Florida High Speed Rail Authority
High Speed Rail Project Civil Infrastructure Design Guidelines
July 16, 2002

1.0 Introduction

It is anticipated that a high speed rail system will be constructed in the State of Florida under a design build operate and maintain (DBOM) contract. Preliminary engineering and environmental assessment are proceeding on the St. Petersburg to Orlando corridor in order to select a preferred alignment, satisfy the NEPA process and develop DBOM request for proposal documents.

Multiple high speed ground transportation technologies exist, including diesel-electric and electric powered steel wheel/steel rail systems and magnetic levitation systems. Rail systems offer both conventional and tilt suspensions. The performance and infrastructure requirements of each technology are different. The key differences for alignment are the maximum speeds attainable with each technology – a range of 120mph to 250 mph.

In order to enable the competitive marketplace to present the best option for the citizens of Florida, the Authority has not made a technology selection. This complicates the preliminary engineering task, as the alignments and infrastructure must be designed to allow the application of the range of technologies. The alignments must be designed, so as not to preclude the use of or unjustly penalize the performance of any technology. (One exception to this concept exists – Maglev systems shall not be permitted adjacent to the existing CSX railroad due in part to the perception by CSX that EMI may affect the performance of the CSX signal system.) The High Speed Rail Project Civil Infrastructure Design Guidelines are established to guide the preliminary design decisions in a manner consistent with these objectives.

The basic infrastructure design during the preliminary engineering phase shall accommodate an electrified high speed rail system capable of speeds of 150 mph. On award of a contract to a DBOM contractor, it is anticipated that the contractor shall optimize the alignment and infrastructure design for his technology within right of way and other constraints.

The high speed rail system shall be designed to serve high speed passenger equipment and will not be used by general railway freight equipment. The high speed passenger equipment may include special, similarly constructed freight cars operating in separate trains or within the passenger train consists. Conventional track maintenance equipment including work trains, diesel electric locomotives, ballast cars, tampers, geometry cars and hi-rail inspection cars shall operate on the track (except Maglev).

2.0 Codes, Standards and Regulations

Tracks shall be designed to meet applicable requirements of Track Safety Standards 49 U.S.C. Part 213 Subpart G for Class 8 track.

Except as noted specifically herein, infrastructure design shall be in accord with Florida DOT standards including:

- Project Development and Environmental Manual
- Roadway Plans Preparation Manual
- Manual of Uniform Minimum Standards for Design, Construction, and Maintenance for Streets and Highways
- Bicycle Facilities Planning and Design Manual
- Right-of-Way Engineering Manual
- Survey Manual
- Drainage Manual
- Soils and Foundations Manual

- Structures Design Guidelines
- Computer Aided Design and Drafting (CADD) Roadway Standards and Guidelines

Railroad track and structures shall be designed in accord with recommended practice of the AREMA Manual for Railway Engineering 2002.

3.0 Survey and Right of Way

The preliminary engineering alignment shall be plotted on scaled low resolution aerial photography base maps. Scaled high resolution aerial photography and digital terrain models shall be provided to potential design build contractors during the RFP process to enable the contractors to optimize the alignment for their systems.

During preliminary engineering, approximate right of way limits shall be determined from existing highway plans and railroad valuation maps. Boundaries shall be plotted on the plan sheets.

Tangent segments of the high speed rail alignment shall be designed to fit within a 44 foot envelope in highway medians and 50 foot envelope within existing railroad alignments. Curves and spirals may require a greater envelope width and/or additional right of way. Excursions outside the existing median or right of way shall be identified on the plans. In addition, excursions outside the existing right of way are required for connections between railroad and highway median alignments, between highway median alignments and station sites and between different highway alignments. Additional right of way requirements shall be identified on the plans.

4.0 Typical Sections

Typical sections are provided for the following configurations:

- Open Terrain Electrified Center Pole Rail Tangent Track
- Open Terrain Electrified Side Pole Tangent Track
- Electrified Rail Tangent Track in Highway Median Depressed Under Roadway Overpass
- Electrified Center Pole Rail Tangent Track Adjacent to Existing CSX at a 25 foot Track Centers with Standard Ditch
- Electrified Center Pole Rail Tangent Track Adjacent to Existing CSX at a 25 foot Track Centers with Underdrains
- Maglev Tangent Track at Grade in Highway Median
- Maglev Tangent Track at Grade in Highway Median Depressed Under Roadway Overpass
- Electrified Side Pole Rail Tangent Track in Highway Median
- Electrified Side Pole Rail Curved Track in Highway Median
- Electrified Side Pole Rail Tangent Track Adjacent to CSX 25 foot Centers
- Electrified Side Pole Rail Curved Track Adjacent to CSX at 25 Foot Centers

Where standard roadbed and ballast section back-slopes intersect existing ground lines beyond the existing ROW, retaining walls shall be designed and constructed within the property with diversion ditches or drains provided behind the retaining wall to divert runoff from adjacent properties toward stabilized drainage outfall structures. Where applicable, profiles may be adjusted to minimize earthwork and reduce or eliminate the need for retaining walls.

Due to the minimal ROW width or inaccessibility due to geological conditions a parallel access roadway shall not be constructed.

Emergency and inspection walkways shall not be required in constrained right of way or highway median construction. Emergency access and evacuation shall be provided along the adjacent track.

Soil engineering and analysis shall be employed to design the subgrade embankments and cuts. New side slopes shall not be steeper than 1.5:1. Unless designed from site specific soils data, slopes shall not be steeper than 2:1

To minimize right-of-way and excavation requirements, underdrains rather than ditches shall be employed where necessary for drainage.

5.0 Design Speeds

The preliminary engineering alignment shall be designed for a peak speed of 160 mph (maximum 150 mph operating speed), where not restricted by right of way limitations.

6.0 Track and Guideway

Mainline roadbed, trackwork and alignment shall be designed for high speed passenger service at speeds up to 160 mph, unless otherwise restricted by geometric considerations, special trackwork, or yard limits. All track on earthen roadbed shall be ballasted construction. Direct fixation shall be permissible on flyover structures to eliminate the dead load of the heavy rock ballast and provide longer span lengths. Where high-speed operation is permissible, the facilities shall be designed to support Class 8 gage, alignment and surface criteria without excessive maintenance.

A double track mainline shall be constructed to ensure reliable service. High speed crossovers are required at roughly 25 mile intervals to allow heavy maintenance under single track operations without shutting down the system.

Main tracks used by passenger service shall be constructed using new 136RE continuous welded and controlled cooled rail (CWR). Rail for sidings and yards shall be either new 136RE CWR (as above) or relayed continuous welded rail of not less than 115 lbs. per yard.

Main track shall use 8’6” reinforced concrete ties, spaced at 24 in centers. Yard track may use either concrete or timber ties. Timber ties shall be spaced at 19.5 in centers. The concrete tie track shall be suitably designed to provide electric isolation of one rail from the other and both from ground to satisfy train control circuit integrity requirements, and, if the track is electrified using the running rails as the negative return, the track shall include electric isolation sufficient to provide suitable protection of adjacent facilities from stray current corrosion.

Track gage shall be 4 ft 8.5 in measured at right angles to the track alignment 5/8 in below the top of rail.

Rail fasteners installed with concrete ties shall be spring clip design with elastomeric pads to prevent tie wear. Timber ties shall employ tie plates, spikes and anchors.

Ballast shall be suitable for use with concrete or timber ties. Mainline ballast gradations shall conform to No. 24, 3 or 4A to provide for drainage and performance under load. Yard ballast shall meet No. 5 gradation requirements to provide for improved walkway and safety conditions along the track. Due to the high crushing loads under concrete ties, ballast materials shall be limited to granite, trap rocks or quartzite. The minimum ballast depth shall be 14 in under mainline ties. The minimum ballast shoulder width shall be 12 inches. Ballast shoulder slopes shall not be steeper than 2H: 1V.

Subballast shall conform to Florida DOT specifications for crushed aggregate base course and shall consist of hard, durable particles of crushed stone or crushed concrete and a filler of natural sand, stone sand or other finely divided mineral matter. Subballast depth shall be not less than 8 inches. Subballast shall be sloped as shown on the cross section prints to promote drainage of the track structure.

The mainline track shall be entirely grade separated. Grade crossings are permitted in yards and possibly in slow speed territory, where grade separation is not economically feasible. Where such grade crossings exist, precast steel reinforced concrete panels with elastomeric flange fillers shall be used. Concrete panels provide the most uniform crossing surface and security of installation of the commercially available grade crossing products. Grade crossings shall include gated warning systems.

7.0 Special Trackwork

All new turnouts, crossovers, and special crossings shall be in accordance with current AREMA Portfolio of Trackwork Plans for standard curved switch and rigid frog lateral turnouts, unless otherwise modified due to location within mainline track curves and spirals.

The point of switch or heel of frog shall be located no closer than the following:

TS or ST of adjoining mainline track curve	200 feet
PVC or PVT of a vertical curve	100 feet

Where unconstrained by geometry, all mainline crossovers shall be #32.75 with movable point frogs. Crossovers and turnouts in close proximity to terminal stations may be #20 with curved switch points and RBM frogs. Yard turnouts shall be no smaller than #8. All mainline turnouts shall be on concrete ties.

8.0 Horizontal Alignment

The following design guidelines are based on AREMA 2002. All horizontal alignment design shall conform to current AREMA guidelines.

8.1 Tangents

The minimum tangent length between curves shall be the greater of 100 feet or three times the design speed. The alignment shall be tangent through the platform area to a distance of 100 feet from platform edges.

8.2 Curvature

Curvature shall not exceed 9 degrees on mainline tracks and 12 degrees on yard tracks. The minimum length of circular curve shall be determined by the formula: L = 2.22*V, where L is in ft and V is in mph. In no case shall the length of circular curve be less than 100 feet

8.3 Superelevation/Cant Deficiency

Mainline curves shall be superelevated. The maximum design superelevation E(A) shall not exceed 6 inches. FRA permits a maximum superelevation of 7 inches.

Maximum cant deficiency E(U) shall not exceed 9 inches. (FRA permits a maximum cant deficiency of 9 inches on qualified equipment, i.e. tilt body equipment. For non-tilt body equipment E(U) shall be limited to 3 inches unless the roll angle is within limits specified by AREMA in which case the E(U) may be increased to 4.5 inches.)

Mainline curves shall be designed with E(A) established to balance forces on both rails, employing cant deficiency as required to achieve design speeds. The balancing speed in a curve shall be determined by the formula: E(A) = .0007*D*V*V, where E(A) is in inches, D is in degrees and V is in mph. The maximum permissible speed in a curve shall be determined by the formula: E(A)+E(U) = .0007*D*V*V, where E(A) and E(U) are in inches, D is in degrees and V is in mph. The sum of E(A)+E(U) shall not exceed 15 inches.

Superelevation shall be run off at a constant rate in the spiral. Superelevation shall not be runoff on tangent track.

Actual and unbalanced superelevation may be simultaneously introduced provided that AREMA spiral length guidelines are followed.

8.4 Spirals

Mainline curves and tangents shall be connected with a spiral transition. The length of the spiral shall be determined by the maximum value determined by the following formulae:

- L(S) = 1.63*E(U)*V, where L(S) is in ft, E(U) is in inches and V is in mph.
- L(S) = 1.30*E(A)*V, where L(S) is in ft, E(A) is in inches and V is in mph.
- L(S) = 124*E(A), where L(S) is in ft and E(A) is in inches. (Applies to Class 8 track)

Spiral and curve geometry shall be determined using the formula and notation of AREMA 5-3-2 through 5-3-5.

The application of spirals for high speed operation is anticipated to result in conflicts with existing CSX railroad and highway median alignments, as the original alignments were not constructed with long spirals. Each curve shall be evaluated to determine site specific solutions. Where the cost of realigning existing infrastructure proves prohibitive, the design speed and spiral length shall be reduced as necessary.

9.0 Vertical Alignment

The following design guidelines are based on AREMA 2002. All vertical alignment design shall conform to current AREMA guidelines.

9.1 Grades

The vertical alignment shall follow the existing track or highway gradients, wherever practicable. The desired maximum grade shall not exceed 3.5%. Under no circumstances shall the grade exceed 5%. The minimum grade length shall be determined by the formula: L=2.22*V, where L is in ft and V is in mph. Yard tracks and station track grades shall not exceed .25%. It is desired to design such tracks at 0% grade.

9.2 Vertical Curves

Where changes in grade occur, gradient lines should be connected by vertical curves, observing the following provisions:

The length of a vertical curve is determined by the difference in grades to be connected and the rate of change adopted. For high-speed main tracks, the rate of change should not be more than 0.05' per station of 100' in sag curves and not more than 0.10' per station of 100' in crest curves.

Where geometric constraints prevail, the following formula shall be used to determine the vertical curve lengths:

LVC = Delta g*V*V*K/A, where:

LVC = Length of Vertical Curve (in ft)
Delta g = difference in grades (in ft/ft)
V = speed (in mph)
K = 2.15, constant to convert mph into feet
A = 0.60 ft/sec/sec)

The minimum vertical curve length, $LVC_{(min)}$, shall not be less than 100 feet

10.0 Clearances and Track Centers

10.1 Tangent

Main tracks shall be constructed at 13.5 foot minimum track centers on tangent The desirable main line high speed rail track centers shall be 15.0 feet. Track centers shall be increased to provide clearance for center catenary support structures. The minimum clearance to catenary poles support structures shall be 9.5 feet as recommended by AREMA. The desired clearance is 12 ft-0 in. High speed rail tracks shall be separated from adjacent freight rail tracks by a distance of not less than 25 feet measured between freight and high speed rail track centerlines.

Yard and storage tracks shall be spaced at not less than 13.5 feet measured between track centerlines.

The minimum permissible clearance from track centerlines to adjacent fixed obstructions shall be 8 feet measured from the track centerline in accord with Florida law.

10.2 Curves

The minimum horizontal clearance (8.0 feet) and track spacing (13.5 feet) shall be increased 1.5 inches per degree of curvature. Where superelevation is applied, the minimum horizontal clearance of 8.0 feet shall be increased on the inside of the curve 3 inches per inch of actual superelevation.

10.3 Vertical Clearance

The high speed rail alignment shall be designed to provide 19 feet of clearance between the top of rail and the low point of the bridge. This clearance value allows the installation of a catenary system with sufficient electrical clearance to the bridge for a 25kV power system. Clearance for existing structures may be obtained by rebuilding the structure or lowering the track elevation.

10.4 Vehicular Dynamic Clearance

The vehicular dynamic clearance shall not exceed AREMA Plate C.

11.0 Structures

11.1 Bridges

Highway bridge piers within 25 feet of a track centerline shall be protected with a reinforced concrete deflection wall to a height of 6 feet above the top of rail elevation.

High speed rail bridges shall be constructed with a side walkway, where permitted by median width or railroad right of way width.

11.2 Retaining Walls

The desirable clearance to retaining walls shall be 10.0 minimum from centerline of track to near face of wall.

11.3 Barriers

Standard Florida DOT highway median barriers shall be employed on the boundaries of highway median running high speed rail systems to deflect errant highway vehicles from entering the guideway. On the inside of curves the height of standard barriers shall be increased to 7.5 feet.

11.4 Culverts

Per FDOT drainage criteria.

12.0 Drainage

Per FDOT drainage criteria.

13.0 Fencing

Chain link fencing 6 feet high shall be installed on the boundaries of the new rail alignment. The fencing shall be installed on the top of the highway median barrier separating high speed rail from automotive traffic.

14.0 Provisions for Systems Elements

Nominal contact wire height shall be 23 feet in accord with AREMA recommendations per 33-4-10. The minimum contact wire height shall be 17 feet. An envelope of 18 inches in width shall be provided for catenary support structures. The preferred location of catenary support structures is on the outside of the double track main line. This permits one catenary support system to remain in service if the other is out of service for any reason. All train control and communications cables shall be installed below grade by either direct burial or in ducts.

15.0 Overhead Roadway Bridges

Per FDOT standards with clearances to high speed rail tracks as defined herein.

16.0 Highway Modifications

Per FDOT standards.

17.0 Maintenance of Traffic

Per FDOT standards for highway traffic. Per affected railroad for work adjacent to operating railroads.

18.0 Stations

Platform length shall be not less than for 9 car trains including locomotives. For preliminary design a platform length of 800 feet shall be used. Center platforms shall be a minimum of 24 feet in width. Platforms shall be high level and meet ADA clearance requirements. For preliminary design, a distance from centerline of track to platform edge of 5.25 feet shall be used.

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