 1.8 seconds o Exceptional attenuation time: not less than 1.5 seconds - An attenuation time of 1.0 seconds on the diverging route in curves adjacent to or between turnouts Minimum segment length : $L_{FEET} = V_{MPH} \times 44/30 \times T_{sec}$ Where alignment segments overlap, each change shall be treated as a separate alignment element for the purpose of calculating minimum segment lengths.	(BLE) ABSOLUTE MINIMUM 100'	
TANGENT LENGTH	(DED) For V < 186 MPH, o Desirable attenuation time: not less than 2.4 seconds o Minimum attenuation time: not less than 1.8 seconds o Exceptional attenuation time: not less than 1.5 seconds Minimum segment length : LFEET = VMPH x 44/30 x Tsec Where alignment segments overlap, each change shall be treated as a separate alignment element for the purpose of calculating minimum segment lengths. Reverse Curves: If there is insufficient distance between curves to provide the minimum required length tangent segment, the spirals shall be extended to provide a reversing curve. If beneficial to design and construction, a straight distance between curves that would be run in less than 0.2 seconds at the normal operating speed may be left between spiral ends.	(COM) BETWEEN REVERSE CURVES: PREFFERED ABSOLUTE MINIMUM $L_{(FT)} = 3 \times V(MPH)$ 100'	(COM) MAX OF 1) 100' 2) L(FT) = 3 x V(MPH)			(DED) For V < 186 MPH, o Desirable attenuation time: not less than 2.4 seconds o Minimum attenuation time: not less than 1.8 seconds o Exceptional attenuation time: not less than 1.5 seconds Minimum segment length : LFEET = VMPH x 44/30 x Tsec Where alignment segments overlap, each change shall be treated as a separate alignment element for the purpose of calculating minimum segment lengths. Reverse Curves: If there is insufficient distance between curves to provide the minimum required length tangent segment, the spirals shall be extended to provide a reversing curve. If beneficial to design and construction, a straight distance between curves that would be run in less than 0.2 seconds at the normal operating speed may be left between spiral ends.	(COM) BETWEEN REVERSE CURVES: PREFERRED ABSOLUTE MINIMUM $L_{(FT)} = 3 \times V(MPH)$ 100'	
EQUILIBRIUM SUPERELEVATION	(COM) EQUILIBRIUM EQUATION $e_{(IN)} = 0.0007 \times D_C \times V^2$ For V < 186 MPH, TOTAL SUPERELEVATION EXPRESSION $e_{(IN)} = E_a + E_u$ (DED) EXCEPTIONAL 11" MAXIMUM 9" DESIRABLE 6"	(COM) EQUILIBRIUM EQUATION $e_{(IN)} = 0.0007 \times D_C \times V^2$ TOTAL SUPERELEVATION EXPRESSION $e_{(IN)} = E_a + E_u$		(COM) EQUILIBRIUM EQUATION $e_{(IN)} = 0.0007 \times D_C \times V^2$ TOTAL SUPERELEVATION EXPRESSION $e_{(IN)} = E_a + E_u$	(COM) TOTAL SUPERELEVATION EXPRESSION $e_{(IN)} = E_a + E_u$	(COM) EQUILIBRIUM EQUATION $e_{(IN)} = 0.0007 \times D_C \times V^2$ For V < 186 MPH, TOTAL SUPERELEVATION EXPRESSION $e_{(IN)} = E_a + E_u$ (DED) EXCEPTIONAL 11" MAXIMUM 9" DESIRABLE 6"	(COM) EQUILIBRIUM EQUATION $e_{(IN)} = 0.0007 \times D_C \times V^2$ TOTAL SUPERELEVATION EXPRESSION $e_{(IN)} = E_a + E_u$	
APPLIED SUPERELEVATION	(DED) EXCEPTIONAL 7" MAXIMUM 6" DESIRABLE 4"	(BLE) Caltrain Approval Required 7" MAXIMUM 5" MINIMUM 0.5"	MAXIMUM 5.5" MINIMUM 0.5"	MAXIMUM 7"		(DED) EXCEPTIONAL 7" MAXIMUM 6" DESIRABLE 4"	(MAT) MAXIMUM 6" MINIMUM 1"	
UNBALANCED SUPERELEVATION	(DED) For V < 186 MPH, EXCEPTIONAL 4" (COM) MAXIMUM 3" (DED) DESIRABLE 2" MINIMUM (at normal speed) 1"	(COM) MAXIMUM 3"	Acela with tilt active on tangents and curves up to 0°-16' Maximum E_u 7" Acela with tilt disabled, AEM7, HHP, F40, Amfleet, Horizon, and Capitoliner cars on curves greater than 0°-16' Maximum E_u5"			(DED) For V < 186 MPH, EXCEPTIONAL 4" (COM) MAXIMUM 3" (DED) DESIRABLE 2" MINIMUM (at normal speed) 1"	(MAT) MAXIMUM 4.5"	
	(DED) HALF-SINE SPIRALS (variable rate transitions) shall be used on all tracks designed for: 1) Ballasted tracks: Curves having design maximum speeds of 80 mph or more 2) Non-ballasted tracks: Curves having design maximum speeds of 60 mph or more 3) Curves associated with turnouts having design maximum speeds of 110 mph or more	(BLE) CLOTHOID			CLOTHOID	**(DED) HALF-SINE SPIRALS** (variable rate transitions) shall be used on all tracks designed for: 1) Ballasted tracks: Curves having design maximum speeds of 80 mph or more 2) Non-ballasted tracks: Curves having design maximum speeds of 60 mph or more 3) Curves associated with turnouts having design maximum speeds of 110 mph or more	(BLE) CLOTHOID	

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HORIZONTAL DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED) | BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE) | MATHEMATIZED BLENDED CRITERIA (MAT) | COMMON CRITERIA (COM)

NOTE: Caltrain Design Standard is valid for Maximum Authorized Speed of 90mph and FRA Track Class 5 standard. The same standard applies for alignment design where speed is over 90mph and for Track Class 6.

DESIGN ELEMENT	HST TM 2.1.2	CALTRAIN DESIGN STANDARD (Chapter 2 - TRACK)	AMTRAK SPECIFICATION NO. 63	CFR Title 49, Subtitle B, Chapter II, Part 213	Don't Spill Your Coffee: The Importance of Spiral Design for Passenger Comfort Thomas W. Williams, P.E., Senior Project Manager, Transit Planning Group, Wight & Company	DEDICATED HST CRITERIA	BLENDED CRITERIA (JPB CTC) (Mathematized Alignment)	COMMENTS
SPIRAL TYPE	**(DED) CLOTHOID SPIRALS** (constant rate transitions) shall be used on all lower speed tracks. Clothoid spirals may also be used on very large radius curves that require small amounts or no superelevation and have very small unbalanced superelevations Spirals on Large Radius Curves: Clothoid spirals may be used instead of half-sine spirals regardless of track type or design speed if the following conditions are met: The required superelevation and unbalanced superelevation are both under 1.0 inches at the maximum design speed; and the "Minimum Segment" length for the spiral is more than twice the length required by any other factor. Spirals may be omitted if the following conditions are met: The required superelevation is zero (balancing superelevation for the maximum speed less than 0.75 inches); and the calculated offset of the curve due to application of the spiral is less than 0.05 feet in ballasted track or less than 0.02 feet in non-ballasted track.					**(DED) CLOTHOID SPIRALS** (constant rate transitions) shall be used on all lower speed tracks. Clothoid spirals may also be used on very large radius curves that require small amounts or no superelevation and have very small unbalanced superelevations Spirals on Large Radius Curves: Clothoid spirals may be used instead of half-sine spirals regardless of track type or design speed if the following conditions are met: The required superelevation and unbalanced superelevation are both under 1.0 inches at the maximum design speed; and the "Minimum Segment" length for the spiral is more than twice the length required by any other factor. Spirals may be omitted if the following conditions are met: The required superelevation is zero (balancing superelevation for the maximum speed less than 0.75 inches); and the calculated offset of the curve due to application of the spiral is less than 0.05 feet in ballasted track or less than 0.02 feet in non-ballasted track.		
SPIRAL LENGTH	**(DED) HALF-SINE SPIRALS** DESIRABLE Superelevation $L_{(FT)} = 1.63 \times E_a \times V$ Unbalance $L_{(FT)} = 2.10 \times E_u \times V$ Twist $L_{(FT)} = 140 \times E_a$ Minimum Segment $L(FT) = 2.64 \times V$; $L_{(FT)} = V \times 44/30 \times T_{sec}$ MINIMUM Superelevation $L_{(FT)} = 1.30 \times E_a \times V$ Unbalance $L_{(FT)} = 1.57 \times E_u \times V$ Twist $L_{(FT)} = 118 \times E_a$ Minimum Segment $L(FT) = 2.20x V$ $L(FT) = V \times 44/30 \times T$ EXCEPTIONAL Superelevation $L_{(FT)} = 1.09 \times E_a \times V$ Unbalance $L_{(FT)} = 1.26 \times E_u \times V$ Twist $L_{(FT)} = 98 \times E_a$ Minimum Segment $L(FT) = 1.47 \times V$ $L(FT) = V \times 44/30 \times T$ **CLOTHOID SPIRALS** DESIRABLE Superelevation $L_{(FT)} = 1.47 \times E_a \times V$ Unbalance $L_{(FT)} = 1.63 \times E_u \times V$ Twist $L_{(FT)} = 90 \times E_a$ Minimum Segment $L(FT) = 2.64 \times V$; $L_{(FT)} = V \times 44/30 \times T_{sec}$ MINIMUM Superelevation $L_{(FT)} = 1.17 \times E_a \times V$ Unbalance $L_{(FT)} = 1.22 \times E_u \times V$ Twist $L_{(FT)} = 75 \times E_a$ Minimum Segment $L(FT) = 2.20x V$ $L(FT) = V \times 44/30 \times T_{sec}$ EXCEPTIONAL Superelevation $L_{(FT)} = 0.98 \times E_a \times V$ Unbalance $L_{(FT)} = 0.98 \times E_u \times V$ Twist $L_{(FT)} = 62 \times E_a$ Minimum Segment $L(FT) = 1.47 \times V$ $L(FT) = V \times 44/30 \times T_{sec}$	(DED) DESIRABLE MAX OF THE FOLLOWING: $L_{S\ EQ.1}$ $L_{(FT)} = 1.63 \times E_u \times V$ $L_{S\ EQ.2}$ $L_{(FT)} = 1.2 \times E_a \times V$ $L_{S\ EQ.3}$ $L_{(FT)} = 62 \times E_a$ MINIMUM MAX OF THE FOLLOWING: $L_{S\ EQ.1}$ $L_{(FT)} = 1.22 \times E_u \times V$ $L_{S\ EQ.2}$ $L_{(FT)} = 1.2 \times E_a \times V$ $L_{S\ EQ.3}$ $L_{(FT)} = 62 \times E_a$	MINIMUM MAX OF THE FOLLOWING: $L_{S\ EQ.1}$ $L_{(FT)} = 1.63 \times E_u \times V_{max}$ $L_{S\ EQ.2}$ $L_{(FT)} = 62'$ (MAT) Track Class 4-7 Rate of change per 31 feet of track should not be more than 3/8"	Class 5 Track Tangent Track The deviation of the mid-offset from a 62-foot line may not be more than 3/4" Curved Track The deviation of the mid-ordinate from a 31-foot chord may not be more than 1/2" The deviation of the mid-ordinate from a 62-foot chord may not be more than 5/8" Class 6 Track Tangent Track The deviation from uniformity of the mid-chord offset for a 31-foot chord may not be more than 1/2" The deviation from uniformity of the mid-chord offset for a 62-foot chord may not be more than 3/4" The deviation from uniformity of the mid-chord offset for a 124-foot chord may not be more than 1 1/2" Curved Track The deviation from uniformity of the mid-chord offset for a 31-foot chord may not be more than 1/2" The deviation from uniformity of the mid-chord offset for a 62-foot chord may not be more than 5/8" The deviation from uniformity of the mid-chord offset for a 124-foot chord may not be more than 1 1/2" Curved Track $E_u > 5"$ The deviation from uniformity of the mid-chord offset for a 31-foot chord may not be more than 1/2" The deviation from uniformity of the mid-chord offset for a 62-foot chord may not be more than 5/8' The deviation from uniformity of the mid-chord offset for a 124-foot chord may not be more than 1 1/4"	DESIRABLE $L_{(FT)} = 0.61 (E_u + 1.5) V$ ACCEPTABLE $L_{(FT)} = 0.49 (E_u + 1.5) V$ (MAT) MINIMUM $L_{(FT)} = 0.41 (E_u + 1.5) V$	**(DED) HALF-SINE SPIRALS** DESIRABLE Superelevation $L_{(FT)} = 1.63 \times E_a \times V$ Unbalance $L_{(FT)} = 2.10 \times E_u \times V$ Twist $L_{(FT)} = 140 \times E_a$ Minimum Segment $L(FT) = 2.64 \times V$; $L_{(FT)} = V \times 44/30 \times T_{sec}$ MINIMUM Superelevation $L_{(FT)} = 1.30 \times E_a \times V$ Unbalance $L_{(FT)} = 1.57 \times E_u \times V$ Twist $L_{(FT)} = 118 \times E_a$ Minimum Segment $L(FT) = 2.20x V$ $L(FT) = V \times 44/30 \times T$ EXCEPTIONAL Superelevation $L_{(FT)} = 1.09 \times E_a \times V$ Unbalance $L_{(FT)} = 1.26 \times E_u \times V$ Twist $L_{(FT)} = 98 \times E_a$ Minimum Segment $L(FT) = 1.47 \times V$ $L(FT) = V \times 44/30 \times T$ **CLOTHOID SPIRALS** DESIRABLE Superelevation $L_{(FT)} = 1.47 \times E_a \times V$ Unbalance $L_{(FT)} = 1.63 \times E_u \times V$ Twist $L_{(FT)} = 90 \times E_a$ Minimum Segment $L(FT) = 2.64 \times V$; $L_{(FT)} = V \times 44/30 \times T_{sec}$ MINIMUM Superelevation $L_{(FT)} = 1.17 \times E_a \times V$ Unbalance $L_{(FT)} = 1.22 \times E_u \times V$ Twist $L_{(FT)} = 75 \times E_a$ Minimum Segment $L(FT) = 2.20x V$ $L(FT) = V \times 44/30 \times T_{sec}$ EXCEPTIONAL Superelevation $L_{(FT)} = 0.98 \times E_a \times V$ Unbalance $L_{(FT)} = 0.98 \times E_u \times V$ Twist $L_{(FT)} = 62 \times E_a$ Minimum Segment $L(FT) = 1.47 \times V$ $L(FT) = V \times 44/30 \times T_{sec}$	(MAT) Track Class 4-7 Rate of change per 31 feet of track should not be more than 3/8" MINIMUM $L_{(FT)} = 0.41 (E_u + 1.5) V$	

CAHSR FJ
VERTICAL DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)

BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)

MATHEMATIZED BLENDED CRITERIA (MAT)

NOTE: Caltrain Design Standard is valid for Maximum Authorized Speed of 90mph and FRA Track Class 5 standard. The same standard applies for alignment design where speed is over 90mph and for Track Class 6.

DESIGN ELEMENT	HST TM 2.1.2	CALTRAIN DESIGN STANDARD (Chapter 2 - TRACK)	AMTRAK SPECIFICATION NO. 63	DEDICATED HST CRITERIA	BLENDED CRITERIA (JPB CTC) (Mathematized Alignment)
ATTENUATION TIME	(DED) DESIRABLE 2.4 seconds MINIMUM 1.8 seconds EXCEPTIONAL 1.5 seconds	N/A	N/A	(DED) DESIRABLE 2.4 seconds MINIMUM 1.8 seconds EXCEPTIONAL 1.5 seconds	N/A
TANGENT LENGTH	(DED) MINIMUM $L_{(FT)} = V_{(MPH)} \times 44/30 \times t_{(SEC)}$	(BLE) PREFERED $L_{(FT)} = 3 \times V$ MINIMUM 100'	MAX OF THE FOLLOWING: MINIMUM $L_{(FT)} = 3 \times V$ 100' MIMINUM BETWEEN VERTICAL CURVES IN SAME DIRECTION 900'	(DED) MINIMUM $L_{(FT)} = V_{(MPH)} \times 44/30 \times t_{(SEC)}$	BLE) PREFERED $L_{(FT)} = 3 \times V$ MINIMUM 100'
GRADES	(DED) DESIRABLE 0.0% TO 1.25% MAXIMUM 1.25% TO 2.50% EXCEPTIONAL 2.50% TO 3.50% MINIMUM WITHOUT A SEPARATE DRAINAGE SYSTEM, GRADES IN CUTS OR TUNNELS (INCLUDED CUT AND-COVER) 0.25%	(BLE) MAXIMUM 1% (NEW CONSTRUCTION w/ CALTRAIN APPROVAL) 2% (STATION PLATFORMS) 1%	MAXIMUM 1.500% ≤ 0.4% PER 100' (STATION PLATFORMS) 0.000%	(DED) DESIRABLE 0.0% TO 1.25% MAXIMUM 1.25% TO 2.50% EXCEPTIONAL 2.50% TO 3.50% MINIMUM WITHOUT A SEPARATE DRAINAGE SYSTEM, GRADES IN CUTS OR TUNNELS (INCLUDED CUT AND-COVER) 0.25%	(BLE) MAXIM~UM 1% (NEW CONSTRUCTION w/ CALTRAIN APPROVAL) 2% (MAT) MAXIMUM (STATION PLATFORMS) 0.25% PREFERRED (STATION PLATFORMS) 0%
LENGTH OF STEEP GRADES	(DED) AVERAGE GRADE 2.5% TO 3.5% 3.7 MILES (MAX) AVERAGE GRADE 1.0% TO 2.5% 6.2 MILES (MAX)	N/A	N/A	(DED) AVERAGE GRADE 2.5% TO 3.5% 3.7 MILES (MAX) AVERAGE GRADE 1.0% TO 2.5% 6.2 MILES (MAX)	N/A
VERTICAL CURVE ACCELERATION RATES	(DED) DESIRABLE 0.6 FT/SEC/SEC MAXIMUM 0.90 FT/SEC/SEC EXCEPTIONAL 1.40 FT/SEC/SEC	(BLE) MAXIMUM PASSENGER TRAINS 0.6 FT/SEC^2 FREIGHT TRAINS 0.1 FT/SEC^2	PASSENGER TRAINS 0.6 FT/SEC^2 FREIGHT TRAINS 0.1 FT/SEC^2	(DED) DESIRABLE 0.6 FT/SEC/SEC MAXIMUM 0.90 FT/SEC/SEC EXCEPTIONAL 1.40 FT/SEC/SEC	(BLE) MAXIMUM PASSENGER TRAINS 0.6 FT/SEC^2 FREIGHT TRAINS 0.1 FT/SEC^2
VERTICAL CURVE LENGTHS	(DED) DESIRABLE MAX OF THE FOLLOWING: $LVC_{(FT)} = 4.55 \times V$ $LVC_{(FT)} = 2.15 \times V^2 \times (\Delta\%/100)/0.60\ FT/SEC^2$ $LVC_{(FT)} = 400 \times \Delta\%$ MINIMUM MAX OF THE FOLLOWING: $LVC_{(FT)} = 3.52 \times V$ $LVC_{(FT)} = 2.15 \times V^2 \times (\Delta\%/100)/0.90\ FT/SEC^2$ $LVC_{(FT)} = 200 \times \Delta\%$ EXCEPTIONAL MAX OF THE FOLLOWING: $LVC_{(FT)} = 2.64 \times V$ $LVC_{(FT)} = 2.15 \times V^2 \times (\Delta\%/100)/1.20\ FT/SEC^2$ $LVC_{(FT)} = 100 \times \Delta\%$	(BLE) MINIMUM MAX OF THE FOLLOWING: $L_{(FT)} = (D \times V^2_{(PASSENGER)} \times K)/A_{(PASSENGER)}$ $L(FT) = (D \times V^2_{(FREIGHT)} \times K)/A_{(FREIGHT)}$ $V_{(FREIGHT)} = 60$ MPH K(CONVERSION FACTOR) = 2.15 MINIMUM 100'	MINIMUM $L_{(FT)} = (2.15 \times D \times V^2)/A$	(DED) DESIRABLE MAX OF THE FOLLOWING: $LVC_{(FT)} = 4.55 \times V$ $LVC_{(FT)} = 2.15 \times V^2 \times (\Delta\%/100)/0.60\ FT/SEC^2$ $LVC_{(FT)} = 400 \times \Delta\%$ MINIMUM MAX OF THE FOLLOWING: $LVC_{(FT)} = 3.52 \times V$ $LVC_{(FT)} = 2.15 \times V^2 \times (\Delta\%/100)/0.90\ FT/SEC^2$ $LVC_{(FT)} = 200 \times \Delta\%$ EXCEPTIONAL MAX OF THE FOLLOWING: $LVC_{(FT)} = 2.64 \times V$ $LVC_{(FT)} = 2.15 \times V^2 \times (\Delta\%/100)/1.40\ FT/SEC^2$ $LVC_{(FT)} = 100 \times \Delta\%$	(BLE) MINIMUM MAX OF THE FOLLOWING: $L_{(FT)} = (D \times V^2_{(PASSENGER)} \times K)/A_{(PASSENGER)}$ $L(FT) = (D \times V^2_{(FREIGHT)} \times K)/A_{(FREIGHT)}$ $V_{(FREIGHT)} = 60$ MPH K(CONVERSION FACTOR) = 2.15 MINIMUM 100'
VERTICAL CURVE AND HORIZONTAL SPIRAL CLEARANCE	(DED) DESIRABLE 160' MINIMUM 100'	N/A	N/A	(DED) DESIRABLE 160' MINIMUM 100'	N/A
VERTICAL CURVE CLEARANCE FROM STATION PLATFORM	N/A	(BLE) MINIMUM 100'	MINIMUM 100'	N/A	(BLE) MINIMUM 100'
VERTICAL AND HORIZONTAL DIRECTION CHANGES	(DED) ≤ 4 CHANGES IN DIRECTION AND PROFILE PER MILE	(BLE) GRADES EXCEEDING 1% ≤ 3 GRADE CHANGES PER 3,000'	N/A	(DED) ≤ 4 CHANGES IN DIRECTION AND PROFILE PER MILE	(BLE) GRADES EXCEEDING 1% ≤ 3 GRADE CHANGES PER 3,000'
VERTICAL CLEARANCE		(BLE) 24'-6"		(DED) Minimum vertical clearances measured from top of rail (TOR) 27'	(BLE) 24'-6"

CAHSR FJ
TURNOUT AND STATION TRACKS DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)

BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)

NOTE: Caltrain Design Standard is valid for Maximum Authorized Speed of 90mph and FRA Track Class 5 standard. The same standard applies for alignment design where speed is over 90mph and for Track Class 6.

DESIGN ELEMENT	HST TM 2.1.3	CALTRAIN DESIGN STANDARD (Chapter 2 - TRACK)	AMTRAK SPECIFICATION NO. 63	DEDICATED HST CRITERIA	BLENDED CRITERIA (JPB CTC) (Mathematized Alignment)
GENERAL	(DED) Use curved frogs. The high-speed turnouts will normally be built on some form of concrete based track, not on ties and ballast.	N/A	Frog numbers other than 8, 10, 15, 20, and 32.75 must not be used without the approval of the Deputy Chief Engineer Track.	(DED) Use curved frogs. The high-speed turnouts will normally be built on some form of concrete based track, not on ties and ballast.	N/A
SUPERELEVATION	(DED) Unbalanced Superelevation ≤ 3" Superelevation in curve off of a turnout ≤ 1.25"	(BLE) Unbalanced Superelevation ≤ 3"	N/A	(DED) Unbalanced Superelevation ≤ 3" Superelevation in curve off of a turnout ≤ 1.25"	(BLE) Unbalanced Superelevation ≤ 3"
MINIMUM TIME	(DED) Minimum time over any turnout segment or curve connected to a turnout, including spirals on the frog end of turnouts and spirals into a curve on the diverging track that is adjacent to the turnout 1 sec	N/A	N/A	(DED) Minimum time over any turnout segment or curve connected to a turnout, including spirals on the frog end of turnouts and spirals into a curve on the diverging track that is adjacent to the turnout 1 sec	N/A
MAXIMUM VIRTUAL TRANSITION RATE AT SWITCH POINT	(DED) 5.0 inches/second	N/A	N/A	(DED) 5.0 inches/second	N/A
KEEP SPIRALS OUT OF FROGS	(DED) Minimum/Exceptional: In order to avoid a special design swing nose frog, the frog end spiral shall begin at or beyond the point where track centerline spacing exceeds 5.85 feet, even if this means that the transition length in a crossover will have a run time of less than 1.0 seconds. Desirable: Start frog end spiral beyond the point where the track centerline spacing exceeds 7.00 feet, if spiral is to a tangent or followed by a reversing curve. If the spiral is to a compound curve, it shall start beyond the point where the track centerline spacing exceeds 8.00 feet.	(BLE) Turnouts and crossovers shall be located on tangent tracks. 100 feet minimum from point of switch (PS) to horizontal or vertical curves. Less than 100 feet from horizontal curves without superelevation with approval from the Caltrain Deputy Director of Engineering.	Do not place turnouts and crossovers on curves, spirals, or elevation runoffs at the ends of curves.	(DED) Minimum/Exceptional: In order to avoid a special design swing nose frog, the frog end spiral shall begin at or beyond the point where track centerline spacing exceeds 5.85 feet, even if this means that the transition length in a crossover will have a run time of less than 1.0 seconds. Desirable: Start frog end spiral beyond the point where the track centerline spacing exceeds 7.00 feet, if spiral is to a tangent or followed by a reversing curve. If the spiral is to a compound curve, it shall start beyond the point where the track centerline spacing exceeds 8.00 feet.	(BLE) Turnouts and crossovers shall be located on tangent tracks. 100 feet minimum from point of switch (PS) to horizontal or vertical curves. Less than 100 feet from horizontal curves without superelevation with approval from the Caltrain Deputy Director of Engineering.
HIGH SPEED TURNOUTS GEOMETRY	(DED) See Table 6.1.1	N/A	N/A	(DED) See Table 6.1.1	N/A
HIGH SPEED TURNOUTS AND CROSSOVERS MAXIMUM AUTHORIZED SPEEDS	(DED) Reference Table 6.1.1. High speed turnouts defined by speed: 60 MPH, 80 MPH, 110 MPH, 150 MPH.	N/A	N/A	(DED) High speed turnouts defined by speed: 60 MPH, 80 MPH, 110 MPH, 150 MPH.	N/A
SEPARATION OF HIGH SPEED TURNOUTS	(DED) Reference NTD 10. Between high-speed turnouts: 1400' desirable, 1000' minimum.	N/A	N/A	(DED) Reference NTD 10. Between high-speed turnouts: 1400' desirable, 1000' minimum.	N/A
SEPARATION OF HIGH SPEED TURNOUTS FROM STATION PLATFORMS	(DED) NTD 13: Provide 2750' minimum length between entry and exit turnouts for platform track. Figure 6.1.4: 75' between platform edge and turnout with refuge/storage track, 85' without refuge/storage track.	N/A	N/A	(DED) NTD 13: Provide 2750' minimum length between entry and exit turnouts for platform track. Figure 6.1.4: 75' between platform edge and turnout with refuge/storage track, 85' without refuge/storage track.	N/A
CROSSOVER BETWEEN MAIN TRACKS	(DED) See Table 6.1.2 for 16.50 feet track centers. Use of highspeed crossovers in tracks with centers of under 16.50 feet shall be an Exceptional condition.	(BLE) See Caltrain Standard Drawing SD-2103, Table 3		(DED) See Table 6.1.2 for 16.50 feet track centers. Use of highspeed crossovers in tracks with centers of under 16.50 feet shall be an Exceptional condition.	(BLE) See Caltrain Standard Drawing SD-2103, Table 3
STATION CONNECTION TRACKS WITH SPIRAL POINT TURNOUTS	(DED) See Table 6.1.3 for 25 feet track centers	N/A	N/A	(DED) See Table 6.1.3 for 25 feet track centers	N/A

CAHSR FJ
TURNOUT AND STATION TRACKS DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED) | **BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)**

NOTE: Caltrain Design Standard is valid for Maximum Authorized Speed of 90mph and FRA Track Class 5 standard. The same standard applies for alignment design where speed is over 90mph and for Track Class 6.

DESIGN ELEMENT	HST TM 2.1.3	CALTRAIN DESIGN STANDARD (Chapter 2 - TRACK)	AMTRAK SPECIFICATION NO. 63	DEDICATED HST CRITERIA	BLENDED CRITERIA (JPB CTC) (Mathematized Alignment)
LOW AND MEDIAN SPEED TURNOUTS GEOMETRY	(DED) See Table 6.1.4	(BLE) See Caltrain Standard Drawing SD-2103, Table 1 & 2	Section 7.3 & 7.4	(DED) See Table 6.1.4	(BLE) See Caltrain Standard Drawing SD-2103, Table 1 & 2
LOW AND MEDIAN SPEED TURNOUTS AND CROSSOVERS MAXIMUM AUTHORIZED SPEED	(DED) Reference Table 6.1.4. 20 MPH for No. 9; 25 MPH for No. 11; 35 MPH for No. 15; 50 MPH for No. 20.	(BLE) Reference Caltrain DCM, Chapter 2, Section D 2.1. 10/10 MPH (passenger/freight) for turnouts No. 9; 25/15 for No. 10; 35/25 for No. 14; 50/40 for No. 20.		(DED) 20 MPH for No. 9; 25 MPH for No. 11; 35 MPH for No. 15; 50 MPH for No. 20.	(BLE) 10/10 MPH (passenger/freight) for turnouts No. 9; 25/15 MPH for No. 10; 35/25 MPH for No. 14; 50/40 MPH for No. 20.
SEPARATION OF LOW AND MEDIAN SPEED TURNOUTS	(DED) Reference NTD 10. Between low-speed turnouts: 600' desirable, 400' minimum. Between high and low speed: 1000' desirable, 700' minimum.	(BLE) Reference Caltrain DCM, Chapter 2, Table 2-2, between: PS of TOs, 50' preferred, 20' min.; PS-Curve, 100' pref., 15' min.; PS-grade crossing, 100' pref., 50' min.; PS-long last tie of TO, 60 pref., 50. min.		(DED) Reference NTD 10. Between low-speed turnouts: 600' desirable, 400' minimum. Between high and low speed: 1000' desirable, 700' minimum.	(BLE) Reference Caltrain DCM, Chapter 2, Table 2-2, between: PS of TOs, 50' preferred, 20' min.; PS-Curve, 100' pref., 15' min.; PS-grade crossing, 100' pref., 50' min.; PS-long last tie of TO, 60 pref., 50. min.
SEPARATION OF LOW AND MEDIAN SPEED TURNOUTS FROM STATION PLATFORMS	(DED) NTD 13: Provide 2750' minimum length between entry and exit turnouts for platform track. Figure 6.1.4: 75' between platform edge and turnout with refuge/storage track, 85' without refuge/storage track.	(BLE) Reference Caltrain DCM, Chapter 2, Table 2-2: between PS and platform, 100' preferred, 60' minimum.		(DED) NTD 13: Provide 2750' minimum length between entry and exit turnouts for platform track. Figure 6.1.4: 75' between platform edge and turnout with refuge/storage track, 85' without refuge/storage track.	(BLE) Reference Caltrain DCM, Chapter 2, Table 2-2: between PS and platform, 100' preferred, 60' minimum.
STORAGE AND REFUGE TRACKS AT HIGH-SPEED STATIONS	(DED) Turnouts smaller than the number 11 shall not be used. See Table 6.1.5 for 22 feet track offset the turnout - return curve selections.	N/A	N/A	(DED) Turnouts smaller than the number 11 shall not be used. See Table 6.1.5 for 22 feet track offset the turnout - return curve selections.	N/A

CAHSR FJ
ROLLING STOCK AND VEHICLE INTRUSION PROTECTION FROM ADJACENT TRANSPORTATION SYSTEMS DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)

BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)

NOTE: Caltrain Design Standard is valid for Maximum Authorzied Speed (MAX) of 90mph and FRA Class 5 Track standard. The same standard applies for alignment design where speed is over 90mph and for Track Class 6.

DESIGN ELEMENT	HST TM 2.1.7	CALTRAIN DESIGN STANDARD (Chapter 2 - TRACK)	DEDICATED HST CRITERIA	BLENDED CRITERIA (JPB CTC) (Mathematized Alignment)
SEPARATION DISTANCE FROM ADJACENT RAILROAD SYSTEMS	1. (DED) No intrusion protection is required for tracks with centerlines separated horizontally by 102 feet or greater. 2. No intrusion protection is required where the closest HST track elevation is 10 feet or higher than the rail elevation of the closest conventional track. 3. Protective structures may be required for piers, abutments or retaining walls if the side clearance is less than 25 feet. 4. Minimum total height for Intrusion protection: 10 FEET Directive Drawing: TM 2.1.7-A TM 2.1.7-B TM 2.1.7-D	N/A	1. (DED) No intrusion protection is required for tracks with centerlines separated horizontally by 102 feet or greater. 2. No intrusion protection is required where the closest HST track elevation is 10 feet or higher than the rail elevation of the closest conventional track. 3. Protective structures may be required for piers, abutments or retaining walls if the side clearance is less than 25 feet. 4. Minimum total height for Intrusion protection: 10 FEET Directive Drawing: TM 2.1.7-A TM 2.1.7-B TM 2.1.7-D	N/A
MINIMUM OFFSET BETWEEN PIER FOR GRADE SEPERATION PROJECTS AND THE CLOSEST TRACK	(DED) 25 FEET Directive Drawing: TM 2.1.7-C	(BLE) 12.5 FEET, See Caltrain Standard Drawing SD-2002	(DED) 25 FEET Directive Drawing: TM 2.1.7-C	(BLE) 12.5 FEET, See Caltrain Standard Drawing SD-2002

CAHSR FJ
STRUCTURE GAUGE AND TRACK CENTER DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)

BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)

NOTE: Caltrain Design Standard is valid for Maximum Authorized Speed of 90mph and FRA Track Class 5 standard. The same standard applies for alignment design where speed is over 90mph and for Track Class 6.

DESIGN ELEMENT	HST TM 1.1.10	CALTRAIN DESIGN STANDARD (Chapter 2 - TRACK)	AMTRAK SPECIFICATION NO. 63	BLENDED CRITERIA (JPB CTC) (Mathematized Alignment)	DEDICATED HST CRITERIA	BLENDED CRITERIA (JPB CTC) (Mathematized Alignment)
MAIN LINE TRACK CENTER	**(DED) For speeds of 125 mph and under:** **Desirable:** 16.5 feet (Use 15.75 feet where 16.5 feet is not practical) **Minimum**: 15.00 feet **Exceptional:** 14.75 feet (do not use above 90 mph) **Tracks with Catenary Poles between them:** **Desirable:** 25 feet **Minimum :** 22 feet, without walkway **Exceptional:** 22.00 feet, without walkway	**(BLE) Minimum**: 15.00 feet	80mph < V < 125mph: 15 feet 16' - For adjacent Main Tracks where the speed is 125 mph or more	Track spacing shall be as follows; […] b. MT1 to MT2 - 20' between track centers; and c. MT2 to MT3 - 20' between track centers. Where alignment, ROW or physical features prevent the above requirements, the order of preference of track spacings shall be as follows; a. Reduce MT2 - MT3 spacing to 15' minimum; b. Reduce MT1 - MT2 spacing to 18' minimum [...]	**(DED) For speeds of 125 mph and under:** **Desirable:** 16.5 feet (Use 15.75 feet where 16.5 feet is not practical) **Minimum**: 15.00 feet **Exceptional:** 14.75 feet (do not use above 90 mph) **Tracks with Catenary Poles between them:** **Desirable:** 25 feet **Minimum :** 22 feet, without walkway **Exceptional:** 22.00 feet, without walkway	**(BLE) Minimum**: 15.00 feet
INCREASE IN TRACK CENTERS DUE TO SMALL RADIUS	**(DED) Desirable**: No need for track center no less than 16.50 feet. **Minimum**: Adding the value determined by the following formula to 14.25 feet. Track Center Increase (in feet) = 1,100 / R (in feet).	N/A	N/A		**(DED) Desirable**: No need for track center no less than 16.50 feet. **Minimum**: Adding the value determined by the following formula to 14.25 feet. Track Center Increase (in feet) = 1,100 / R (in feet).	N/A
EFFECTS OF SUPERELEVATION ON TRACK CENTERS	1) **(DED) Desirable** Track Centers: No need. 2) In the case of curves under 3,000 feet radius and the inside track having less superelevation than the outside track, additional space is required between tracks with track centers set to Minimum and Exceptional track center distances. This widening shall be 2.0 times the difference in superelevation.	(BLE) 1) A minimum of one (1) inch for every 30 minutes of curvature where the amount of superelevation is the same on adjacent tracks or the superelevation of the inner track is greater than that of the outer track. 2). A minimum of one (1) inch for every 30 minutes of curvature, plus 3-1/2 inches for every inch of difference in elevation between the two tracks where the superelevation of the outer track is greater than that of the inner track.	1) Where the amount of superelevation is the same on adjacent tracks or the supereleva-tion of the inner track is greater than that of the outer track, increase the tangent track center distance 1" for each 0°-30' of curvature. 2) Where the superelevation of the outer track is greater than that of the inner track, the tangent track center distance should be increased 1" for each 0°-30' of curvature, plus 3-1/2" for each 1" of difference in superelevation of the two tracks considered.		1) **(DED) Desirable** Track Centers: No need. 2) In the case of curves under 3,000 feet radius and the inside track having less superelevation than the outside track, additional space is required between tracks with track centers set to Minimum and Exceptional track center distances. This widening shall be 2.0 times the difference in superelevation.	(BLE) 1) A minimum of one (1) inch for every 30 minutes of curvature where the amount of superelevation is the same on adjacent tracks or the superelevation of the inner track is greater than that of the outer track. 2). A minimum of one (1) inch for every 30 minutes of curvature, plus 3-1/2 inches for every inch of difference in elevation between the two tracks where the superelevation of the outer track is greater than that of the inner track.
WALKWAY REQUIREMENTS	1) (DED) Minimum width: 3 feet. 2) The vertical walkway space shall be no less than 7.50 feet above the walkway surface or top of rail elevation, whichever is higher. 3) The walking surface shall be no less than 6 inches wider than the walkway envelope.	(BLE) Minimum width: 2 feet. (Caltrain Standard Drawing SD-2004)	N/A		1) (DED) Minimum width: 3 feet. 2) The vertical walkway space shall be no less than 7.50 feet above the walkway surface or top of rail elevation, whichever is higher. 3) The walking surface shall be no less than 6 inches wider than the walkway envelope.	(MAT) Minimum width: 2.5 feet. (NFPA 130)
WALKWAY ENVELOPE	(DED) Figure 6.3.1 Figure 6.3.2	N/A	N/A		(DED) Figure 6.3.1 Figure 6.3.2	N/A
STRUCTURE GAUGE OUTLINE REQUIREMENTS	(DED) Figure 6.3.3 Figure 6.3.4 **Desirable and Minimum** Widening of Structure Gauge for Effects of Radius of Curve: 550 / R (feet)	(BLE) 12.5 FEET (Caltrain Standard Drawing SD-2002)	N/A		(DED) Figure 6.3.3 Figure 6.3.4 **Desirable and Minimum** Widening of Structure Gauge for Effects of Radius of Curve: 550 / R (feet)	(BLE) 12.5 FEET (Caltrain Standard Drawing SD-2002)
ROTATION OF STRUCTURE GAUGE FOR EFFECTS OF SUPERELEVATION	(DED) Table 6.3.3, Figure 6.3.7, 6.3.8, 6.3.9, 6.3.10	N/A	N/A		(DED) Table 6.3.3, Figure 6.3.7, 6.3.8, 6.3.9, 6.3.10	N/A

CAHSR FJ
ROADWAY WORK (GRADE SEPARATION) DESIGN CHECKLIST

Note: Without knowing exactly which roads will be impacted, all criteria are assumed applicable except for rolling/mountainous rural roadways.

	DESIGN ELEMENTS	REFERENCES										COMMENTS
		CAHSR	AASHTO	Caltrans (HDM)	City of San Jose	City of Santa Clara*	City of Burlingame*	City of Millbrae*	San Francisco County*	City of San Mateo*	City of Brisbane*	
1	**VEH CLASSIFICATION**	WB50		WB50	20'/WB50							
	Curb Radius, Arterial				R=65'	R=25' min						
	Curb Radius, Collector				R=65'	R=25' min						
2	**DESIGN SPEED**				(5-10 abv SL)							
	Design Speed, Arterial (4-6 lanes)				45 mph						45-50 mph	
	Design Speed, Collector (2-4 lanes)				40-45 mph						25-30 mph	
	Design Speed, Residential/local (2 lanes)				30 - 40 mph						25 mph	
	Design Speed, Level (Access Rd)	30 mph										
	Design Speed, Roll/Mtn (Access Rd)	20 mph										
	*SL = posted Speed Limit											
3	**ROADWAY GRADES, G**											
	Level Terrain, Urban/Local Road, Gmax			6.0%								
	Level Terrain, Rural, Gmax			4.0%								
	Level Terrain, Expw/Fwy, Gmax			3.0%								
	Level Terrain, Urban/Local/Expyw/Fwy, Gmin			0.3%								
	Rolling Terrain, Urban/Local Road, Gmax			7.0%								
	Rolling Terrain, Rural Road, Gmax			5.0%								
	Rolling Terrain, Expwy/Fwy, Gmax			4.0%								
	Rolling Terrain, Urban/Rural/Expwy/Fwy, Gmin			0.3%								
	Mtn Terrain, Urban/Local Road, Gmax			9.0%								
	Mtn Terrain,Rural Road, Gmax			7.0%								
	Mtn Terrain, Expwy/Fwy, Gmax			6.0%								
	Mtn Terrain, Urban/Rural/Expwy/Fwy, Gmin			0.3%								
	Fwy/Expwy Ramp, Gmax			8.0%								
	HST Access Rd, Gmax	6.0%										
	HST Access Rd, Gmin	0.50%										
	HST Access Rd, Reccm G	5% max, 1% min										
4	**ROADWAY X-SLOPES**											
	Road X-slope	2.0%		2.0%								
	Road lane same dir X-slope, Algebraic diff, A, max			4%								
	Road lane/shldr same dir X-slope, Algebraic diff, A, max			8%								
5	**GRADE DIFFERENTIAL, A**											
	Crest Vert Curve (local road)											
	Sag Vert Curve (local road)											
	Crest Vert Curve (HST Road/Access Rd)	9.0%										
	Sag Vert Curve (HST Road/Access Rd)	6.5%										

CAHSR FJ
ROADWAY WORK (GRADE SEPARATION) DESIGN CHECKLIST

Note: Without knowing exactly which roads will be impacted, all criteria are assumed applicable except for rolling/mountainous rural roadways.

	DESIGN ELEMENTS	REFERENCES										COMMENTS
		CAHSR	AASHTO	Caltrans (HDM)	City of San Jose	City of Santa Clara*	City of Burlingame*	City of Millbrae*	San Francisco County*	City of San Mateo*	City of Brisbane*	
6	**ROADWAY WIDTH**											
	Arterial				106' - 130'	84'					40'	
	Collector				60' - 90'	68'		60'				
	Residential				52' - 56'	60'		50'				
	Roadway Width (Access Rd)	22 ft (incl. Shldr)										
	Roadway Width W/FH (Access Rd)	26 ft (incl. Shldr)										
	Overcrossing 2-lane, Min			32' curb-curb								
7	**CUT/FILL SLOPES**											
	Cut slope	2h:1v		4h:1v								
	Fill slope	2h:1v		4h:1v								
8	**VERTICAL CLEARANCES**											
	Vertical Clr (from HST TOR to New Struct)	27 ft min										
	Vertical Clr (from HST TOR to ex Struct) >125 mph	27 ft min										
	Vertical Clr (from HST TOR to ex Struct) ≤125 mph	24 ft min										
	Vertical Clr (HST Access Rd)	14.5 ft min										
	*up to 25 ft laterally fr CL of outside HST track											
	Vertical Clr (fr Expwy/Fwy FG)			16.5 ft min								
	Vertical Clr (fr local roads FG)			15.0 ft min								
9	**HORIZONTAL CLEARANCES**											
	To Permanent Structure	25 ft fr Trk CL										
	To Fixed Equipment/Object	10 ft fr Trk CL		52' to edge of traveled way								
	Clear Recvry Zone, rd w/posted speed>40 mph			20 ft								
	Clear Recvry Zone, rd w/posted speed≤40 mph&curb			N/A								
	Horiz Clr fr Edge of Shldr, Foc, pole, wall	2.5 ft min										
	Horiz Clr fr edge of traveled way to rail,conc barrier, mbgr			shldr width, or 4 ft min for shldr<4'								
	Ramps - Horiz Clr fr edge of Traveled way to abutwalls, Retwall in cutslope			10' min								
	Local Rds - Horiz Clr fr edge of Traveled way to abutwalls, Retwall in cutslope			shldr width								
	Local Rds w/curbs - Horiz Clr fr edge of Traveled way to abutwalls, Retwall in cutslope			1.5' fr FOC or back of S/W	1.5' fr Foc or back of S/W							
10	**VERTICAL CURVES (L_{min})**											
	Crest Vertical Curve, Arterial				450 ft	200' min						
	Crest Vertical Curve, Collector				400 ft	200' min						
	Crest Vertical Curve, Residential				350 ft	200' min						
	Sag Vertical Curve, Arterial					200' min						
	Sag Vertical Curve, Collector					200' min						
	Sag Vertical Curve, Residential					200' min						
	Crest, HST Roads (A=alg diff in grades)	28 x A (20' min)										
	Sag, HST Roads (A=alg diff in grades)	35 x A (20' min)										
11	**HORIZONTAL CURVES (min R_c)**											
	Arterial (DS 45-55 mph); Caltrans (60-70 mph)			1150'-2100'	900 ft							
	Collector (DS 30-40 mph); Caltrans (40-50 mph)			550'-850'	300/667/900							
	Residential (DS 25-30 mph); Caltrans (20-30 mph)			130'-300'	300 ft							

CAHSR FJ
ROADWAY WORK (GRADE SEPARATION) DESIGN CHECKLIST

Note: Without knowing exactly which roads will be impacted, all criteria are assumed applicable except for rolling/mountainous rural roadways.

	DESIGN ELEMENTS	REFERENCES										COMMENTS
		CAHSR	AASHTO	Caltrans (HDM)	City of San Jose	City of Santa Clara*	City of Burlingame*	City of Millbrae*	San Francisco County*	City of San Mateo*	City of Brisbane*	
	Hillside											
	HST Roads (DS 20-30 mph)			130'-300'								
12	**STOPPING SIGHT DISTANCE (VERT)**											
	Highway (DS 65-75 mph)		645' - 820'	660'-840'								
	Arterial (DS 45-55 mph)		360' - 495'	360'-500'	360' - 500'						360'	
	Collector (DS 35-40 mph)		250' - 305'	250'-300'	250' - 300'					305'		
	Residential (DS 25-30 mph)		155' - 200'	150'-200'	150' - 200'							
	HST Roads (20-30 mph)		115' - 200'	120'-200'								
	*on Sag Curves, increase SSD 20% for g>3% & L>1mile											
13	**K-VALUES**											
	Highway (DS 65-75 mph): CREST/SAG		193-312/157-206									
	Arterial (DS 45-55 mph): CREST/SAG		61-114/79-115									
	Collector (DS 35-40 mph) : CREST/SAG		29-44/49-64									
	Residential (DS 25-30 mph) : CREST/SAG		12-19/26-37									
14	**SUPERELEVATION, e**											
	Urban Rd (<35 mph); e_{max}=0.04; Rc=500 to ovr 5k			0.04 to 0.02								
	Urban Rd (35-45 mph); e_{m}ax=0.06;Rc=600 to ovr 7k			0.06 to 0.02								
	Expwy/Multi-lane Hwy; e_{max}=0.10; Rc=1100-ovr 20k			0.10 to 0.02								
	Ramp/2-lane Hwy; e_{max}=0.12; Rc=625-ovr 20k			0.12 to 0.02								
15	**LANE WIDTH**											
	Arterial Rd Lane Width			12' min	4-6 Lanes 11/12/12/11	4 Lanes 11/12/12/11				4 Lanes 10/11/11/10	2 Lanes 11/11	
	Collector Rd Lane Width			12' min	2-4 Lanes 11/13/13/11							
	Residential Rd Lane Width			12' min	17/17							
	HST Roads	22' rd width										
	Sidewalk				9' res/10' coll/12' art	4.5' res 9.5' com	4' min	4' min	12' min	5 ft	4' min / 6' max	
	Bike Lane			4' min. Speed limit> 40, use 6'	5 ft	5 ft				5 ft	5 ft	
	2-Lane Fwy/Expwy, Paved Shldr, LT/RT			8' min, 10' pref								
	2-lane Rd, Paved Shldr, LT/RT											
	4-lane Rd, Paved Shldr, LT/RT			5'/8' min, 10' pref								
	6-lane Rd, Paved Shldr, LT/RT			8'/8' min, 10' pref								
	Urban Rd, posted speed ≤45 mph & curb median, L/R			2'/8' min, 10' pref								
	Urban Rd, posted speed ≤35 mph & curb med, L/R			0'/8' min, 10' pref								
	Single Ramp, L/R			4'/8'								
17	**CUL DE SAC**											
	Commercial				Curb R=40'	60						
	Residential				Curb R=30'	48						
	HST Roads											

* requires input from Cities. San Francisco may consider case-by-case basis.

CAHSR FJ TEMPORARY CONSTRUCTION FACILITIES DESIGN CHECKLIST

The High Speed Rail Authority has no geometric design criteria for temporary construction facilities. Such facilities can be highly variable in extent and location, and are subject to site selection that depends on such factors as expected construction methods, distance to suppliers and material, access and egress to working areas, and many more. Moreover, although these facilities can be described and even acquired by the project owner in anticipation of construction, the means and methods of construction rely largely on the construction contractor's preferences. This being the case, imposition of rigid geometric criteria for temporary facilities would ignore many important factors and hold a contractor to rigid constraints that could adversely affect the efficiency and expense of the work.

Therefore, a design checklist would not be generated.

CAHSR FJ
STATION DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)

BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)

DESIGN ELEMENT		HST (TM2.2.2) (TM2.2.3) (TM 2.2.4)	CALTRAIN DESIGN STANDARD (Chapter 3)	CAHSR FJ DEDICATED HST CRITERIA	BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA	COMMENTS
STATION FUNCTIONAL REQUIREMENTS	Station Design Consideration	(DED) HST TM 2.2.2, 6.1	(BLE) A. General	(DED) HST TM 2.2.2, 6.1	(BLE) A. General	
	Station Program Requirements	(DED) HST TM 2.2.2, 6.2		(DED) HST TM 2.2.2, 6.2		
PASSENGER STATION SITE	Station Site Spaces and Factors Influencing Sizing	(DED) HST TM 2.2.3, 6.2	N/A	(DED) HST TM 2.2.3, 6.2	N/A	
	Pedestrian Facilities	(DED) HST TM 2.2.3, 6.2.1	(BLE) E.3.0	(DED) HST TM 2.2.3, 6.2.1	(BLE) E.3.0	
	Transit Facilities	(DED) HST TM 2.2.3, 6.2.2	(BLE) E.2.0	(DED) HST TM 2.2.3, 6.2.2	(BLE) E.2.0	
	Bicycle Facilities	(DED) HST TM 2.2.3, 6.2.3	(BLE) E.2.0	(DED) HST TM 2.2.3, 6.2.3	(BLE) E.2.0	
	Pick-Up and Drop-Off Facilities	(DED) HST TM 2.2.3, 6.2.4	(BLE) E.2.0	(DED) HST TM 2.2.3, 6.2.4	(BLE) E.2.0	
	Automobile Parking	(DED) HST TM 2.2.3, 6.2.5 Max. distance from parking to station entrance = 1500' or a 5 to 7 minute walk. Provide ADA, carsharing, carpool/vanpool, and staff parking spaces.	(BLE) E.4.0	(DED) HST TM 2.2.3, 6.2.5 Max. distance from parking to station entrance = 1500' or a 5 to 7 minute walk. Provide ADA, carsharing, carpool/vanpool, and staff parking spaces.	(BLE) E.4.0	
	Roadways and Vehicle Access and Circulation	(DED) HST TM 2.2.3, 6.2.6 Single lane driveway: min. 11.5' wide. Min. 10' wide driveway for multiple lanes.	(BLE) E.2.0	(DED) HST TM 2.2.3, 6.2.6 Single lane driveway: min. 11.5' wide. Min. 10' wide driveway for multiple lanes.	(BLE) E.2.0	
	Additional Site Layout Considerations	(DED) HST TM 2.2.3, 6.3.8	N/A	(DED) HST TM 2.2.3, 6.3.8	N/A	
STATION PLATFORM GEOMETRIC DESIGN	Platform Configuration	(DED) HST TM 2.2.4, 6.1.1	(BLE) Figure 3-3, 3-4 & 3-5	(DED) HST TM 2.2.4, 6.1.1	(BLE) Figure 3-3, 3-4 & 3-5	
	Usable Platform Length	**(DED) HST NTD 13:** 800'. Not applicable for joint facility stations (e.g. 4th and King or LAUS) where the platform length should be the same as the other rail operators in the facility, but not shorter than 800 ft.	(BLE) 700' for six car train consist 1000' for eight car train consist At the San Francisco and San Jose Diridon terminal stations, the station platforms shall be designed to accommodate two (2) 8-car trains.	**(DED) HST NTD 13:** 800'. Not applicable for joint facility stations (e.g. 4th and King or LAUS) where the platform length should be the same as the other rail operators in the facility, but not shorter than 800 ft.	(BLE) 700' for six car train consist 1000' for eight car train consist Provision to allow for double train length. At the San Francisco and San Jose Diridon terminal stations, the station platforms shall be designed to accommodate two (2) 8-car trains.	
	Platform Width	(DED) HST TM 2.2.4, 6.1.3 Center Platform: 30' Min.; 25' Exceptional. Side Platform: 20' Min.; 18' Exceptional	(BLE) Outboard Platform: 16' Min.; 20' Preferred. Center Platform: 28' Min.; 32' Preferred.	(DED) HST TM 2.2.4, 6.1.3 Center Platform: 30' Min.; 25' Exceptional. Side Platform: 20' Min.; 18' Exceptional	(BLE) Outboard Platform: 16' Min.; 20' Preferred. Center Platform: 28' Min.; 32' Preferred.	
	Platform Cross Slope	(DED) HST TM 2.2.4, 6.1.4 1% Min.; 2.1% Max.	(BLE) 1% 2%Max	(DED) HST TM 2.2.4, 6.1.4 1% Min.; 2.1% Max.	(BLE) 1% 2%Max	
	Platform Longitudinal Slope	(DED) HST TM 2.2.4, 6.1.5 0% Desirable; 0.25% Max.	0% Desirable; 1% Max.	(DED) HST TM 2.2.4, 6.1.5 0% Desirable; 0.25% Max.	0% Desirable; 1% Max.	
	Platform Curvature	(DED) HST TM 2.2.4, 6.1.6 Largest radius possible, platform edge be convex, subject to variance process.	(BLE) Station through curved track, either horizontal or vertical curve shall be avoided. If unavoidable, the curve shall be as shallow a curve as possible to no more than one (1) degree and 30 minutes, and at either ends of the platforms.	(DED) HST TM 2.2.4, 6.1.6 Largest radius possible, platform edge be convex, subject to variance process.	(BLE) Station through curved track, either horizontal or vertical curve shall be avoided. If unavoidable, the curve shall be as shallow a curve as possible to no more than one (1) degree and 30 minutes, and at either ends of the platforms. Shared-use platforms shall be tangent horizontally.	
	Platform Height Above Rail	(DED) HST TM 2.2.4, 6.1.7 45.47" to 51.18" above top of rail.	(BLE) 8" above top of rail.	(DED) HST TM 2.2.4, 6.1.7 45.47" to 51.18" above top of rail.	(BLE) Caltrain platforms: 8" above top of rail. Shared-use platforms: 51" above TOR	
	Track Centerline to Platform Dimension	(DED) HST TM 2.2.4, 6.1.8 1/2 width of vehicle + 2.75" (or 5'-9" nominal for preliminary design.)	(BLE) 5'-4"	(DED) HST TM 2.2.4, 6.1.8 1/2 width of vehicle + 2.75" (or 5'-9" nominal for preliminary design.)	(BLE) Caltrain Platforms: 5'-4" Shared-use platforms: 6'-0"	
	Platform Edge to Train Gap	(DED) HST TM 2.2.4, 6.1.9 Horizontal Gap: 3" Max.; Vertical Gap +/- 5/8" Max.	N/A	(DED) HST TM 2.2.4, 6.1.9 Horizontal Gap: 3" Max.; Vertical Gap +/- 5/8" Max.	N/A	
	Setback of Obstruction from Edge of Platform	(DED) HST TM 2.2.4, 6.1.10 6.5' min. setback for small obstruction less than 3.3' in length parallel to platform. 8.25' min. setback for obstruction greater than 3.3' in length parallel to platform	(BLE) Figure 3-1& 3-2	(DED) HST TM 2.2.4, 6.1.10 6.5' min. setback for small obstruction less than 3.3' in length parallel to platform. 8.25' min. setback for obstruction greater than 3.3' in length parallel to platform	(BLE) Figure 3-1& 3-2	
	Under Platform Refuge Area	(DED) HST TM 2.2.4, 6.1.11 30" x 30" min. entire length of platform. Exits from this space shall be provided at platform ends.	N/A	(DED) HST TM 2.2.4, 6.1.11 30" x 30" min. entire length of platform. Exits from this space shall be provided at platform ends.	N/A	
	Platforms Adjacent to Through Tracks	(DED) HST TM 2.2.4, 6.1.12 Train speed on tracks adjacent to station platforms not to exceed 125 mph. Through train operating on track adjacent to platform should have one or more following provisions: 1) Passenger access to platform shall only be permitted when train is intended to stop, 2)Provide platform doors/barriers as access control to train, 3) Provide audible and visual warning on platform to provide advance notice of approaching trains.	N/A	(DED) HST TM 2.2.4, 6.1.12 Train speed on tracks adjacent to station platforms not to exceed 125 mph. Through train operating on track adjacent to platform should have one or more following provisions: 1) Passenger access to platform shall only be permitted when train is intended to stop, 2)Provide platform doors/barriers as access control to train, 3) Provide audible and visual warning on platform to provide advance notice of approaching trains.	N/A	
	Protection Screen between Station platform & Through Tracks	(DED) HST TM 2.2.4, 6.1.13 Provide 25' between track centers to allow for installation of protection screens, if required.	(BLE) Reference Section G 3.1 and Figure 3-1. Track centers at station platforms shall be expanded to 18 feet minimum to accommodate center fencing so that the fence is at least 8 feet six inches (8'-6") clear from the track center. The center fence shall extend 100 feet minimum beyond the ends of the platforms. If there are atgrade pedestrian crossings at the stations, then the fence shall continue to the edge of the crossings, and extend a minimum of 100 feet beyond past the at-grade pedestrian crossings.	(DED) HST TM 2.2.4, 6.1.13 Provide 25' between track centers to allow for installation of protection screens, if required.	(BLE) Reference Section G 3.1 and Figure 3-1. Track centers at station platforms shall be expanded to 18 feet minimum to accommodate center fencing so that the fence is at least 8 feet six inches (8'-6") clear from the track center. The center fence shall extend 100 feet minimum beyond the ends of the platforms. If there are atgrade pedestrian crossings at the stations, then the fence shall continue to the edge of the crossings, and extend a minimum of 100 feet beyond past the at-grade pedestrian crossings.	
	OCS Poles on Platforms	(DED) HST TM 2.2.4, 6.1.14 To meet National Electrical Safety Code (NESC) requirements. Grounding and Bonding and Protection required per TM 3.2.6.	N/A	(DED) HST TM 2.2.4, 6.1.14 To meet National Electrical Safety Code (NESC) requirements. Grounding and Bonding and Protection required per TM 3.2.6.	N/A	

CAHSR FJ
BRIDGES AND ELEVATED STRUCTURE DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)
BLENDED CRITERIA (BLE)
COMMON CRITERIA (COM)

DESIGN ELEMENT		HST TM	Caltrain Standards for Design and Maintenance of Structures	BNSF/UPRR Guidelines 1. UPRR - BNSF Railway Guidelines for Railroad Grade Separation Projects (Dated 01/05/2016)	AREMA	DEDICATED HST FJ CRITERIA	BLENDED CRITERIA
Superstructure	**General Span/Structure Type**	(DED) Proposed basic aerial structure is a prestressed concrete single cell box girder, spanning approximately 100 to 130 feet and supporting two parallel tracks. Simply supported spans. (TM 2.3.3)	(BLE) Simple span structures are preferred over a continuous span type of superstructure for use along the corridor (2-2). Deck type structures are preferred over through type structures. (2-2)	Only simple spans with ballast decks are allowed. Cast-in-place concrete superstructures are unacceptable. (6.1)[1]		(DED) Proposed basic aerial structure is a prestressed concrete single cell box girder, spanning approximately 100 to 130 feet and supporting two parallel tracks. Simply supported spans. (TM 2.3.3)	(BLE) Simple span structures are preferred over a continuous span type of superstructure for use along the corridor (2-2). Deck type structures are preferred over through type structures. (2-2)
	Structure Type	(DED) Prestressed concrete single cell box girder, spanning approximately 100 to 130 feet.	1. (BLE) Steel rolled beams (4 or more per track) 2. Steel plate girders (4 or more per track) 3. Prestressed concrete box girders or solid slab girders (no voids) 4. Steel deck plate girders (2 per track) 5. Prestressed concrete "AASHTO" type girders 6. CIP/RC box girder 7. PT box girder 8. Through type steel structures. (Figures 2.7-2.12)	Cast-in-place concrete superstructures are unacceptable. (6.1)[1] 1. Steel rolled beams + steel plate deck (5 or more per track) 2. Steel plate girders + steel plate deck (4 or more per track) 3. Steel rolled beams + concrete deck (5 or more per track) 4. Steel plate girders + concrete deck (4 or more per track) 5. Railroad Standard Prestressed Double Cell Box Beams 6. Prestressed Concrete Box Beams 7. Prestressed Precast Concrete AASHTO Type Beams 8. Through type steel structures. (6.8.1)[1]		(DED) Prestressed concrete single cell box girder, spanning approximately 100 to 130 feet.	1. (BLE) Steel rolled beams (4 or more per track) 2. Steel plate girders (4 or more per track) 3. Prestressed concrete box girders or solid slab girders (no voids) 4. Steel deck plate girders (2 per track) 5. Prestressed concrete "AASHTO" type girders 6. CIP/RC box girder 7. PT box girder 8. Through type steel structures. (Figures 2.7-2.12)
Substructure	**Type**	(DED) 10'x6' elliptical single column supports (TM 2.3.3) Substructure to satisfy requirements of TM 2.3.3, Section 6.1.5.	(BLE) Piers with two columns or solid pier wall are preferred over single column piers. (2.6.1)	Piers with a minimum of two columns shall be provided. A solid pier wall with a minimum of 4'-0" thickness is preferable. Single column piers shall not be considered for Underpass Structures. (6.9.1)[1]		(DED) 10'x6' elliptical single column supports (TM 2.3.3)	(BLE) Piers with two columns or solid pier wall are preferred over single column piers. (2-20)
	Skew	N/A	(BLE) 30 degree maximum, at abutment must be squared off support perpendicular to track (Figure 2-2, page 2-7)	15 degree maximum for concrete structures and 30 degrees max for a steel structure (6.3)[1]	15 degree maximum for precast concrete slabs and box girders, 30 degree maximum for precast concrete I-girder and T-girder, 60 degree maximum for CIP concrete slabs and girders. (8-2.1.6)	N/A	(BLE) 30 degree maximum, at abutment must be squared off support perpendicular to track (Figure 2-2, page 2-7)
Clearance	**Vertical Permanent Overhead**	(DED) 27'-0" for new structures (TM 1.1.21) 24'-6" for shared use track (TM 1.1.21)	(BLE) 24'-6" Min & 25'-6" Preferred (3.3.1 & Fig 3.1). 23'-6" Absolute Min (3.3.1).	23'-4" minimum within 25'-0" of centerline track (Plan 711100)[1]	23'-0" (Figure 28-1-6)	(DED) 27'-0" for new structures (TM 1.1.21) 24'-6" for shared use track (TM 1.1.21)	(BLE) 24'-6" Min (3.3.1 & Fig 3.1)
	Vertical Permanent Underpass	(DED) 16'-6" Freeway / Expressway (TM 1.1.21) Varies / Others (TM 1.1.21)	(BLE) 16'-6" over Freeways and Expressways (2.4.2) 15'-6" over highways and local streets (2.4.2) (Collision protection device required) (Page 2-14)	16'-6" for steel superstructure with 5 or more beams or 4 or more deck plate girders per track 17'-6" for concrete superstructure or steel through plate girders with bolted bottom flanges 20'-0" for steel through plate girders without bolted bottom flanges (6.6.1)[1]		(DED) 16'-6" Freeway / Expressway (TM 1.1.21) Varies / Others (TM 1.1.21)	(BLE) 16'-6" over Freeways and Expressways 15'-6" over highways and local streets (Collision protection device required) (2-14)
	Vertical Temporary	N/A	(BLE) 21'-6". CPUC approval required for vertical clearance less than 22'-6" (Fig 3.1)	21'-0"		N/A	(BLE) 21'-6". CPUC approval required for vertical clearance less than 22'-6" (Fig 3.1)
	Horizontal Permanent Overhead	(DED) 25' preferred, 12' minimum from CL exterior track to face of column, protection required < 25'-0" (TM 1.1.21)	(BLE) 25' preferred, 15' minimum from CL exterior track to face of column unless approved by Chief Engineer (Fig 3.1)	25'-0" minimum (Plan 711100)[1] Piers within 25'-0" shall be protected. Absolute minimum shall be 18'-0" from centerline track to pier protection wall (5.2.2)[1]	25'-0", less than 25'-0" requires crash walls (Figure 28-1-6) Tangent track, 9'-0" minimum (Figure 28-1-1)	(DED) 25' preferred, 12' minimum from CL exterior track to face of column, protection required < 25'-0" (TM 1.1.21)	15' minimum. Add 1ft thick crash wall wherever tracks are being added/modified under an existing bridge, and the horizontal clearance is less than 25'
	Horizontal Temporary	N/A	(BLE) 10'-0" (Note 5, Fig 3.1)	12' for UP (4.4.1)[1]		N/A	(BLE) 10'-0" (Note 5, Fig 3.1)
Serviceability	**Span to Depth Minimum**	(DED) Span Length / 10 (TM 2.3.3)	(BLE) Span Length / 12.5 (Steel Beam Span, Concrete Box Girder Span, Precast Concrete Beams) (Figure 2.7, 2.8, 2.10, 2.11) Span Length / 10 (Steel Deck Plate Girder Span) (Figure 2.9)			(DED) Span Length / 10 (TM 2.3.3)	(BLE) Span Length / 12.5 (Steel Beam Span, Concrete Box Girder Span, Precast Concrete Beams) (Figure 2.7, 2.8, 2.10, 2.11) Span Length / 10 (Steel Deck Plate Girder Span) (Figure 2.9)
Loading	**Ballast Track Section**	(DED) 4200 plf per track, which includes the weight of the ties. Increase by 1000 for superelevated track (DC 12.5.1.1 Table 12-1).	(BLE) Min. 12" / Max. 30" (2.3.3)	Up to 30" (6.1.1)[1]		(DED) 4200 plf per track, which includes the weight of the ties. Increase by 1000 for superelevated track (DC 12.5.1.1 Table 12-1).	(BLE) 30" depth of ballast measured from top of tie to the highest point of the deck below the tie (2.3.3)
	Direct Fixation Track Section	(DED) 2500 plf per track, increase by 1000 for superelevated track (DC 12.5.1.1 Table 12-1)	(BLE) N/A	N/A		(DED) 2500 plf per track, increase by 1000 for superelevated track (DC 12.5.1.1 Table 12-1)	(DED) 2500 plf per track, increase by 1000 for superelevated track (DC 12.5.1.1 Table 12-1)
	Live Load	E-50 (TM 2.3.2)	(COM) E-80 (2.3.3)	per AREMA (6.1.1)[1]	E-80 (8-2.2.3)	(COM) E-80 (2-8)	(COM) E-80 (2-8)
	Track Placement	(DED) Assume that the track locations are fixed transversely.	(BLE) Tracks can be placed anywhere on deck to maximize load.			(DED) Assume that the track locations are fixed transversely.	(BLE) Tracks can be placed anywhere on deck to maximize load.
Construction	**Excavation adjacent to tracks**	N/A	(BLE) 8'-6" minimum from centerline of track unless approved by Chief Engineer (Appendix B)	Excavation not permitted within 12'-0" of track centerline. (Standard Plan 710000)		N/A	(BLE) 8'-6" minimum from centerline of track unless approved by Chief Engineer (3-7)

4/10/2019

CAHSR FJ
BRIDGES AND ELEVATED STRUCTURE DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)
BLENDED CRITERIA (BLE)
COMMON CRITERIA (COM)

DESIGN ELEMENT		HST TM	Caltrain Standards for Design and Maintenance of Structures	BNSF/UPRR Guidelines 1. UPRR - BNSF Railway Guidelines for Railroad Grade Separation Projects (Dated 01/05/2016)	AREMA	DEDICATED HST FJ CRITERIA	BLENDED CRITERIA
STRUCTURE DESIGN LOADS	6.4 Permanent Loads	**(DED) TM 2.3.2** o 6.4.1 Dead Load (DC, DW, EV) o 6.4.2 Downdrag Force (DD) o 6.4.3 Earth Pressure (EV, EHAC, EHAR) o 6.4.4 Earth Surcharge (ES) o 6.4.5 Earth Settlement Effects (SE) o 6.4.6 Creep Effects (CR) o 6.4.7 Shrinkage Effects (SH) o 6.4.8 Secondary Forces from Prestressing (PS) o 6.4.9 Locked-In Construction Forces (EL) o 6.4.10 Water Loads (WA)	**(BLE) Chap 2.3.3 Design Load for Railroad Bridge Structures** **Dead Loads: Table 2.1**	**AREMA CHAPTER 11**	**AREMA CHAPTER 11** **Dead Loads: Table 2.1**	**(DED) TM 2.3.2** Dead Load (DC, DW, EV) Downdrag Force (DD) Earth Pressure (EV, EHAC, EHAR) Earth Surcharge (ES) Earth Settlement Effects (SE) Creep Effects (CR) Shrinkage Effects (SH) Secondary Forces from Prestressing (PS) Locked-In Construction Forces (EL) Water Loads (WA)	**(BLE) Chap 2.3.3 Design Load for Railroad Bridge Structures Dead Loads: Table 2.1**
	Transient Loads	(DED) o 6.5.1 Live Loads (LLP, LLV, LLRR, LLHR, LLH,LLHL, LLHT) o 6.5.2 Vertical Impact Factors (I) o 6.5.3 Centrifugal Force (CF) o 6.5.4 Traction and Braking Forces (LF) o 6.5.5 Nosing and Hunting Effects (NE) o 6.5.6 Wind Loads (WS) o 6.5.7 Slipstream Effects (SS) o 6.5.8 Thermal Load o 6.5.9 Frictional Forces (FR) o 6.5.10 Seismic Loads (EQM, EQD, EQL) o 6.5.11 Derailment Load (DR) o 6.5.12 Dynamic Earth Pressures (ED) o 6.5.13 Derailment Loads (DR) o 6.5.14 Collision Loads (CL)	**(BLE) Chap 2.3.3 Design Load for Railroad Bridge Structures** **Live Load: Cooper E-80** **AREMA CHAPTER 11**	**AREMA CHAPTER 11**	**AREMA CHAPTER 11** **Live Load: Cooper E-80**	(DED) Live Loads (LLP, LLV, LLRR, LLHR, LLH, LLHL, LLHT) Vertical Impact Factors (I) Centrifugal Force (CF) Traction and Braking Forces (LF) Nosing and Hunting Effects (NE) Wind Loads (WS) Slipstream Effects (SS) Thermal Load Frictional Forces (FR) Seismic Loads (EQM, EQD, EQL) Derailment Load (DR) Dynamic Earth Pressures (ED) Derailment Loads (DR) Collision Loads (CL)	**(BLE) Chap 2.3.3 Design Load for Railroad Bridge Structures** **Live Load: Cooper E-80** **AREMA CHAPTER 11**
	Miscellaneous Loads	(DED) o 6.6.1 Overhead Contact System (OCS) Loads o 6.6.2 Construction Loads and Temporary Structures o 6.6.3 Rail-Structure Interaction Forces o 6.6.4 Blast Loading	**(BLE) AREMA CHAPTER 11**	**AREMA CHAPTER 11**	**AREMA CHAPTER 11**	(DED) Overhead Contact System (OCS) Loads Construction Loads and Temporary Structures Rail-Structure Interaction Forces Blast Loading	**(BLE)** **AREMA CHAPTER 11**
	Load Factors and Load Modifiers	(DED) o 6.7.1 Design Load Combinations o 6.7.2 Resistance Factors	**(BLE) AREMA CHAPTER 11** **Design Load Combinations: GROUP I & GROUP II**	**n/a**	**AREMA CHAPTER 11** **Design Load Combinations: GROUP I & GROUP II**	(DED) Design Load Combinations Resistance Factors	**(BLE)** **AREMA CHAPTER 11** **Design Load Combinations: GROUP I & GROUP II**
DESIGN GUIDELINES FOR HIGH-SPEED TRAIN AERIAL STRUCTURES	Basic High-Speed Train Aerial Structure	**(COM) TM 2.3.3** o 6.1.1 Material Type o 6.1.2 Constructability o 6.1.3 Span Length and Span to Depth Ratio o 6.1.4 Span Articulation o 6.1.5 Substructures	**n/a**	**n/a**	**n/a**	**(COM) TM 2.3.3** Material Type Constructability Span Length and Span to Depth Ratio Span Articulation Substructures	**(COM) TM 2.3.3** Material Type Constructability Span Length and Span to Depth Ratio Span Articulation Substructures
TYPICAL CROSS SECTIONS FOR 15% DESIGN		**(DED) TM 1.1.21** o 6.1.2 Track Centers o 6.1.3 Overhead Contact System (OCS) Poles o 6.1.4 Walkways o 6.1.5 Drainage Requirement o 6.1.6 Systems Elements Requirement o 6.1.7 Access Control Appendix B: Supplemental Criteria In Shared Rail Corridors	**(BLE)** **See Track Alignment Check List**	**See Track Alignment Check List**	**See Track Alignment Check List**	**(DED) TM 1.1.21** Track Centers Overhead Contact System (OCS) Poles Walkways Drainage Requirement Systems Elements Requirement Access Control	**(BLE)** **See Track Alignment Check List**
INTERIM SEISMIC DESIGN CRITERIA		**(DED) TM 2.10.4** 6.5 Bridges and Aerial Structures	**(BLE)** **CHAPTER 4 Design Guide line for SEISMIC DESIGN**	**AREMA CHAPTER 9 SEISMIC DESIGN**	**AREMA CHAPTER 9 SEISMIC DESIGN**	**(DED) TM 2.10.4** Bridges and Aerial Structures	**(BLE)** **CHAPTER 4 Design Guide line for SEISMIC DESIGN**
TRACK SECTION DEPTH	Ballasted Track	(DED) 3.0ft from top of rail to top of deck, inclusive of waterproofing (HSR provided clarification to DC 5.10)	(BLE) 28" from top of rail to top of deck (Fig 2.7 to 2.12)	**n/a**	**n/a**	(DED) 3.0ft from top of rail to top of deck, inclusive of waterproofing (HSR provided clarification to DC 5.10)	(BLE) 28" from top of rail to top of deck (Fig 2.7 to 2.12)
	Direct Fixation Track	(DED) 2.5ft from top of rail to top of deck (DC 5.9)	**n/a**	**n/a**	**n/a**	(DED) 2.5ft from top of rail to top of deck (DC 5.9)	(DED) 2.5ft from top of rail to top of deck (DC 5.9)
THERMAL LENGTH		**(COM) Design Criteria 12.6.5.2** The thermal length kept under the 330ft threshold	**n/a**	**n/a**	**n/a**	(COM) The thermal length kept under the 330ft threshold	(COM) The thermal length kept under the 330ft threshold
EMERGENCY ACCESS		**(COM) Design Criteria** Emergency Access is provided at a minimum of 2.5 miles via stairs	**n/a**	**n/a**	**n/a**	(COM) Emergency Access is provided at a minimum of 2.5 miles via stairs	(COM) Emergency Access is provided at a minimum of 2.5 miles via stairs

CAHSR FJ
GRADING DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)

BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)

DESIGN ELEMENT	HST TM 2.6.7	CALTRAIN DESIGN STANDARD SD-2151	AMTRAK SPECIFICATION NO. 63	DEDICATED HST CRITERIA	BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA	COMMENTS
Slope Angles	(DED) Normally Adopted 1.5H:1V or 2H:1V In case of coarse rock fill, benches, toe walls 1H:1V or 1.25H:1V For slopes supported by compressible soft foundation soils required slope stability analysis For 15% Design Level: Soil Cuts 2H:1V For 15% Design Level: Rock Cuts 1H:1V Granular Soils 1.5H:1V to 2H:1V according to the height of the cut Cohesive Soils 1.5H:1V to 2H:1V according to the height of the cut, or even flatter, with benches if required Pre-historic landslide areas required slope stability analyses	(BLE) Cut & Fill 2H:1V	Cut & Fill 2H:1V All soil, subballast, and ballast slope No steeper than 2H:1V	(DED) Normally Adopted 1.5H:1V or 2H:1V In case of coarse rock fill, benches, toe walls 1H:1V or 1.25H:1V For slopes supported by compressible soft foundation soils required slope stability analysis For 15% Design Level: Soil Cuts 2H:1V For 15% Design Level: Rock Cuts 1H:1V Granular Soils 1.5H:1V to 2H:1V according to the height of the cut Cohesive Soils 1.5H:1V to 2H:1V according to the height of the cut, or even flatter, with benches if required Pre-historic landslide areas required slope stability analyses	(BLE) Cut & Fill 2H:1V	
Specific Consideration for Maintenance According to the Structure Height	(DED) Cuts with depth greater than 40' or Embankment over 40' height 6 feet wide bench with a 6% gradient toward the toe of the slope/the high-side line Place bench every 30 feet in height (allowance from 26 to 32 feet can be considered) The bench shall be connected to the natural ground at each end of the cut/ground for access.	n/a	n/a	(DED) Cuts with depth greater than 40' or Embankment over 40' height 6 feet wide bench with a 6% gradient toward the toe of the slope/the high-side line Place bench every 30 feet in height (allowance from 26 to 32 feet can be considered) The bench shall be connected to the natural ground at each end of the cut/ground for access.	n/a	

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HYDROLOGY / HYDRAULICS / DRAINAGE DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED) | **BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)** | **COMMON CRITERIA (COM**

DESIGN ELEMENT	HST TM 2.6.5	CALTRAIN DESIGN STANDARD (Chapter 8)	CALTRANS HDM	Amtrak Spec No. 63	DEDICATED HST CRITERIA	BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA
Storm Frequency	(DED) Drainage Facilities Crossing the HST track (i.e. culverts) Urban 1% (100-yr) Rural 2% (50-yr) Drainage facilities not crossing the HST track (i.e. parking lots, station drainage facilities) Urban 2% (50-yr) Rural 10% (10-yr) Ditches/storm drainage systems adjacent to the HST track Urban 2% (50-yr) Rural 4% (25-yr) Drainage systems crossing under bridge structure and on the ROW Urban 1% (100-yr) Rural 2% (50-yr) Critical Facilities (Electrical, vents, communication buildings, etc.) Min 1% (100-yr)	(BLE) Culverts crossing beneath at-grade track 100-yr Yard & Station runoff collection systems (including those in streets and parking lots) 100-yr Ditches 50-yr Drainage systems crossing under bridge structure and on the ROW 100-yr Strom drain systems adjacent to tracks 100-yr All facilities 100-yr	Refer to Hydraulic Engineering Circular No. 22, 3rd Edition Most highway agencies min. 10-year drain sag points min. 50-year High check storm 100-year	Drainage Facilities 100-yr	(DED) Drainage Facilities Crossing the HST track (i.e. culverts) Urban 1% (100-yr) Rural 2% (50-yr) Drainage facilities not crossing the HST track (i.e. parking lots, station drainage facilities) Urban 2% (50-yr) Rural 10% (10-yr) Ditches/storm drainage systems adjacent to the HST track Urban 2% (50-yr) Rural 4% (25-yr) Drainage systems crossing under bridge structure and on the ROW Urban 1% (100-yr) Rural 2% (50-yr) Critical Facilities (Electrical, vents, communication buildings, etc.) Min 1% (100-yr)	(BLE) Culverts crossing beneath at-grade track 100-yr Yard & Station runoff collection systems (including those in streets and parking lots) 100-yr Ditches 50-yr Drainage systems crossing under bridge structure and on the ROW 100-yr Strom drain systems adjacent to tracks 100-yr All facilities 100-yr
Basin Characteristics	(DED) Refer to Caltrans HDM, Topic 812	(BLE) Not Defined	Size, Shape, Slope, Land Use, Soil and Geology, Storage, Elevation, and Orientation are the characters described in Topic 812.	Not Defined	(DED) Refer to Caltrans HDM, Topic 819	(BLE) Not Defined
Design Discharge	(DED) Refer to Caltrans HDM, Topic 819	(BLE) Max expected discharge from drainage tributary area shall be computed by using the Rational Method Facilities owned and/or maintained by the Local Agency, the design discharge shall be computed using other applicable procedures as required and approved by the Local Agency Precipitation, intensity, and duration data shall be based on the data either from San Francisco, San Mateo, or Santa Clara counties depending on where the project is located	Refer to Caltrans HDM, Topic 819, Table 819.5A Summary of Methods for Estimating Design Discharge Empirical methods have been used in hydrology, including: Rational methods, Regional Analysis Methods, Flood Frequency Analysis, National Resources Conservation Service (NRCS) Methods, Statistical Methods, Hydrograph Methods	Not Defined	(DED) Refer to Caltrans HDM, Topic 819	(BLE) Max expected discharge from drainage tributary area shall be computed by using the Rational Method Facilities owned and/or maintained by the Local Agency, the design discharge shall be computed using other applicable procedures as required and approved by the Local Agency Precipitation, intensity, and duration data shall be based on the data either from San Francisco, San Mateo, or Santa Clara counties depending on where the project is located
Floodplain Information	(DED) FEMA provides floodplain maps with flood zones identified improvements cannot be higher than the 100-year BFE Refer to Caltrans HDM, Topic 804, Floodplain Encroachments, for FEMA guidelines	(BLE) Not Defined	23CFR, Section 650.115 Identify flood hazards Water surface elevation for the 100-yr flood	Not Defined	(DED) FEMA provides floodplain maps with flood zones identified improvements cannot be higher than the 100-year BFE Refer to Caltrans HDM, Topic 804, Floodplain Encroachments, for FEMA guidelines Consult with local flood control agency.	(BLE) FEMA provides floodplain maps with flood zones identified improvements cannot be higher than the 100-year BFE Refer to Caltrans HDM, Topic 804, Floodplain Encroachments, for FEMA Consult with local flood control agency.
Application of Approved Software	(DED) Hydrologic/hydraulic - industry accepted design programs are recommended (see Caltrans HDM Topic 808.	(BLE) Follow Caltrans HDM/Local Agency	Various H&H software including FHWA Hydraulic Toolbox, TR-55, HEC-HMS, HY-8, HEC-RAS, FESWMS, WMS, NOAA Atlas 14, USGS SteamStats, AutoDesk Civil 3D/Hydraflow	Not Defined	(DED) Hydrologic/hydraulic - industry accepted design programs are recommended (see Caltrans HDM Topic 808.	(BLE) Follow Caltrans HDM/Local Agency
Culvert Design	(DED) Max allowable headwater of 1.5 times pipe diameter up 0.5 feet below sub-ballast. For 100-year storm event, min freeboard between water surface elevation and the subballast shall be 2 feet 36" Min. Dia RCP (Class V) within ROW Min. 6' below top of rail, and 3' below the flow line of ditch along the track way For pipes not under track use 4' of cover with 45' of the track centerline & 3' min elsewhere	(BLE) Min. diameter 12" Pipes directly under the track or within 15' from centerline of the tracks: Caltrans Class V RCP required pipe size min. 24" diameter	Caltrans HDM, Topic 825 Min diameter for cross culverts under the roadways 18" Self-cleaning velocity, pipe sizes of 18" or more in diameter should be considered Pipe runs exceed 100' between inlet and outlet, or intermediate cleanout Larger diameter pipe without the median access is preferred	n/a	(DED) Max allowable headwater of 1.5 times pipe diameter up 0.5 feet below sub-ballast. For 100-year storm event, min freeboard between water surface elevation and the subballast shall be 2 feet 36" Min. Dia RCP (Class V) within ROW Min. 6' below top of rail, and 3' below the flow line of ditch along the track way For pipes not under track use 4' of cover with 45' of the track centerline & 3' min elsewhere	(BLE) Min. diameter 12" Pipes directly under the track or within 15' from centerline of the tracks: Caltrans Class V RCP required pipe size min. 24" diameter
Open Channel Design	(DED) Avoid critical and supercritical flow in trackside ditches Ditches should be deep enough and sized for handling the design runoff anticipated while allowing the subgrade to drain Required minimum freeboard, minimize erosion, maintain soil stability Refer AREMA Chapter 1, Part 1 for design adjacent to tracks. Also refer to Caltrans HDM Topic 860.	(BLE) Not Defined	Caltrans HDM, Topic 860 The shape of a channel section is generally determined by considering the intended purposed, terrain, flow velocity and quantity of flow to be conveyed. Rectangular Channel Freeboard Height Subcritical Flow: 0.1He Supercritical Flow: 0.20d Trapezoidal Channel Freeboard Height Subcritical Flow: 0.2He Supercritical Flow: 0.25d	Not Defined	(DED) Avoid critical and supercritical flow in trackside ditches Ditches should be deep enough and sized for handling the design runoff anticipated while allowing the subgrade to drain Required minimum freeboard, minimize erosion, maintain soil stability Refer AREMA Chapter 1, Part 1 for design adjacent to tracks. Also refer to Caltrans HDM Topic 860.	(BLE) Not Defined
Bridge/Aerial Structure Design	(DED) Freeboard above the design frequency water surface elevation min. 2' For ballasted bridge deck drains up to 500' Min. 6" pipe For ballasted bridge deck drains over 500' 8" pipe Longitudinal slope on bridge deck min. 0.5% Or generate minimum velocity 2 ft/sec No standing water on bridge HEC-21 Design of Bridge Drainage HDS-01 Hydraulic of Bridge Waterways	(BLE) Not Defined	Not Defined	Not Defined	(DED) Freeboard above the design frequency water surface elevation min. 2' For ballasted bridges lengths up to 500' Min. 6" pipe For ballasted bridges lengths over 500' 8" pipe Longitudinal slope on bridge deck min. 0.5% Or generate minimum velocity 2 ft/sec No standing water on bridge	(BLE) Not Defined
Underdrain System	HDS-01 Hydraulics of Bridge Waterways AREMA Chapter 1, Part 3 HEC-09, Debris Control Structures Evaluations and Countermeasures (DED) Refer Caltrain Chapter 8.0 & Caltrans HDM	(COM) min. 6" in diameter at min. grade of 0.2% Cleanout Every 300' (BLE) Manhole/inlet spacing 500' max (up to 30" diameter) 600' - 1000' (>30" diameter) (COM) Pipe cover below top of rail min. 48"	n/a for track	Not Defined	(COM) min 6" in diameter Cleanout installed every 300' pipe cover min. 48" below top of rail for all pipes (DED) Refer to Caltrain Chapter 8.0 & Caltrans HDM	(BLE) min. 6" in diameter at min. grade of 0.2% Cleanout Every 300' Manhole/inlet spacing 500' max (up to 30" diameter) 600' - 1000' (>30" diameter) Pipe cover below top of rail min. 48"
Roadway Drainage	(DED) Refer Caltrans HDM, Topic 830	(BLE) Not Defined	Min pipe diameter for storm drain systems Trunk drain 18" Trunk Laterals 15" Inlet Laterals 15"	Not Defined	(DED) Refer Caltrans HDM, Topic 830	(BLE) Not Defined
Pump Station	(DED) Refer HEC-24 to design pumps & pump stations	(BLE) Avoid as much as possible Require prior approval of Caltrain Deputy Director of Engineering	District and the Division of Structures responsible for the design	Not Defined	(DED) Refer HEC-24 to design pumps & pump stations	(BLE) Avoid as much as possible Require prior approval of Caltrain Deputy Director of Engineering
Debris Control	(DED) Refer FHWA, HEC-9 on Debris Control Structures Evaluation & Countermeasures Refer Caltrans HDM, Topic 822	(BLE) Not Defined	Refer FHWA Hydraulic Engineering Circular No. 9 to aid the designer in	Not Defined	(DED) Refer FHWA, HEC-9 on Debris Control Structures Evaluation & Countermeasures Refer Caltrans HDM, Topic 822	(BLE) Not Defined
Detention / Retention of Surface Water Runoff	(DED) Refer Caltrans Project Planning and Design Guide HEC-22, Urban Drainage Design Manual, FHWA	(BLE) Not Defined		Not Defined	(DED) Refer Caltrans Project Planning and Design Guide HEC-22, Urban Drainage Design Manual, FHWA Consult with local flood control agency.	(BLE) Not Defined

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CAHSR FJ
UTILITIES DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)

COMMON CRITERIA (COM)

BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA (BLE)

DESIGN ELEMENT	HST TM 2.7.4	CALTRAIN DESIGN STANDARD (CHPATER 8)	CALIFORNIA PUBLIC UTILITIES COMMISSION	DEDICATED HST CRITERIA	BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA	COMMENTS
Underground Utilities	(DED) Underground facilities located within the right of way must be located in a steel casing pipe (3/8" minimum thickness) with welded joints. Exception: For electrical and communication lines, a duct bank can be used in lieu of steel casing pipe.	(BLE) Utilities specifically designed for the Caltrain facilities at stations and right-of-way shall conform to the standards, codes, and requirements of the CPUC and the local jurisdiction within which the utilities are located, as appropriate.	(COM) Clearance and Depth Requirements for Supply and Communication Systems (COM) General Order No. 128 Appendix A. Table 1 and General Order 176.	(DED) Underground facilities located within the right of way must be located in a steel casing pipe (3/8" minimum thickness) with welded joints. Exception: For electrical and communication lines, a duct bank can be used in lieu of steel casing pipe.	(BLE) Utilities specifically designed for the Caltrain facilities at stations and right-of-way shall conform to the standards, codes, and requirements of the CPUC and the local jurisdiction within which the utilities are located, as appropriate.	
	(DED) Where a portion of the line crosses under the tracks or is located within 45 feet of the nearest track centerline, it must meet the requirements of Exhibit A.	(BLE) Third party utilities owners include private owners, state, and municipal government. Work shall be coordinated with and done in accordance with the standards of the utilities owner.		(DED) Where a portion of the line crosses under the tracks or is located within 45 feet of the nearest track centerline, it must meet the requirements of Exhibit A.	(BLE) Third party utilities owners include private owners, state, and municipal government. Work shall be coordinated with and done in accordance with the standards of the utilities owner.	
	(DED) Underground Utilities High Risk facilities • (DED) Maintain 500 feet minimum horizontal separation from other High Risk facilities • Maintain 5 feet minimum horizontal separation from other Low Risk facilities • Maintain 20 feet minimum horizontal separation from load carrying structural elements	(BLE) General requirements for crossing utilities and requirements for crossing utils (flammable, non-flammable, and hazardous) shall conform to Caltrain Std. Dwgs. SD-8000 through SD-8002.		(DED) Underground Utilities High Risk facilities • (DED) Maintain 500 feet minimum horizontal separation from other High Risk facilities • Maintain 5 feet minimum horizontal separation from other Low Risk facilities • Maintain 20 feet minimum horizontal separation from load carrying structural elements	(COM) Clearance and Depth Requirements for Supply and Communication Systems (COM) General Order No. 128 Appendix A. Table 1 and General Order 176.	
	(DED) Underground Utilities Low Risk facilities • (DED) Maintain 3 feet minimum horizontal separation from other Low Risk facilities • Maintain 5 feet minimum horizontal separation from load carrying structural elements and 3 feet minimum horizontal separation from other structures • Maintain 1 foot minimum vertical separation from drainage conduits			(DED) Underground Utilities Low Risk facilities • (DED) Maintain 3 feet minimum horizontal separation from other Low Risk facilities • Maintain 5 feet minimum horizontal separation from load carrying structural elements and 3 feet minimum horizontal separation from other structures • Maintain 1 foot minimum vertical separation from drainage conduits	(BLE) General requirements for crossing utilities and requirements for crossing utils (flammable, non-flammable, and hazardous) shall conform to Caltrain Std. Dwgs. SD-8000 through SD-8002.	
				(COM) Underground Electric Supply and Communication Systems (COM) General Order No. 128		
Overhead Utilities	(DED) Except for electrical and communication lines, overhead utilities shall cross the tracks at local street overpasses encased in a steel casing sleeve. Where electrical and communication lines cannot be accommodated in an overpass structure, their design shall be governed by the requirements of CPUC General Orders.	(BLE) Minimum Vertical Clearance per CPUC General Order 95	(COM) Minimum Clearances of Wires above Railroads (COM) General Order No. 95 Section III Table 1 and General Order No. 176.	(DED) Except for electrical and communication lines, overhead utilities shall cross the tracks at local street overpasses encased in a steel casing sleeve. Where electrical and communication lines cannot be accommodated in an overpass structure, their design shall be governed by the requirements of CPUC General Orders.	(COM) Minimum Clearances of Wires above Railroads (COM) General Order No. 95 Section III Table 1 and General Order No. 176.	
				(COM) Minimum Clearances of Wires above Railroads (COM) General Order No. 95 Section III Table 1	(BLE) Minimum Vertical Clearance per CPUC General Order 95	
Above Ground Utilities	(DED) In exclusive Authority right of way, all above ground utilities shall be moved outside of the right of way or conform to the requirements of Sections 6.3.1 and 6.3.2. In shared corridors, where design and location of existing utilities may be governed by existing agreements, and where relocation of the utility will have significant impact with respect to cost, environment or public inconvenience, the designer shall investigate the use of fencing, walls, cages, or other sources of protection in order to separate or isolate the utility from CHSTP features.	N/A	(COM) General Order No.176.	(DED) In exclusive Authority right of way, all above ground utilities shall be moved outside of the right of way or conform to the requirements of Sections 6.3.1 and 6.3.2. In shared corridors, where design and location of existing utilities may be governed by existing agreements, and where relocation of the utility will have significant impact with respect to cost, environment or public inconvenience, the designer shall investigate the use of fencing, walls, cages, or other sources of protection in order to separate or isolate the utility from CHSTP features.	(COM) General Order No. 176.	
				(COM) Minimum Clearances of Wires above Railroads (COM) General Order No. 95 Section III Table 1		
Exempt Utilities	(DED) Exemptions from these requirements will not be permitted. Where the requirements of this technical memorandum 2.7.4 can not be met, the Design Variance process shall be followed.	(BLE) HSR requirements shall be used for shared corridors.	N/A	(DED) Exemptions from these requirements will not be permitted. Where the requirements of this technical memorandum 2.7.4 can not be met, the Design Variance process shall be followed.	(BLE) HSR requirements shall be used for shared corridors.	
Location of Proposed Utilities	(DED) Proposed utilities that are not related to the operation and maintenance of CHSTP shall be located outside the Authority right of way.	(BLE) HSR requirements shall be used for shared corridors.	N/A	(DED) Proposed utilities that are not related to the operation and maintenance of CHSTP shall be located outside the Authority right of way.	(BLE) HSR requirements shall be used for shared corridors.	

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CAHSR FJ GEOTECHNICAL DESIGN CHECKLIST

A draft Geotechnical Investigation Report was prepared by ENGEO in May 2016, which included two volumes. Volume 1 was the Geotechnical Data Report, which contained no recommendations or design values and a design checklist will not be generated. Volume 2 was a Preliminary Geotechnical Recommendations Report for Four Structural Areas and included preliminary and general soil parameters for design at the four station areas. In developing the design soil parameters, many common geotechnical engineering publications were used such as those published by the California Department of Transportation, Federal Highway Transportation Authority, United States Army Corps of Engineers, the American Society of Civil Engineers and the California Buildings Standards Commission. There are also numerous other private publications that are frequently used in applying our engineering judgment. Since the design soil parameters are highly dependent on the location, type of structures, and anticipated loading conditions, separation of geotechnical engineering into design elements and application of a checklist would not be appropriate.

CAHSR FJ RIGHT OF WAY DESIGN CHECKLIST

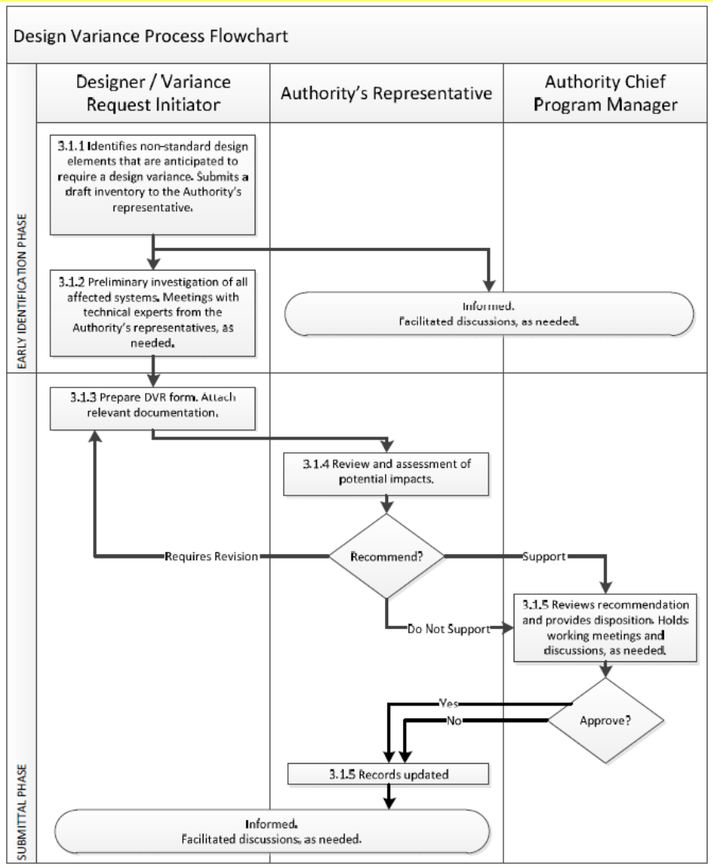
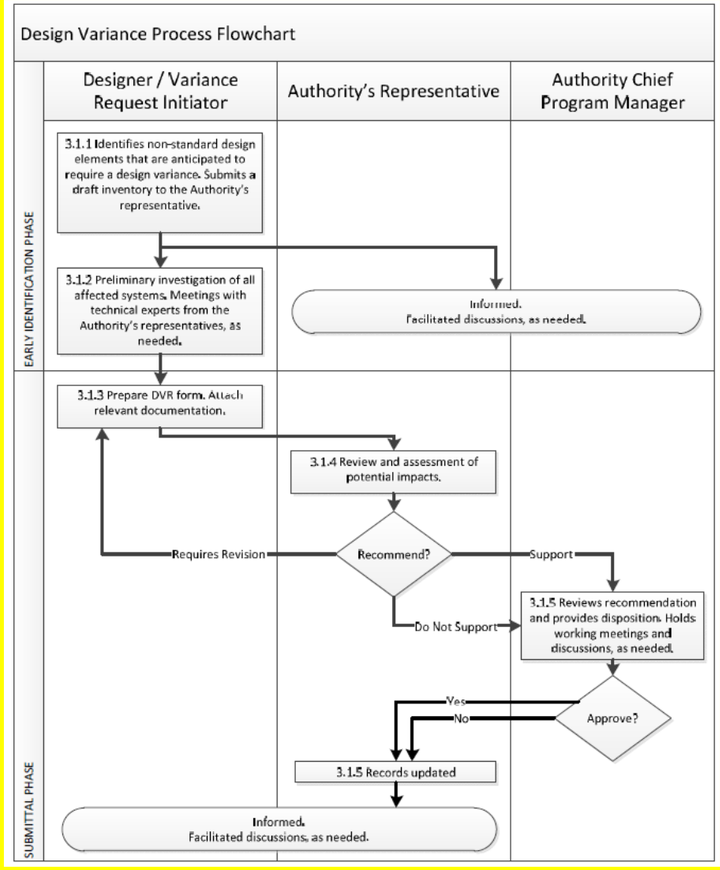
The High Speed Rail Authority has not promulgated geometric criteria for Right of Way. Right of way limits, both permanent and temporary construction easements (TCEs), are designed taking a number of factors into account. Many of these are qualitative and have to do with the surroundings of the rail alignment. HSRA design guidance exists for typical cross-sections. The right of way width and TCE limits vary for different standard cross-sections. Right of way and TCE will also vary depending on surrounding topography and land features, development, environmental considerations, and a host of other non-quantifiable conditions. For these reasons, right of way and TCE are generally determined by the judgment of the engineers, which reflects railroad clearance and alignment requirements, but also the many other factors that do not lend themselves to strict quantification.

Therefore, a design checklist would not be generated.

CAHSR FJ
GENERAL DESIGN CHECKLIST

DEDICATED HST CRITERIA (DED)

BLENDED CRITERIA /DEDICATED CALTRAIN CRITERIA (BLE)

DESIGN ELEMENT	HST TM 1.1.18	CALTRAIN DESIGN STANDARD (Chapter 1)	DEDICATED HST CRITERIA	BLENDED CRITERIA / DEDICATED CALTRAIN CRITERIA
DESIGN VARIANCE PROCESS	(DED) 	(BLE) Standard ('shall') means required, no exception. Guidance ('should') means recommended, involving engineering judgment. Option ('may') means permission. Support is informational statement. Any deviations from all these criteria shall receive prior approval by The Caltrain Deputy Director of Engineering. It shall be noted that variances or deviations are not for convenience. They shall be very rare, and only as a last resource and only after exhaustive analysis. Designers or other Project personnel shall not request a variance based on precedence. To request a variance, designers shall prepare written justifications documenting the reasons and justifications. If approved, the variance is only valid for the specific location of the project. This variance can not be used for future variance request. Any design variances shall never be less than the regulatory standards, and shall not introduce unacceptable safety and functionality of the railroad.	(DED) 	(BLE) Standard ('shall') means required, no exception. Guidance ('should') means recommended, involving engineering judgment. Option ('may') means permission. Support is informational statement. Any deviations from all these criteria shall receive prior approval by The Caltrain Deputy Director of Engineering. It shall be noted that variances or deviations are not for convenience. They shall be very rare, and only as a last resource and only after exhaustive analysis. Designers or other Project personnel shall not request a variance based on precedence. To request a variance, designers shall prepare written justifications documenting the reasons and justifications. If approved, the variance is only valid for the specific location of the project. This variance can not be used for future variance request. Any design variances shall never be less than the regulatory standards, and shall not introduce unacceptable safety and functionality of the railroad.
DOCUMENT CONTROL	1) (DED) Design Variance Request Form 2) Required Data 3) Supporting Documentation	(BLE) To request a variance, designers shall prepare written justifications documenting the reasons and justifications.	1) (DED) Design Variance Request Form 2) Required Data 3) Supporting Documentation	(BLE) To request a variance, designers shall prepare written justifications documenting the reasons and justifications.

4/10/2019

CAHSR FJ
SYSTEMS DESIGN CHECKLIST

	HIGH-SPEED TRAIN TM			HIGH-SPEED TRAIN DIRECTIVE DRAWING			HIGH-SPEED TRAIN NTD			CAHSR FJ CRITERIA		COMMENTS
STAND-ALONE RADIO SITES												
STAND-ALONE RADIO SITES	SITE REQUIREMENT			SITE REQUIREMENT		-	SITE REQUIREMENT	NTD 6	SITE ARE REQUIRED WHEN SPACING BETWEEN TP FACILITIES, SIGNAL EQUIPMENT HOUSES (TYPE A, AA, D, E), AND TUNNEL PORTAL SITES IS GREATER THAN 3 MILES	SITE REQUIREMENT	SITE ARE REQUIRED WHEN SPACING BETWEEN TP FACILITIES, SIGNAL EQUIPMENT HOUSES (TYPE A, AA, D, E), AND TUNNEL PORTAL SITES IS GREATER THAN 3 MILES	NO REQUIREMENT ON SIZE OF PARKING AREA
	SITE SIZE	TM 3.4.2	8'X12'	SITE SIZE	NTD 6 - DRAWING NO. 2	40'x25'	SITE SIZE	NTD 6	40'x25'	SITE SIZE	40'x25'	
	SITE SPACING		N/A	SITE SPACING		-	SITE SPACING	NTD 6	NOMINAL 2.5 MI NO GREATER THAN 3 MI. SITE SPACING TO BE MAINTAINED BETWEEN DESIGN SEGMENTS	SITE SPACING	NOMINAL 2.5 MI NO GREATER THAN 3 MI. SITE SPACING TO BE MAINTAINED BETWEEN DESIGN SEGMENTS	
	ACCESS REQUIRED	TM 3.3.2 TM 2.8.1	ACCESS ROAD AND GATE	ACCESS REQUIRED		-	ACCESS REQUIRED	NTD 6	ACCESS ROAD AND GATE	ACCESS REQUIRED	ACCESS ROAD AND GATE	
	PARKING	TM 3.3.2 TM 2.8.1	REQUIRED FOR EACH SITE	PARKING		-	PARKING	NTD 6	REQUIRED FOR EACH SITE	PARKING	REQUIRED FOR EACH SITE	
	TCE FOR INSTALLATION		N/A	TCE FOR INSTALLATION	NTD 6 - DRAWING NO. 2	MINIMUM 40'x60'	TCE FOR INSTALLATION	NTD 6	MINIMUM 40'x60'	TCE FOR INSTALLATION	MINIMUM 40'x60'	