Florida Department of Transportation District IV

DESIGN-BUILD REQUEST FOR PROPOSAL for Wave Streetcar DB Project

ATTACHMENT D

SE 3rd AVENUE BRIDGE

REHABILITATION REQUIREMENTS

May 13, 2016

This Draft RFP Package is submitted for Industry Forum purposes.

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This document defines the minimum rehabilitation design and construction requirements for the SE 3rd Avenue Bridge required in conjunction with implementation of the new streetcar system.

Existing Bridge Description: The existing bridge was originally constructed in 1960 and designed in accordance with AASHO Standard Specifications for Highway Bridges, 1953 with an H-20 design live load.

Per the June 22, 2015 Florida Department of Transportation Bridge Inspection Report in the Reference documents, the bridge has a Sufficiency Rating of 66.5, is not considered "Structurally Deficient", but is considered "Functionally Obsolete", with narrow roadway and narrow shoulder widths, substandard bridge railings, and limited vertical clearance over North and South New River Drive. The bridge does not require weight restrictions.

The bridge is 366 feet long and is a seven (7) span structure that includes a 92 feet long, steel double-leaf rolling-lift type bascule main span over the navigation channel, four (4) 55 feet long prestressed concrete girder spans, and two (2) 27 feet long steel beam spans flanking the bascule span.

The bridge is on a symmetric roadway vertical profile with 5 percent grades, 240-foot long vertical crest curve, and 100-foot long vertical sag curves at each end. The minimum horizontal navigation clearance at the bascule span is 60 feet between fenders. The minimum vertical navigation clearance above mean high water with the bascule span fully lowered is 18.50 feet at the fenders and 21.83 feet at the center of channel. There is unlimited vertical clearance with the bascule span fully raised.

The bridge has an overall width of 60 feet and currently carries four (4) lanes of vehicular traffic (two northbound and two southbound) within a 46 feet wide roadway between 9-inch high curbs. The roadway is crowned on the approach spans and has no cross slope on the bascule span. There are 6 feet wide raised sidewalks each side of the roadway and 2.83 feet high bridge railings at the back of sidewalks. The bridge railings do not meet current standards for crash testing and pedestrian safety standards.

The Department is currently evaluating the need to replace the bridge railings throughout the bridge.

The bascule span consists of two leaves, one on each side of the navigation channel. The superstructure consists of combination of steel open grid deck and reinforced concrete slab supported on a lightweight steel framework including pair of variable-depth main girders. A concrete counterweight at the heel end of each leaf balances the span and reduces the forces required to operate the span. The bascule span is of a Scherzer rolling-lift configuration that operates by rolling on curved steel tread plates on the underside of the main girders and steel track plates on the bascule piers below the main girders. The bascule leaves roll away from the navigation channel to open and roll toward the channel to close. A pair of span locks that connect the two bascule leaves at the center of the span maintains continuity of the bascule span deck under traffic. The bascule leaves are stabilized, and prevented from opening while traffic is on the span, with live load shoes and operable tail lock assemblies at the heel end of each main girder that engage steel anchor frames on the bascule piers. The span drive machinery is mounted on and rotates with the bascule leaves and consists of an electro-mechanical system with pair of electric motors, brakes, and gear train. Main pinion gears, located at the bascule leaf center of rotation, engage fixed rack gears mounted on the bascule piers, and move horizontally along the rack gears as the machinery operates causing the span to roll on the curved treads and flat tracks.

Concrete bascule piers support the bascule leaves and enclose the operating machinery and pivoting counterweight. The bascule piers are supported on driven steel H-pile foundations with footings below the river bottom that were constructed using cofferdams and tremie concrete seals. The depth of the existing piles is not known and there are no available pile driving records, but the piles have an original specified maximum design load of 50 tons and minimum penetration of 40 feet into the soil below the concrete seals. Steel frames that support the bascule leaves are encased within the bascule pier concrete. The north bascule pier includes a two-story concrete control house that includes an electrical room and bathroom on the lower level, and control room on the upper level.

The Department is in the process of performing additional geotechnical investigations to obtain a more accurate assessment of the load carrying capacity of the piles.

The approach span superstructure consists of a combination of spans with prestressed concrete beams and spans with steel beams that support a concrete deck with an asphalt overlay and raised concrete sidewalks behind 9-inch high curbs. The spans are supported on concrete wall-type abutments on spread footings at the bridge ends and intermediate pile bents with concrete caps and driven concrete piles. The depth of the existing piles is not known and there are no available pile driving records, but the piles have an original specified maximum design load of 65 tons and minimum penetration of 40 feet into the soil. The original design bearing pressure for the spread footings is not known.

The Department is in the process of performing additional geotechnical investigations to obtain a more accurate assessment of the load carrying capacity of the piles and spread footings.

Electrical power consists of 120/240 Volt, 3-Phase, 60-Hz service provided by Florida Power & Light from a meter pole on the north side of the river. Emergency back-up power is provided by a 90 kW standby generator with automatic transfer switch located in the north bascule pier. The bascule span is controlled with drum control switches on the control desk, a series of limit switches that sense span position, and relay based control system for safety interlocking. A submarine cable buried below the river bottom delivers electrical power and control signals across the channel.

During bridge openings, vehicular traffic is stopped by traffic signals and warning gates located on the approach spans. Boat traffic is controlled with navigation lights mounted on the bascule span that turn from red to green when the span is fully raised.

Bascule Leaf Balance Calculations: Balance calculations and sizing of the counterweight for each bascule leaf shall be in accordance with the following minimum requirements:

- Calculations shall be prepared using a computer spreadsheet and submitted in electronic form, both .pdf and computer spreadsheet format, to the Department for review and approval.

- Calculations shall be based on approved shop drawings of fabricated components, shop measured weights of the new steel grid deck panels after galvanizing, average equilibrium unit weight of approved deck and counterweight concrete mixes based on unit weight testing.
- Use actual fabricated steel component dimensions including deductions for holes, copes, cuts, clips, and machining. Include actual weight of bolt assemblies excluding shanks between the grip and actual weight of welds. Account for dimensional tolerances of rolled plate and shapes, including average of permissible overrun and underrun in material thickness, per ASTM A6. Include allowances for hot-dip galvanizing steel paint coatings.
- Account (deduct) for items embedded in the deck concrete and counterweight concrete.
- Use calculated or published shipping weights of machinery and estimated of electrical component weights.
- Perform separate balance calculations for each bascule leaf.
- Compute weights of individual components.
- Compute location of Center of Gravity (C.G.) for each component or sub-assembly of components both horizontally and vertically.
- Reference C.G.'s longitudinally to the center of rotation:
  - Positive (+) distances are recorded for elements forward of the center of rotation (i.e., toward the channel).
  - Negative (-) distances are recorded for elements behind the center of rotation (i.e., away from channel).
- Reference the C.G.'s vertically to the center of rotation:
  - Positive (+) distances are recorded for elements above the center of rotation.
  - Negative (-) distances are recorded for elements below the center of rotation.
- Account for the vertical geometry of the bascule leaf (i.e., the roadway vertical curve) when computing vertical distances to component C.G.'s.
- Report the weight and C.G. of each component using the following terminology and accuracy:
  - Weight, *W* in kips.
  - Distances from center of rotation to C.G., *X* (horizontal), *Y* (vertical), and *R* (radial) in feet.
  - Component contribution to imbalanced torque about center of rotation in kip-ft shown as the products *W*X* and *W*Y*.
  - Angle, *α*, between horizontal line through center of rotation and line passing through center of rotation and C.G. in degrees. Positive (+) angle upwards and negative (-) angle from a horizontal line extending forward of the center of rotation (toward the channel).
  - Net bascule leaf imbalanced torque vectors as products, *W*X*, *W*Y*, and *W*R*, and the leaf imbalanced torque, $T = W*R*\cos(\theta + \alpha)$, as function of leaf opening angle, *θ*, shown at ten degree increments.

- Tabulate weights (W), C.G. distances (X and Y) and imbalanced torque vectors (W*X and W*Y). Sum the weights (ΣW) and imbalanced torque vectors (ΣW*X and ΣW*Y) into logical sub-assemblies including total forward of the center of rotation, backward of the center of rotation, and total bascule leaf.
- Calculations shall demonstrate that the balanced condition (i.e. location of the bascule leaf C.G. and magnitude of imbalance is within the specified tolerances per the

requirements in the RFP.

- Calculations shall demonstrate that counterweight adjustment pockets are of the required size per the requirements in the RFP.
- The bascule leaf center-of-gravity shall be such that the bascule leaf has a toe-heavy condition for positions from fully-closed to an opening angle of 56 degrees +/- 10 degrees and heel-heavy condition for positions from an opening angle of 56 degrees +/- 10 degrees to fully-raised position.
- The magnitude of the toe-heavy imbalance about the center-of-roll for the span fully-lowered position shall be 70 kip-ft +/- 10 kip-ft.
- The counterweight size and density and the adjustment pocket size shall be established such that the total dead load moment behind the center-of-roll with the pockets empty (i.e. no balance blocks) shall equal a maximum of 0.95 times the total dead load moment forward of the center-of-roll and with the pockets full (i.e. maximum recommended number of balance blocks installed) shall equal a minimum of 1.075 times the total dead load moment forward of the center-of-roll. The adjustment pockets shall be used for fine adjustment of the balance and shall include two separate levels, a lower level and upper level, so that the bascule leaf center-of-gravity can be raised or lowered as required.
- The total number of balance blocks in the adjustment pockets shall be as required to achieve the final balanced condition, confirmed by span balance testing using the dynamic strain gauge method. Provide a minimum number of spare balance blocks for each counterweight equal to a weight of 0.005 times the total dead load moment forward of the center-of-roll divided by the horizontal distance from center-of-roll to the centroid of the adjustment pockets.

Span Balance Testing: Bascule leaf balance testing for each bascule leaf shall be performed in accordance with the following minimum requirements.

Final balance adjustments for each leaf shall be determined based on span balance testing using the dynamic strain gauge method (i.e. strain gauges applied to the main drive shafts of the bascule span operating machinery, torsional strains measured and recorded using a data acquisition system as the bascule leaves are raised and lowered, and the strains converted to imbalanced torque about the center of rotation.)

The Design-Build Firm shall employ the services of an established testing company experienced in dynamic strain gauge balance testing of movable bridges. Submit qualifications of the proposed testing company and personnel to the Department for review and approval. Experience shall include satisfactory dynamic strain gauge testing and reporting of at least six (6) movable bridges including a minimum of three (3) bascule bridges. The measurements shall be made under the direction of a Professional Engineer registered in the State of Florida with demonstrated hands-on-experience of dynamic strain gauge testing of movable bridges.

The testing company shall furnish and install the required strain gauges, cabling and transmission equipment, data acquisition equipment and strip chart recorders, perform the measurements, and produce fully documented reports detailing the results of the measurements.

Span balance testing results shall be submitted in report format, signed and sealed by the Professional Engineer responsible for the testing, and shall include the testing methodology, equipment, plots of the raw data, and data conversion calculations.

Counterweight Requirements: Bascule leaf counterweights shall be constructed in accordance with the following minimum requirements.

Counterweight ballast shall include a combination of concrete and steel ballast and cast-iron balance blocks. Use of heavyweight concrete with heavy weight aggregate, such as hematite or similar, steel or lead punchings or shot will not be permitted.

Counterweight concrete shall meet the minimum requirements of Class IV and shall be constructed in accordance with the Specifications. Perform unit weight testing for the counterweight concrete in advance of preparation of final balance calculations to establish wet and equilibrium unit weights for use in balance calculations and verification testing during construction. Counterweight concrete may extend to the roadway surface, finished, profiled and grooved per the Specifications. Concrete surfaces at free edges shall be reinforced with a minimum of No. 6 reinforcing bars at 6-inch spacing in each direction, fully developed as required, and furnished and installed per the Specifications.

Embedded steel ballast shall be fully encased with a minimum of 6-inches of concrete cover to exposed surfaces of the concrete. Steel ballast may bear directly against the interior surface of steel counterweight boxes. Steel ballast is not required to meet specific minimum mechanical properties. Steel ballast that is stacked or grouped shall meet dimensional tolerances of ASTM A6 to minimize voids between stacks or groups.

Balance blocks shall be fabricated from ASTM A48 Class 30 gray cast iron, shall be prismatic and of uniform dimensions for stacking, shall include recessed handles for lifting, and shall weigh no more than 80 pounds.

Existing Bridge Re-use and Demolition:

Existing concrete that is removed shall be saw cut to provide clean and squared edges around the perimeter. Existing reinforcing steel may be cut-off or the reinforcing may remain and temporarily bent to provide clearance. Cut and/or damaged reinforcing steel shall be replaced with new reinforcing steel installed in drilled holes with approved epoxy adhesive. Portions of existing steel elements encased in the bascule pier concrete, no longer to be used, shall be removed by cutting off a minimum of 1-inch below the surface of the concrete and the concrete patched with an approved epoxy mortar. Pre-wet existing concrete surfaces to receive new concrete to saturated surface dry conditions prior to placement of the concrete.

Rolling-lift Flat Tracks and Curved Treads: The rolling-lift flat tracks and curved treads shall meet the following minimum requirements.

Each curved tread and flat track shall each be fabricated as single solid component from an ASTM A668 steel forging of the required class and shall be machined for proper fit-up and alignment on the respective main girders and track girders. The bearing surfaces of the tracks and treads shall be machined for proper alignment and uniform bearing contact. The track and tread mating lugs and pockets shall be machined for proper alignment and clearances. The track and tread bearing surfaces, sides and ends shall be inscribed with longitudinal and transverse reference centerlines at the center-of-roll for both fully-closed and fully-open positions to facilitate survey and alignment. The curved treads shall be bolted to the main girder bottom flange and flat tracks bolted to the top flange of the track girders with high-strength turned bolts.

The new main girder bottom flanges shall be machined for proper fit-up and alignment of the curved treads on the main girders. The top of the new flange plates, flange angles, and existing web reinforcing plates shall be machined together at assembly for uniform bearing contact and alignment. New top flange angles shall be fabricated from new rolled angles or steel weldments with complete joint penetration welds. Stress relieve and hot dip galvanize new flange angle weldments after fabrication. If strengthening of the track girder connections is required, existing rivets shall be replaced with new mechanically galvanized high-strength bolts.

Stress relieve and hot dip galvanize new track girder weldments and machine the top surface of the top flanges flat to receive the new flat tracks.

Install and align new track girders with flat tracks mounted with temporary undersized bolts. Encase lower portion of track girders in concrete after alignment of the flat tracks is verified and prior to installation of the bascule leaves. Reconstruct the track wall concrete surrounding the track girders with Class IV concrete per the Specifications. The top surface of the concrete shall be sloped away from the new flat tracks. Do not place the concrete until flat track proper alignment is verified. Provide supplemental reinforcing steel installed in drilled holes with an approved epoxy adhesive, as required, per the Specifications.

Perform roll testing of the mating curved treads and flat tracks at various stages of construction including in the machine shop after machining the tracks and treads, in the steel fabrication shop after assembly of the treads on the main girders with the flat tracks bolted to temporary or new steel track girders, and in the field after installation and alignment of the track girders, flat tracks, and assembled bascule leaves on the bascule piers.

The Department is in the process of determining the survey requirements, the alignment tolerances, and establishing base specifications.

Span Locks and Centering Devices: The span locks and centering devices shall meet the following minimum requirements.

- Each span lock shall be independent and shall be a complete stand-alone system.
- The span lock actuator equipment shall be accessed by way of access doors in the sidewalk and from access platforms below the sidewalks. Access doors shall be fabricated from stiffened aluminum construction and include engineered gas lifters, automatic hold-open features, slam locks, locking feature with removable key, recessed handle, and stainless steel hardware. The access platform floor shall consist of a solid aluminum plate.
- Forward guides and receivers shall be mounted in the web of the end floorbeams, with access to adjust the shims from the toe side of the end floorbeams with the bascule leaves partially raised.
- Lock bars, guides, receivers, actuator machinery, support weldments shall be of robust construction, designed to meet the RFP loading, strength, deflection, and streetcar alignment requirements.
- Guides and receivers shall include shoes with shims for initial and periodic adjustment.

Shims shall be slotted for convenient adjustment and include keepers.

- The span locks shall accommodate maximum lateral and vertical misalignment of 0.5 inches between the bascule leaves with tapers on the ends of the lock bars and bearing shoes. The bearing shoes in the forward and rear guides shall include features to guide the lock bar as it is driven. The bearing shoes on the receivers shall include side clearances to accommodate lateral misalignment.
- Bearing shoe geometry shall minimize edge loading of the lock bar on the shoes as the main girders deflect under traffic. Shoes shall include a cylindrical surface.
- Moving parts shall be lubricated with grease with lubrication ports and lines directed to stations conveniently located on the access platforms.
- Lock bars shall be fabricated from steel forgings and guide and receiver shoes from hard bronze. Lock bars shall have a Brinell hardness a minimum of 25 points higher than that of the bearing shoes.
- Lock bar actuators shall consist of electric linear actuators or electric motors with brakes, fully enclosed gear reduction, links and cranks. Fluid power systems, such as hydraulic cylinders or hydraulic motor systems, are not permitted. The actuator machinery shall be connected to the lock bar linkage system with clevis pins for quick disconnect. Actuators shall drive or retract the lock bar in no more than 5 seconds. Provide manual means to operate the actuator, such as a hand crank or wheel, with convenient access from the access platform.
- Provide limit switches to disable primary operation when manual operation is in use. Provide limit switches to detect lock bar fully-driven and fully-retracted positions.
- Guide and receiver shoes shall be fabricated from hard bronze and supported on steel weldments incorporated into the end floorbeams of the two bascule leaves. The guide and receiver shoes shall include means of adjustment with shims.

Alignment requirements …

Reference to Specifications …

Access hatches to the span lock machinery platform shall consist of heavy-duty single-leaf access door with the following features:

- Doors fabricated from 0.25-inch thick stiffened mill-finish aluminum plate with diamond tread surface, slotted for vertical ladder rails, and hinged on side away from channel,
- Extruded mill-finish aluminum perimeter support frames,
- Door and frame designed for 300 pounds per square foot live load,
- Stainless steel (Type 316) hardware including hinges, hinge pins, slam lock latch, fixed interior handle, recessed turn-lift handle, and fasteners,
- Engineered lift assistance with compression spring actuators enclosed in telescopic tubes,
- Automatic hold-open arm with release handle to automatically secure the door in the open position,
- Mill finish.

<u>Live Load Shoes and Tail Stops</u>: The live load shoes and centering devices shall meet the following minimum requirements.

Live load shoes shall consist of a robust steel weldments and/or plates and machined for uniform bearing contact between parts. Live load shoes shall be bolted with high-strength turned bolts. Either the shoes or strike plates shall include a machined cylindrical bearing surface with radius sized for the line contact forces, to accommodate end rotations associated with main girder deflections. The shoes and strike plates shall include shims for adjustment. The bascule leaf and anchor frame steel to receive the live load shoes and strike plates shall be of sufficient flatness for uniform contact and shall be machined or ground flat as required.

New concrete anchorages shall use high-strength steel anchors that provide a net preload of the connection to the bascule pier when tensioned. Anchors shall be installed of sufficient depth to develop the adjacent concrete reinforcing steel. Anchors set in drilled holes with epoxy adhesive shall not be used for pre-loaded anchorages. New anchor frame girders and columns may be partially encapsulated within the bascule pier concrete to assist with the anchorage. The new anchor frame girders may support and be made composite with the bascule pier concrete sidewalk with welded headed stud shear connectors.

Bascule pier concrete removed to facilitate partial to full replacement of the steel anchor frames and new columns for support of the tail stops shall be constructed with Class IV concrete and supplemental reinforcing steel installed in drilled holes with an approved epoxy adhesive per the Specifications.

The tail stop shall be configured to produce the specified pre-load reaction at the live load shoes. The geometry shall be such that the arc of the pivoting strut lifts the rocker arm after the rocker engages the strike plate. The lifting action shall deform the tail stop column, anchor girder and/or anchor column. The pre-load reaction shall result from the combined flexural resistance of the anchor girder and axial resistance of the tail stop columns and/or anchor column as the members are deformed. The geometry of the tail stop (i.e. amount the rocker lifts after engagement with the strike plate) and stiffness of the new anchor girder shall be adjusted to produce the required pre-load reaction.

The articulated steel column assemblies shall consist of robust steel weldments that are pinned at two locations including the base and an intermediate location on the columns using lubricated and machined forged steel pins, bronze bushings, and clevises. Provide lubrication ports and lines directed to convenient locations on the bascule pier access platforms. Steel assemblies shall be hot dip galvanized after fabrication and stress relieving, and machined after galvanizing. The top of the columns shall include a steel rocker that engages steel strike plates. Provide means to adjust the position and alignment of the assemblies with shims and grout pads.

Tail stop actuators shall consist of independent electric linear actuators or electric motors, brakes, fully enclosed gear reduction, cranks, and/or linkages. Fluid power systems, such as hydraulic cylinders or hydraulic motor systems are not permitted. The actuators for the tail stop shall meet the following minimum requirements:

- Connect the actuators to the tail stop columns with clevis pins for quick disconnect.
- Actuators shall drive or retract the tail stop in no more than 5 seconds.
- Provide manual means to operate the actuator, such as hand crank or wheel, with convenient access from the bascule pier access platforms.
- Provide limit switches to disable primary operation when manual operation is in use.
- Provide limit switches to detect lock bar fully-driven and fully-retracted positions.

Alignment requirements …

Reference to Specifications …

<u>Span Drive Machinery</u>: The span drive machinery for each bascule leaf shall meet the following minimum requirements.

- Vector duty electric motors, with AC flux vector drives, encoders, drive-line and load-side filters and reactors, that alternate operation. Motors shall be sized for the required power to operate the span per AASHTO LRFD Movable.
- Steel grid type motor couplings between the motors and primary speed reducers. Couplings shall be rated for the larger of 1.5 times the motor full load rated torque or the braking forces.
- Pair of motor brakes between the motors and primary speed reducers and pair of machinery brakes on the primary speed reducer output shafts, or secondary reducer input shafts. Brakes shall consist of spring actuated, thruster released, drum type brakes with adjustable torque setting and set time delay settings. Brakes shall be sized to stop and/or hold the span in accordance with AASHTO LRFD Movable. Brake mounting and design shall account for the change in orientation of the assembly as the bascule leaves rotate during operation.
- Three (3) custom speed reducers including a parallel-shaft, double-reduction, differential primary speed reducer and two (2) epicyclical planetary, double reduction secondary speed reducers. Use of a single speed reducer in lieu of three speed reducers will not be permitted. Speed reducers shall use through-hardened gearing to minimize size of the boxes. Output torque rating shall be based on 1.0 service factor and 300 percent motor full load rated torque (shop testing torque). Reducer mounting and design shall account for the change in orientation of the assembly as the bascule leaves rotate during operation. Speed reducers shall be shop tested per the Specifications.
- Floating shafts between primary and secondary speed reducers and between the secondary reducers and main drive shaft with single engagement steel gear type couplings. The shafts shall be sized and couplings rate for the larger of 1.5 times the motor full load rated torque or the braking forces.
- Main drive shaft with integral pinion gears. The drive shaft and pinion shall be sized for the larger of 1.5 times the motor full load rated torque or the braking forces. The shaft and pinion shall be fabricated from a single steel forging. Pinion gear teeth shall have a 20 degree involute full-depth tooth profile, minimum AGMA gear quality number of 10, tip relief on each side of every tooth, a Brinell hardness value that is 40 to 80 points higher than the hardness of the rack teeth, and face width that is 0.5 inches wider than the rack.
- Rack gears shall be fabricated from a single steel forging with a Brinell hardness value that is 40 to 80 points lower than the hardness of the pinion teeth. The rack gears may be integral with a weldment. Stress relieve the weldment after fabrication and machine the gear teeth and flange after stress relieving. The rack gear teeth shall have 20 degree involute full-depth profile and minimum gear quality number of 10. Tip relieve each side of every tooth.
- The main drive shaft shall be supported on a pair of spherical roller bearings including one bearing with a custom housing assembly mounted in the web of the main girders (fixed axial restraint) and the other bearing with a standard split pillow block (float with no axial restraint). Bearings shall include double-lip oil seals, and shall be rated for

maximum static and dynamic loads based on the larger of 1.5 times the motor full-load rated torque or maximum braking torque and shall include magnified loads from overhung pinion.

- Span drive machinery shall be supported on steel weldments connected directly to the bascule leaf machinery platform steel framing. Access platform plates shall be omitted from the connection of the machinery weldments to the steel framing. Provide a single steel support weldment for the motors, motor brakes, and primary speed reducer; pair of support weldments for the secondary speed reducers and machinery brakes; and pair of support weldments for the main drive shaft support bearings. Weldments shall be hot-dip galvanized and stress relieved after fabrication and the top and bottom surfaces machined flat and parallel to within 0.010 inches. Machinery shall be bolted to the weldments with high-strength turned bolts. Weldments shall be bolted to the steel framing with mechanically galvanized high-strength bolts.

The rack and pinion gear teeth shall be aligned such that the 75 percent of the teeth have a minimum of 80 percent tooth contact across the width of the teeth and no less than 50 percent tooth contact on the remaining 25 percent, as measured using “bluing” (i.e. Dykem layout fluid). The rack gears shall be parallel to the flat tracks to within 0.020 inches. The backlash between mating teeth shall be within the tolerances specified by AGMA for the tooth size.

Reference to Specifications …

Machinery access platform shall have level surface with no steps. The access ladder and hatch and openings in the front of the counterweight to the adjustment pockets shall be located between the secondary speed reducer and main drive shaft support bearing. Provide a minimum clearance of 2.5 feet between the machinery components and deep floorbeam at the front of the machinery platform and minimum clearance of 1 feet between machinery components and front of counterweight. Access to the machinery platform shall be by way of a steel vertical ladder from the bascule pier front diaphragm, through an aluminum access hatch in the machinery platform. The vertical ladder shall meet OSHA worker safety requirements. The access hatches shall consist of heavy-duty single-leaf access door with the following features:

- Doors fabricated from 0.25-inch thick stiffened mill-finish aluminum plate with diamond tread surface, slotted for vertical ladder rails, and hinged on side away from channel,
- Extruded mill-finish aluminum perimeter support frames,
- Door and frame designed for 300 pounds per square foot live load,
- Stainless steel (Type 316) hardware including hinges, hinge pins, slam lock latch, fixed interior handle, recessed turn-lift handle, and fasteners,
- Engineered lift assistance with compression spring actuators enclosed in telescopic tubes,
- Automatic hold-open arm with release handle to automatically secure the door in the open position,
- Mill finish.

Electrical Power and Controls:

This section is under development.