TECHNICAL SPECIAL PROVISION

FOR

MOVABLE BRIDGE CONSTRUCTION

LOXAHATCHEE RIVER BRIDGE REHABILITATION
NS 282.58

The official record of this Technical Special Provision has been electronically signed and sealed using a Digital Signature as required by Rule 61G 15-23.004, F.A.C. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

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SECTION T465 - MOVABLE BRIDGES

T465-1. GENERAL

T465-1.1. Description

Execute movable bridge work in accordance with the Contract Documents.

T465-1.2. Standards

Portions or all of certain recognized industry or association standards or specifications referred to as a requirement in these Technical Special Provisions are to be considered as binding as though reproduced in full unless supplemented and modified by more stringent requirements of the Contract Documents. Unless otherwise stated the reference standard or specification, which is current at the time the Contract Documents are sent out for solicitation, will apply. The following abbreviations will be used throughout the Contract Documents to designate standard specifications for material and workmanship:

American Gas Association	AGA
American Refrigeration Institute	ARI
Anti-Friction Bearings Manufacturers Association	AFBMA
National Electrical Contractors Association	NECA

T465-1.3. Supervisory Personnel Qualifications

Meet the requirements of the FDOT Specification 105.

Bridge Operator(s) and Foreman:

A. Provide a qualified bridge operator for operation, testing, and adjusting of the bridge from the first chargeable workday through final acceptance.

B. Provide a foreman, who is qualified to operate the bridge, to supervise its operation, and to make any minor adjustments that may be required to the electrical or mechanical equipment.

T465-1.4. Field Measurements and Surveys

Conduct field surveys to verify existing dimensions shown on the plans, prior to development of submittals. Identify field verified dimensions on submittals. Conduct field measurements and surveys as required to supplement information provided in the plans and as necessary to provide a complete and satisfactory fitting and operational installation.

T465-1.5. Products

Provide materials and equipment meeting the requirements of this TSP. Where particular are called for, provide said products unless otherwise approved by the Engineer.

T465-1.6. Bridge Operator, Preventive Maintenance, and Routine Repair

Assume responsibility for the operation and all maintenance on the movable bridge as directed by the Engineer.

For Maintenance Requirements refer to the established Maintenance Procedures.

T465-1.7. Coordination

Coordinate installation and testing of the bridge drive and control systems.

Coordination of Shop Drawings: Provide Shop Drawings meeting the requirements of FDOT Specification 5.

T465-1.8. Quality Control

Perform all work under this Technical Special Provision in accordance with an approved Quality Control Plan meeting the requirements of FDOT Specification 105.

T465-1.9. Equipment Start-Up

Verify that utilities, connections, and controls are complete and equipment is in operable condition.

Observe start-up and adjustment. Record date and time of start-up, and results.

Observe equipment demonstrations to the Engineer. Record times and additional information required for operation and maintenance manuals.

Provide the services of a factory authorized start-up representative at the time of energizing and for the Functional Checkout as required in this Technical Special Provision.

T465-1.10. Inspection and Acceptance of Equipment

Prior to inspection, verify that equipment is tested, operational, clean, and ready for operation.

Assist Engineer with review. Prepare list of items to be completed and corrected.

T465-1.11. Submittals

T465-1.11.1. General

Shop Drawings:

1. Refer to FDOT Specification 5.

2. Before preparation of shop drawings for new components that must mate with the existing structure, obtain all necessary field dimensions to provide proper fit of the new components. Where new components are to be attached to the existing structure where existing fasteners exist, take care that any fastener holes in the new components will mate with the bolts/holes in the existing material.

3. Mark standard drawings showing more than one model or size, to indicate the model or size proposed.

4. Submit shop drawings of cabinets containing electrical equipment and include outside dimensions, areas for conduit penetrations, one-line and three-line diagrams, wiring diagrams, schematic and interconnection diagrams, terminal block arrangements and numbers (if such terminal blocks are intended for connection in the field) and operating instructions.

5. Provide layout drawings and geographic diagrams for the complete electrical and hydraulic systems.

6. Submit shop drawings when installation and mounting details of switches, fixtures, and devices are different from or not specifically detailed on the Plans.

Samples: Refer to FDOT Specification 6.

T465-1.11.2 Product Data

Submit products meeting the requirements of FDOT Specification 5-1.4.4.

T465-1.11.3 As-Built Drawings

As a condition precedent to final acceptance under FDOT Specification 5-11, submit for review and approval by the Engineer, complete as-built drawings meeting the requirements of FDOT Specification 5-1.4.4. In addition provide an electronic copy of all documents in a format acceptable to the Engineer.

Draft as built drawings from the marked up working drawings. Provide the working drawings for checking purposes.

Ensure that as-built drawings are essentially the same as the working plans and shop drawings submitted for approval but showing all the changes made during construction.

T465-1.11.4. Operations and Maintenance Manuals

Operations and maintenance manuals will be comprised of a compilation of the manufacturers' catalog data, installation, and maintenance instructions.

Provide an electronic copy of all documents in a format acceptable to the Engineer.

As a condition precedent to final acceptance under FDOT Specification 5-11, submit for review and approval by the Engineer, complete as-built drawings as well as operations and maintenance instructions meeting the requirements of FDOT Specification 5-1.4.4. Initially submit outlines of the booklets. Provide final, complete copies prior to Phase C of Functional Testing.

First Booklet: Include the following items in the first booklet:

1. Table of Contents.

2. Operator's Instructions, covering in full the step-by-step sequence of operation of the bridge and its auxiliaries, and noting all precautions required for correct operation. Include complete instructions for the following:

a. Selection of the power supply (commercial or stand-by).

b. Normal operation of the bascule leaf drive electric motors on commercial power source.

c. Auxiliary operation of bascule leafs with either bascule leaf drive motor energized by the stand-by generator. Include in this description the method of transfer to stand-by operation, the arrangement of the machinery, and the necessary controls.

d. Emergency Operation of bascule leafs by use of the emergency procedures. Include in this description the method of transfer, the arrangement of the machinery, the necessary controls, and a step-by-step sequence of operation under the conditions of a functioning Programmable Logic Controller and a nonfunctioning Programmable Logic Controller.

3. Detailed maintenance instructions for adjusting, calibrating and operating all of the electrical and instrumentation equipment, including the manufacturer's recommended preventative maintenance lubrication schedule.

4. A set of descriptive leaflets, bulletins, and drawings covering all items of equipment and apparatus made a part of the completed bridge operation and control, the service lighting system, the heating system, the instrumentation system, the lightning protection system, and the grounding system.

5. The catalog number of each piece and, where applicable, a complete parts list, to be used in case it becomes necessary to order replacement parts from the manufacturer. Furnish this information for all equipment such as motors, switches, circuit breakers, relays, controllers, cables, hydraulic system, etc.

6. Copies of all warranties on equipment supplied to the project.

Second Booklet: Include, in the second booklet, legible reduced size photocopies of the following drawings, corrected to show the work as constructed:

1. The complete spare parts list.

2. All schematic wiring diagrams and mechanical schematic diagrams.

3. The control console and control panel layouts and wiring diagrams for all equipment.

4. The schedule of electrical and mechanical apparatus.

5. The complete speed-torque-current curves for main drive motors (i.e., factory test data).

6. All conduit and piping layout and installation drawings.

7. All approved electrical and mechanical shop drawings.

8. Lubrication Charts:

a. Provide lubrication charts.

b. Note: In addition to providing lubricating charts in the instruction books, mount full size wall charts as follows:

Mount copies of the first chart in the pier area near each piece of main drive machinery.

Mount a copy of the second chart in the Control House.

Provide mounted charts of at least 22 by 36 inch in size, mounted in a permanent frame behind transparent plastic. Furnish 2 full size permanent type reproducibles of these charts for replacement purposes.

T465-1.12. Training

Provide classroom and on-site training for operations and maintenance personnel. Provide a DVD of all classroom training sessions.

T465-1.12.1. Maintenance Training

Provide a minimum of 24 hours classroom and on-site training for 10 persons. Distribution of time may be divided as required but with a minimum of 8 hours on-site.

Coordinate the location and time of the training with the Department.

Include the following topics:

A. Lubrication.

B. Preventive maintenance for all machinery including drive system, locking devices and barriers.

C. Electrical equipment.
D. Adjusting of control system parameters.
E. Emergency generator operation.
F. Control system troubleshooting.

Perform maintenance training prior to the end of the Operational Testing period.

T465-1.12.2. Operations Training

Provide a minimum of 8 hours on-site training for 10 persons.

Include the following in training:

A. Operation of bridge under all conditions.
B. Interlock functions.
C. Bypass functions.
D. Emergency stops.
E. Manual gate and locking device operation.
F. Emergency generators and manual transfer switch operations.
G. Interpretation of trouble alarms.
H. Operation under different operating and redundancy modes.

Perform operations training within the first 10 working days of the Operational Testing period, following Functional Acceptance.

T465-2. BASCULE LEAF ERECTION AND ALIGNMENT REQUIREMENTS

T465-2.1. Description

Develop and implement procedures necessary to obtain satisfactory alignment. Develop and implement necessary temporary supports, tie-backs, falsework, shoring, jacking, etc., and procedures to safely erect the Bascule Leaf.

Review and approval of alignment procedures and temporary supports, tie-backs, falsework, shoring, and/or jacking systems is for compliance with the minimum requirements of the Contract Documents and is not a relief of responsibility for the satisfactory alignment and safe erection of the Bascule Span.

Perform shop fabrication of structural steel for the Bascule Leaf in accordance with the provisions stated herein, the Plans, approved Shop Drawings, Section 460 of the Specifications, and AASHTO/ANSI/AWS Bridge Welding Code D1.5.

Ensure the fabrication and shop assembly of the Bascule Leaf is performed by a shop certified under the AISC Quality Certification program as meeting the requirements of Category IIIF or Cbr (Major Bridge).

T465-2.1.1. Submittals for Field Assembly Shop Drawings, Erection, and Alignment Records

A. For installation and alignment procedures of structural steel components, have Supervisory Erector review and initial all procedure submittals.

B. For installation and alignment procedures of machinery components, have Supervisory Millwright review and initial all procedure submittals.

C. Submit as a minimum, the following items:

1. Detailed erection procedures and sequence.
2. Detailed placement sequence for concrete in grid flooring.
3. Submit adjustment procedures for live load shoe assemblies.
4. Temporary tie-downs, live load shoe supports, supports, and jacking devices and their arrangements.
5. Manufacturer’s instructions and procedures for assembly, installation and alignment of end lock receiver assemblies.
6. Detailed sequence for erection of the bascule leaf.
7. Detailed alignment and millwright procedures for all field assembly and erection operations; provide assembly tolerances to be utilized.

8. Detailed shop drawings and installation procedures for the alignment wire holding devices; a mockup device may be utilized in lieu of shop drawings; provide engineering computations for calculation of the catenary deflection of the alignment wire.

9. Detailed measurement and recording procedures including proposed measuring devices for physically establishing datum axes in the field.

10. Provide list identifying all machinery components and assemblies which when delivered to the field must be accompanied with critical dimensions that will affect interfacing with structural components; assemble measurements from Designated Machinery Fabricator and submit as part of the field erection process.

11. Provide description of methods to be employed for establishing millwright information for verification of alignment, fit and tolerance requirements for field assembly and alignment of all machinery components.

12. Scope and schedule of periodic alignment checks.

13. Develop reporting forms for all measurements required by the provisions of this Specification Section and as determined through the submittal process.

T465-2.2. Construction Requirements

T465-2.2.1. Protection

Conduct construction and erection operations and provide protection as necessary to preclude dust and debris to settle upon or enter machinery or electrical components of the bridge.

When temporary supports are not in place preclude live loads from the leaf when the leaf is in the closed position prior to the conclusion of the installation operation of the live load shoe assemblies; failure to preclude live loads from the leaf could result in considerable damage to anchor bolts for the live load shoe assemblies; repair of anchor bolts and pedestal that are damaged by the failure to preclude such loading will be at no cost to All Aboard Florida.

T465-2.2.2. Bascule Leaf Shop Assembly

A. Shop Assembly Dimensional Control Points:

1. Prior to assembly of the bascule leaf, establish control points for use in establishing and maintaining the alignment of the bascule leaf during assembly, consisting of semi-permanent fixed points on the assembly floor and corresponding marks on the structural steel to be aligned, to permit daily verification of the alignment of the bascule leaf during assembly.

2. Provide fixed control points on the assembly floor consisting of clearly marked and labeled targets mounted on a semi-permanent and stable fixture (e.g., clearly labeled punch marks on a steel plate securely bolted to a concrete floor). If intersecting alignment wires are used to establish the control points, provide semi-permanent means to secure and establish the location of the alignment wire to allow for identical re-establishment of the wire in the event that the wire becomes damaged. Provide control points on the structural steel consisting of clearly labeled punch marks or intersecting scribe lines. Provide means of preserving the control points on the Bascule Leaf (e.g., masking), in order that these points will be readily identifiable following cleaning and shop painting of the structural steel. Label each control point with a unique designation.

3. Establish control points, at the following locations on both the floor and the bascule leaf structural steel, using the horizontal (plan) dimensions from the Shop Drawings. (Adjust longitudinal dimensions to account for increased or decreased member lengths while the main girders are supported in their fully cambered profiles):

a. Intersection of the centerlines of each main girder and the trunnion,

b. Intersection of the centerlines of each main girder and the floor beam at the tip end of the bascule leaf,

c. Intersection of the centerlines of each main girder and the counterweight girder at the tail end of the leaf.

4. Establish additional control points on the floor for use in establishing the centerline of the Bascule Leaf. As a minimum, establish the following additional control points at the following locations:

a. Intersection of a line parallel and midway between the main girders and the centerline of the floor beam at the tip end of the leaf,

b. Intersection of a line parallel and midway between the main girders and the trunnion centerline.

c. Establish additional control points along the centerline of the main girder top flanges at the centerline of each of the floor beams for the purpose of verifying the main girder vertical profile during assembly.

5. Accurately locate the floor control points to within 0.060 inch of their plan dimensions. Measure and record the following horizontal distances:

a. Longitudinal distance from trunnion to floor beam at tip of leaf (both main girders),

b. Longitudinal distance from trunnion to back of counterweight at tail of leaf (both main girders),

c. Lateral distance from main girder to main girder at trunnion, floor beam at tip of leaf and between counterweights at tail of leaf,

d. Diagonal distance from trunnion at one main girder to floor beam at tip of leaf of other main girder (both diagonals),

e. Diagonal distance from trunnion at one main girder to counterweight at tail of leaf of other main girder (both diagonals).

f. In addition, measure and record the elevation of each floor control point as a baseline reference.

6. Establish the locations of the control points along the main girders after fabrication of the main girders and with the girders in their fully cambered profile. Establish a longitudinal line along the centerline of each main girder. Accurately locate the control points along the main girder to within 0.060 inch using the web cutting geometry as the control parameters.

7. Prior to assembly, have the locations of the floor and main girder control points independently verified by the Engineer.

8. Following final shop assembly and alignment and prior to disassembly, perform and record as-built measurements of the assembled leaf to an established set of dimensional control points on the top of the bascule leaf structural steel for convenience in reestablishing shop alignment during field erection. Ensure the as-built dimensions include horizontal control dimensions at the same intersecting locations used to establish the shop alignment and the main girder reference elevations. In addition, establish the centerline of the bascule leaf (i.e., the centerline between the main girders on the top flanges of the floor beam at the tip of the leaf and the counterweights at the tail of the leaf. Use the centerline of the bascule leaf to align the bascule leaf to the centerline of the bridge during field erection.

B. Bascule Leaf Shop Assembly and Alignment:

1. Do not assemble the Bascule Leaf until the control points are properly established and verified. During layout and assembly, adjust the positions of the main girders until they are aligned within the specified tolerances. Take measurements of the control dimensions (i.e., distances between the control points) to verify the locations. As a minimum, measure and record control dimensions at the beginning and end of each working day that work is performed on the Bascule Leaf. Measure and verify the alignment by dropping plumb lines from the control points on the structural steel over the control points on the floor.

2. Set the main girders above the assembly floor on falsework to the fully cambered profile. Provide false work of substantial construction to limit the amount of displacement (horizontal and vertical) to less than 0.060 inch during the complete assembly. Adequately secure the false work and main girders to minimize the risk of inadvertent movement during assembly. Do not use unsecured stacks of plate or other material to support or adjust the girder elevation. Support the main girders in their fully cambered profiles. As a minimum, locate the supports near the tip, tail, trunnion, and at a position mid length between the trunnion and tip of each main girder. Locate the supports offset from the control points to permit the use of plumb lines from the main girders to the assembly floor without interference.

3. Adjust the location of the main girders such that the control points on the bottom flanges will be located over the control points on the assembly floor. Drop plumb lines from the control points on the structural steel to verify the location of the main girders with respect to the control layout on the floor. Locate the bascule leaf control points within 0.125 inch (measured horizontally) of the control points on the floor.

4. Adjust the main girder elevations and camber such that the elevations of the main girder top flange control points are within 0.125 inch of their theoretical shop assembly profile elevations.

5. Within the immediate vicinity of the trunnions, set the webs of the main girders plumb and straight to an accuracy that will minimize need for machining of the webs. At all other locations along the length of the main girders set the girders plumb within tolerances defined in Specifications Section 460.

6. Line bore the webs of the main girders to the proper fit and alignment about a common alignment wire with the leaf shop assembled and properly aligned. Machine the faces of the webs to the required flatness and perpendicularity about the same alignment wire. (See Trunnion Assemblies for detailed requirements.)

7. After the main girders, floor beams, and main lateral bracing are assembled and properly aligned, and the trunnion alignment wire set-up and aligned, determine the amount of machine-facing of the web required to accommodate the trunnion assembly. Verify that the location of the stiffeners is within 0.060 inch of the adjusted measured location.

8. Accurately align the tops of the stringers supporting the ties. Locate the tops of the stringers within 0.060 inch of the theoretical grade. Provide shims between the stringer bottom flanges and the floor beam top flanges to allow for adjustment. Align the top of the stringer at the same elevation either side of the splice.

10. Shop install and align all main members and lateral bracing. Maintain alignment of the components with a combination of drift pins and temporary undersize bolts until all holes can be drilled and/or reamed full size. Use a minimum of two drift pins per connection.

C. Shop Assembly of Machinery

1. Rack Assemblies:

a. Complete shop structural steel assembly of the bascule leaf and trunnion assemblies prior to machining girder flanges. Upon completion of trunnion installation, utilize the physically established centerline of the bascule girders and centerline of trunnion in the steel fabricator’s shop for layout of the machining of the rack mounting locations on the main girders. Account for alignment wire catenary sag in all layouts and measurements.

b. Accurately machine the rack mounting locations on the main girders to the specified tolerances. Machine the locations to the finish required in the Plans to achieve precise gear alignment tolerances.

c. Machine finish the main girder mounting locations (at the interface with the rack frame) vertical within plus or minus 0.005 inch.

d. Following girder machining, submit a report of as-built dimensions to the Engineer, measured to the nearest 0.0008 inch.

e. Install the rack assembly to meet the alignment requirements.

f. Take care not to damage the rack, rack frame or machined surface finishes during this process.

g. After the rack assembly is aligned with the bascule girder web and alignment wire, drill-mounting bolt holes. The rack frame is to be used as a template for drilling the bascule girder. The bascule girder web is to be drilled from solid.

h. Notify the Engineer of the rack and rack frame installation procedure.

T465-2.3.3. Conditions for Satisfactory Alignment

A. Alignment of the bascule span will be considered satisfactory when the following conditions are achieved for the completed span:

1. Alignment Condition No. 1 (Trunnions): individual trunnion shaft centerlines for an individual leaf have a common axis of rotation; and the common axis of rotation for each pair of trunnion shafts is parallel to the common axis of rotation for the pair of trunnion shafts of the opposing leaf.

2. Alignment condition No. 3 (Leaf and Piers): Opposing points of leafs and piers when the bridge is in the completed and closed position match vertically, horizontally and angularly.

T465-2.2.4. Trunnion Alignment Tolerances - Erection of Main Girders

A. Established Axis of Rotation:

1. The radial deviation of the Outboard Centerline Bore from the Established Axis of Rotation: 0.010 inch (0.020 inch positional tolerance).

2. The radial deviation of the Inboard Centerline Bore from the Established Axis of Rotation: 0.010 inch (0.020 inch positional tolerance).

B. Trunnion Axis of Rotation: The radial deviation of the Inboard Centerline Bore from the Trunnion Axis of Rotation: 0.010 inch (0.020 inch positional tolerance).

T465-2.2.5. Trunnion Alignment Tolerances - Partial Leaf Assembly

The radial deviation of the Inboard Centerline Bore from the Trunnion Axis of Rotation at the completion of erection and assembly of structural steel framing and prior to removal of temporary Inboard Vertical Supports at the main girder jacking fixture: 0.015 inch (0.030 inch positional tolerance).

T465-2.2.6. Alignment Wire Calibration Procedure

Install alignment wire holding devices per approved shop drawings and installation procedures.

Install alignment wire and Base Weights at each end of wire for initial stressing; the Base Weight is defined as 80% of the calculated weight that is required at each end of the alignment wire in order to fail the wire.

Add one 2.5 pound incremental weight at each Base Weight; continue adding incremental weights in one 2.5 pound increments until failure of the wire occurs; record the weight added at each end of the wire; sum the total of weight at each end of the wire and divide by two; this quotient is defined as the Failure Weight.

For stressing of wire to establish datum axes, utilize Failure Weight less two 2.5 pound weights at each end of the wire; this weight is referenced as the Stressing Weight.

Utilize Stressing Weight for determination of catenary deflection of the alignment wire.

T465-2.2.7. Established Axis of Rotation

Utilizing surveying techniques and alignment wire holding device assemblies, physically establish a tentative Established Axis of Rotation with alignment wire utilizing the stressing weight; establish for each leaf.

Verify that tentative Established Axes of Rotation for each leaf meet the requirements of Alignment Condition No. 1 of these requirements, adjusting as required. Index the milling table once verification is complete.

Axis established at indexing (Established Axis of Rotation) is to be utilized for all future alignment operations.

Establish and fix the established axis of rotation prior to installation of trunnion bearing sub plate assemblies.

T465-2.2.8. General Erection and Alignment Requirements

Continuously monitor and record trunnion and girder alignments and attitude during the sequence of erection.

The erection of the structural steel framing should be done with match-marks established during shop assembly such that the relative position of connected components will be to the assembled configuration established in the shop at the time of complete structure assembly.

Generally, full makeup and tightening of connections is to progress in the same manner as erection of the framing.

Temperature: Closing of span for verification of alignment should be accomplished in the early morning immediately following sunrise to avoid temperature effects.

T465-2.2.9. General Erection Sequence - Leaf in the Closed Position

This general erection sequence series describes those erection and assembly operations which are to occur with the leaf in the closed position; movement of the leaf is accomplished utilizing the main drive system.

Erect temporary live load shoes or supports; utilize temporary shoes or supports at the live load shoes in order to provide support for construction loads; be aware of the importance of the location and elevation of these temporary supports; should the method of support not be carefully considered, subsequent erection operations, in particular the welding of the grid flooring and placement of the concrete in the grid flooring, may result in a twisting of the leaf and possibly a permanent set of that twist and a leaf out of tolerance with the opposing leaf.

Verify leaf balance and bring leaf to the closed position.

Erect balance of structural steel members, including joints and platforms.

Install ties and rails, beginning at the end nearest the trunnion and progressing towards the toe of the leaf; to maintain balance, complete counterweight and install adjusting blocks as appropriate.

Complete tensioning of bolts for stringer connections (closed leaf position).

T465-2.2.10. General Erection Sequence - Completion of Span Erection

Complete erection sequence for each leaf, bring leafs to the fully closed position, make and record alignment measurements.

Complete live load shoe and end lock installations.

T465-3. COUNTERWEIGHTS AND BRIDGE BALANCING

T465-3.1. Description

T465-3.1.1. Terminology

The terms “tie down assembly”, “tie-down device”, “tie down”, “tie-down”, and “hold down assembly” are used interchangeably.

The terms “counterweight adjusting blocks”, “counterweight balancing blocks”, “counterweight blocks”, “adjusting blocks”, and “balance blocks” are used interchangeably.

The terms “balance state” and “balance condition” are used interchangeably.

The terms “steel ballast (counterweight)”, “counterweight steel ballast”, “steel ballast”, “counterweight transition slabs”, and “transition slabs” are used interchangeably.

T465-3.1.2. Requirements for Balance States

Properly balance the bridge for all angles of operation and ensure the Counterweight will adequately clear adjacent pier walls, slabs, railings, beams, columns, machinery, etc. Consider the properly balanced condition for the bascule leaf as follows:

A. Ensure that the bascule leaf is unbalanced toward the channel (tip heavy) by a moment of 108 kip-ft plus or minus 14 kip-ft with the bridge in the lowered (closed) position.

B. Ensure the bascule leaf remains tip heavy during all angles of operation and the unbalanced moment does not exceed 175 kip-ft and is no less than 50 kip-ft.

C. Properly size the Counterweight adjustment pockets to allow for adjustment to accommodate an underrun and overrun of the bascule leaf. Detail final counterweight shop drawings such that the moment back of the trunnion is adjustable, via removable balance blocks located in adjustment pockets in the Counterweight, by an amount equal to 10% under and 10% over the moment forward of the trunnion less the unbalanced moment.

D. Ensure that, upon completion of leaf construction, sufficient pocket space is provided to allow for future balance adjustment by an amount equal to 5% under and 5% over the moment forward of the trunnion using balance blocks of the type shown in the Plans.

E. Center of gravity of the leaf forward of the centerline of rotation (trunnion) of the leaf with an alpha angle between a minus 20 degrees and a minus 40 degrees. The alpha angle is defined as the angle of elevation of the center of gravity of the leaf above (minus being below) the horizontal axis through the centerline rotation of the leaf. Location of the center of gravity within this range will yield a closing imbalance moment for the full rotation of the leaf, with maximum imbalance being near the fully closed position and minimum imbalance at the fully open position of the leaf.

Required Interim Balance State: During the course of construction and for conditions where the leaf is not secured with tie-down devices, the maximum permitted imbalance requirement is indicated in Paragraph A (above). The Engineer may consider an imbalance outside this range acceptable for specific operations. For such operations, submit detailed request along with calculations completed in accordance with Specifications to the Engineer for review and approval.

T465-3.1.3. General Scope of Work

A. General: The work specified in this Section is required for the bascule span; items are not necessarily listed in the order of occurrence.

B. Provide span tie-down devices for the specified conditions and for conditions determined as producing an unstable leaf.

C. Develop and submit counterweight computations and finalized counterweight configuration.

D. Develop and submit Leaf Balancing and Stability Plan.

E. Furnish and install steel ballast per approved counterweight computations and configuration.

F. Furnish and place concrete or cast-iron counterweight adjusting blocks as required for achieving balancing.

G. Achieve and maintain acceptable interim balance states for the bascule leaf throughout the course of the work.

H. Achieve an acceptable final balance state for the bascule leafs upon completion of the work.

I. Furnish and install Span Balancing Test Gage Assemblies.

J. Field survey and document final dimensional configuration of counterweight concrete, steel ballast and adjusting blocks.

T465-3.1.4. Work Restriction and Requirements

A. Meet the requirements of FDOT Specification 7 and 103.

B. Machining of the bore of the main girder trunnion hub housing assembly will not be permitted prior to the completion of counterweight computations and acceptable establishment of the vertical location of the trunnion centerline.

C. Maintain a Balanced Leaf Condition at all times, the exception being those periods where tie-down devices are erected and fully functional.

D. Ensure that a Balanced Leaf Condition is present prior to the removal of tie-down devices.

E. Ensure the main drive system is fully secured and operable at the initiation of the removal of tie-down devices.

F. The use of span locks as a tie-down device or as a supplement to a tie-down device is not permitted.

G. Installation of a steel ballast piece is not permitted until All Aboard Florida has received certified dimensions and shipping weight for that individual piece to be installed in the leaf.

T465-3.1.5. Tie Down Device Requirements

A. Tie-Down Devices: Provide tie-down devices on an individual leaf for an operation where the leaf will become unstable as a result of that operation.

B. Have tie-down devices in place prior to conducting the following operations:

1. Erection of the bascule leaf.
2. Condition where the unbalanced moment exceeds the permissible limits designated under the provisions of this Technical Special Provision; and
3. All other operations which will result in an unstable leaf.

C. Structural Capacity: Provide tie-down devices capable of sustaining the sum of the maximum imbalance moment and a 20 psf wind load in accordance with the AASHTO Standard Specifications for Movable Highway Bridges.

D. Utilize tie-down devices in pairs, one located at each main girder, unless otherwise permitted by the Engineer.

E. Connection of tie-down device elements to the main girder by welding will not be permitted; connection will be by bolting utilizing approved hole patterns.

F. Hold-down brackets detailed in the plans are permanent components of the bridge and are to remain on the bridge; remove all other tie-down devices the pier and leaf at the completion of the work.

G. Fabricate tie-down devices in accordance with the provisions of FDOT Specification 460.

T465-3.1.6. Counterweight Details

The configuration of transition slabs, counterweight concrete, and adjusting blocks depicted in the Plans is intended as a guide to establish the final dimensional configuration of the counterweight.

T465-3.1.7. Coordination

Meet the requirements of FDOT Specification 8.4.

Coordinate the work of this Section to ensure:

A. Proper installation and alignment of live load shoe assemblies.

B. Proper installation and alignment of span lock receivers.

T465-3.1.8. Quality Assurance

Counterweight Computations: Provide signed and sealed counterweight computations and shop drawings.

Computations for Tie-Down Devices: Provide signed and sealed computations and shop drawings.

T465-3.1.9. Shop Drawings

A. As a minimum, submit the following for review and approval: Shop drawings for concrete or cast-iron counterweight adjusting blocks; provide weight of block; product data for coal tar epoxy coating for cast-iron blocks; and shop and erection drawings for steel ballast (transition slabs).

B. Counterweight Computations:

1. Submit detailed counterweight computations and shop drawings for interim leaf configurations and interim balance states.

2. Submit detailed counterweight computations and shop drawings for the final leaf configuration and final balance state.

3. Provide all counterweight shop drawings and counterweight computations signed and sealed by a Professional Engineer registered in the State of Florida.

4. Counterweight computations are to identify as a minimum, the center of gravity of the following component assemblies: Leaf structural steel, leaf machinery, ties, track, miter rails, steel ballast (transition slabs) at each counterweight girder, counterweight concrete at each girder, and counterweight adjusting blocks.

5. The shipping weight (actual weight) of the individual transition slabs is to be determined by the steel manufacturer and utilized to finalize computations.

6. Use weights from approved structural steel and machinery shop drawings for computations.

7. For counterweight computational purposes, verify the unit weight of concrete used in the counterweight from preliminary test blocks.

8. In determining the final production dimensions of the transition slabs, consider production tolerances for the transition slabs.

9. Provide a minimum of the following in adjusting blocks in the leaf (whichever requires the maximum number of adjusting blocks): 1% of the counterweight weight (transition slabs and

counterweight concrete) in adjusting blocks, or 3-1/2% of the span weight in adjusting blocks (span weight includes all leaf components with the exception of the transition slabs and the counterweight concrete).

10. Provide a minimum of the following in additional adjusting blocks for future balancing (whichever requires the maximum number of adjusting blocks): 1/5% of the counterweight weight (transition slabs and counterweight concrete) in adjusting blocks, or 1/2% of the span weight in adjusting blocks (span weight includes all leaf components with the exception of the transition slabs and the counterweight concrete).

11. Shop and erection drawings for placement of counterweight blocks: in addition to conventional drawings, provide isometric showing configuration of blocks to be utilized to achieve an acceptable final balance state.

12. After achieving an acceptable final balance state, submit revised drawings depicting the final as-built configuration of the counterweight concrete, steel ballast and adjusting blocks.

13. At the completion of Balance Verification Testing, submit revised erection drawings documenting the final configuration of adjusting blocks in the counterweight pockets (main girders).

C. Request for Trunnion Centerline Location Approval: After completion of preliminary test blocks and applicable revisions to the counterweight computations, submit formal “Request for Trunnion Centerline Location Approval”.

D. Tie-Down Devices: Submit design computations and shop drawings, design computations and shop drawings to be signed and sealed by a Professional Engineer registered in the State of Florida.

E. Span Balancing (Interim and Final): Submit description of proposed equipment to be utilized, proposed balancing procedures, and proposed reporting forms.

F. Leaf Balancing and Stability Plan:

1. Prepare and submit a Leaf Balancing and Stability Plan for the leaf.

2. Outline proposed leaf stability for the duration of the project.

3. Specifically address each element of the Work associated with the leaf and the machinery of the leaf that will affect the balance and stability of the leaf and the proposed measures that will be taken to ensure balanced and stable leaf conditions throughout the duration of the Work.

4. Specifically address and identify the sequence for placement of counterweight concrete.

5. Submit supporting shop drawings and counterweight computations.

6. Balance State Report:

a. Submit for final balance state after all work on the leaf is complete but prior to Balance Verification Tests.

b. As a minimum, the balance state reports must contain the following: Geometric parameters for equating pressure/torque and imbalance moment, pressure/torque measurements with associated leaf positions, accompanying weather, wind, and temperature measurements, quantification of the location of the center of gravity of the leaf, summary and conclusions, and Signed and Sealed by Professional Engineer registered in the State of Florida.

G. Steel Ballast (Transition Slabs): Provide certified dimensions and shipping weights referenced to piece identification. Submit prior to installation in the leaf.

T465-3.1.10. Balance Calculations

A. Complete weight and center of gravity calculations from approved shop details of the Bascule Leaf and all parts attached thereto. Perform balance calculations for the Bascule Leaf. Compute the balance calculations in two phases: Phase 1 - Preliminary Balance Calculations using computed weights and Phase 2 (Final Balance Calculations) using measured weights for counterweight concrete. Ensure the calculations are prepared, signed and sealed by a Professional Engineer registered in the State of Florida. In order to permit detailed checking, prepare these calculations as detailed below.

B. Compute weights on the basis of the net finished dimensions of the parts as shown in the Shop Drawings deducting for copes, cuts, clips and all open holes, except bolt holes.

C. Base the weight of heads, nuts, single washers, and threaded stick-through of all high tensile strength bolts, both shop and field, on the following unit weights:

Diameter of Bolt (in)	Weight per 100 Bolts (lb)
1/2	17
5/8	31
3/4	52
7/8	78
1	114
1 1/8	154
1 1/4	205

D. Base the weight of fillet welds as follows:

Size of Fillet Weld (in)	Weight (lbs/ft)
1/4	0.11
5/16	0.17
3/8	0.24
7/16	0.65

E. No allowance is required for the weight of paint. Compute the weight of galvanizing as 7.5% of the steel weight of the components to be galvanized.

F. Compute weights of individual components to the nearest 0.1 lb accuracy. Summarize weights of assemblies to the nearest 1.0 lb accuracy. Summarize Bascule Leaf weight to the nearest 0.1 kip accuracy.

G. Locate the Center of Gravity (C.G.) of each component or assembly of components both horizontally and vertically.

1. Reference the C.G.'s longitudinally to the center of rotation:
   a. Positive (+) distances are recorded for elements forward of the trunnion (i.e., toward the channel).
   b. Negative (-) distances are recorded for elements behind the trunnion.
2. Reference the C.G.'s vertically to the center of trunnions:
   a. Positive (+) distances are recorded for elements above the trunnion.
   b. Negative (-) distances are recorded for elements below the trunnion.

Record distances to components or assemblies to the nearest 0.010 foot of accuracy.

H. Use unit weights of rolled shapes per AISC. Use a unit weight of steel of 490 lb/ft^3.

I. Properly account (deduct) for items embedded in the Counterweight concrete (e.g., reinforcing steel, Counterweight bracing, etc.).

J. In computing the vertical distances to the C.G.'s of the components, account for the vertical geometry of the Bascule Leaf (i.e., the roadway vertical curve profile) and the effects of camber and dead load deflection. Compute dimensions based on the deflected shape with the bridge in the lowered (closed) position.

K. Summarize the computations in tabular form with components and/or subassemblies grouped together.

L. Report the weight and C.G. of each component as follows:

1. Weight, W in kips (to the nearest 0.01 kip).
2. Distances from center of trunnions to C.G., X (horizontal) and Y (vertical) in feet (to the nearest 0.010 ft).

3. The component contribution to unbalance torque in kip-ft shown as the products W*X and W*Y (to the nearest 0.1 kip-ft.).

4. Add the component weights and unbalanced torques to produce totals for each Bascule Leaf.

M. Report the weight and C.G. of the sum total of all components for each Bascule Leaf in Department terminology as follows:

1. Weight, W in kips (to the nearest 1.0 kip).

2. Distances from center of trunnions to C.G., X (horizontal), Y (vertical) and L (radial) in feet (to the nearest 0.010 ft).

3. Angle, α, between a horizontal line through the trunnion axis and a line from the trunnion axis through the C.G. of the Bascule Leaf in degrees (accuracy to 0.010 degrees). The angle is measured positive (+) upwards from a horizontal line extending forward (toward the channel) of the trunnion axis.

4. The net Bascule Leaf unbalance torque as the products, W*X, W*Y, and W*L, and the leaf unbalance torque, $T = W*L*\cos(\theta + \alpha)$, shown at ten degree increments of leaf angle, θ.

N. Perform a check of the size of the Counterweight and the Counterweight adjustment pockets as follows:

1. Report the sum total of components (or portion of components) forward of the trunnion in Department terminology (W, X, and $W*X_{forward}$).

2. Report the sum total of components (or portion of components) backward of the trunnion including the Counterweight with the adjustment pockets empty of balance blocks in Department terminology (W, X, and $W*X_{back\ empty}$).

3. Report the sum total of components (or portion of components) backward of the trunnion including the Counterweight with the adjustment pockets full of balance blocks in Department terminology (W, X, and $W*X_{back\ full}$).

4. $W*X_{back\ empty}$ is equal to or less than the product $0.950*(W*X_{forward} - M_{unbalance})$.

5. $W*X_{back\ full}$ is equal to or greater than the product $1.075*(W*X_{forward} - M_{unbalance})$.

6. For the above calculations, $M_{unbalance}$ equals 200 kip*ft.

The above calculations are to verify that the size of the adjustment pockets is adequate to provide the range of adjustment required.

T465-3.2. Materials

T465-3.2.1. Tie-Down Devices

Provide tie-downs for securing leaf when an unstable condition exists.

Tie-Down Concept: Only tie-down concepts which anchor the main girder to the pier will be considered.

Utilize tie down devices in pairs, one located at each main girder, unless otherwise permitted by the Engineer.

Connection of tie-down device elements to the main girder by welding will not be permitted; connection will be by bolting utilizing approved hole patterns.

Hold-down brackets detailed in the plans are permanent components of the bridge and are to remain on the bridge; remove all other tie-down devices the pier and leaf at the completion of the work.

Fabricate tie-down devices in accordance with the provisions of FDOT Specification 460.

T465-3.2.2. Steel Ballast

A. Material: Steel Transition Slabs.

B. Minimum Unit Weight: 490 pcf.

C. Fabrication Tolerances:

1. Length: Plus or minus 1 inch.

2. Width: Plus or minus 1/2 inch.

3. Thickness: Plus or minus 1/8 inch.

4. Flatness: 1/4 inch per square meter.

D. Mill Preparation prior to Shipment: Mark, by die stamping, piece identification on the top surface where lifting lugs are to be attached such that the piece can be identified after placement in the leaf. Lifting lugs may be attached at the mill or at the Site.

E. Dimensions: Plan Dimensions are for conceptual purposes only. Production Dimensions: Per approved counterweight computations and shop drawings.

T465-3.2.3. Counterweight Blocks (Cast Iron)

Cast-iron Blocks:

A. Material: ASTM A48 or equivalent.

B. Unit Weight: Minimum 450 pcf.

C. Protective Coating: Coat Tar Epoxy: Abrasive blast and apply one coat of coal tar epoxy coating minimum 8 mils dry film thickness. Optional: Hot-dipped galvanized in accordance with ASTM A153.

T465-3.3. Construction Requirements

T465-3.3.1. Falsework

Bascule leaf Counterweight girders and bracing are not designed to support the wet weight of the Counterweight concrete. Design and provide adequate falsework and forms to support the weight of the concrete until it has achieved adequate strength to support its own weight. Prepare design of the falsework and forms, signed and sealed by an Engineer registered in the State of Florida, and submit to the Engineer for review.

T465-3.3.2. Concrete Placement

Whenever there is a lapse of time between the placing of successive layers of concrete, insert No. 4 deformed steel reinforcement 12 inch into the fresh concrete for the purpose of tying the next succeeding layer to that just poured. Insert bars not less than 24 inch long spaced at 24 inch on center. In addition, roughen and clean the surface for the next pour and coat with cement mortar immediately before additional concrete is placed thereon.

T465-3.3.3. Notifications

Notify the Engineer a minimum of 28 days prior to the date that is anticipated that the final Balance Testing is going to be performed.

Submit final Balance Report a minimum of 7 days prior to Functional Testing.

T465-3.3.4. Preliminary Test Blocks

A. The purpose of preliminary test blocks is to verify the unit weight assumptions/ requirements utilized in the counterweight computations are achievable, and to provide a basis for final adjustment of the counterweight computations and configuration subsequent to establishing the vertical location of the centerline trunnion and subsequent machining of the bore of the trunnion hub housing assembly.

B. Make a minimum of six test blocks containing not less than one cubic foot each for the concrete mix proposed for the counterweight concrete and the concrete fill in the grid flooring.

C. Cast blocks from a minimum batch volume of 1 cubic yard or the minimum single batch volume at the proposed plant where the concrete is to be batched, whichever is greater; discharge batch into concrete mixer truck and mix as appropriate.

1. Obtain corresponding concrete cylinders for 7 and 28 day cylinder strengths.
2. Determine the weight of all test blocks at one, 2, 3, and 7 days old.
3. Make test blocks in the presence of the Engineer.
4. Submit test block data as a part of the finalized counterweight computations and request for approval of the vertical location of the centerline trunnion.

T465-3.3.5. Final Test Blocks

The purpose of final test blocks is to determine the actual unit weight of the concrete utilized in the bascule leaf flooring and counterweight.

Make a minimum of three test blocks containing not less than one-half cubic foot for each pour of concrete placed on the bascule leaf.

Determine the weight of all test blocks at one, 3, 7 and 28 days old.

Make test blocks in the presence of the Engineer.

Submit test block data as a part of the finalized counterweight computations and request for approval of the vertical location of the centerline trunnion.

T465-3.3.6. Counterweight Adjusting Blocks

Fabricate counterweight adjusting blocks only after approval by the Engineer of the appropriate counterweight computations as specified elsewhere in this Technical Special Provision.

Place and arrange blocks throughout the course of the Work as required for achieving or maintaining acceptable balance states.

T465-3.3.7. Documentation of Final Location of Transition Slab

Prior to concrete encasement of transition slabs, survey and record the actual spatial position of each transition slab piece with respect to an established reference datum, with measurement tolerance plus or minus 1/8 inch.

Compare actual position to position proposed in the counterweight computations; revise counterweight computations and configuration as appropriate; submit for the record.

T465-3.3.8. Span Balancing - General

A. For the initial and final balance states, obtain, as a minimum, torque measurements as follows: At leaf angular positions of every 10 degrees from Fully Closed to Fully Open. For a minimum of three cycles of the leaf; the intent is to obtain three measurements at each angular position, the second and third measurement being made after the leaf is cycled back to the closed position.

B. For interim balance states (maintenance balancing), obtain, as minimum, torque measurements as follows: At leaf angular positions of one, 30 and 60 degrees. For a minimum of two cycles of the leaf, same intent as paragraph A above.

C. Given the numerous variables that may have an effect on the values of the torque measurements, schedule testing generally as follows in order that measurements taken on one day may be better correlated with measurements taken on another day:

1. In the morning at sunrise so as to minimize the differential in ambient temperature.
2. At a time with no wind; if wind exists, preferably the wind should not be in a direction along centerline of the bridge (perpendicular to the bridge deck surface).
3. If hydraulic drive: At a time where the main hydraulic system has remained idle for a period of time and the hydraulic oil is being maintained by the system at its lowest temperature.

D. For each torque measurement, obtain and record the following data: Ambient temperature, weather conditions, wind speed and direction at the roadway surface, and, if hydraulic drive, oil temperature in power unit reservoirs and surface temperature of blind end cylinder piping.

T465-3.3.9. Initial Balance State

Establish the initial balance state of each leaf at the time that tie-downs are disengaged and the leaf is moved for the first time utilizing the main drive system.

If appropriate, revise Leaf Balancing and Stability Plan and submit for the record.

T465-3.3.10. Maintenance Balance During the Course of Construction

Maintain balance in accordance with the Leaf Balancing and Stability Plan.

Maintain the bascule leaf in balance for those periods where the main drive system is operable and tie down devices are not in place.

Verify the condition of balance at time intervals appropriate with the work being performed in order to ensure a Balanced Condition at all times.

For periods where tie down devices are in place, maintain the balance of the leaf(s) as the work progresses based on computational work and in accordance with the Leaf Balancing and Span Stability Plan.

T465-3.3.11. Final Balancing

Complete all work on the leaf, including application of protective coatings, with the exception of the installation of the live load shoe assemblies and the adjustment of the span lock assemblies, prior to initiation of the final balancing program.

Perform the final balancing of the leaf; achieve an acceptable final balance state.

Achieve an acceptable final balance state prior to the Department conducting Balance Verification Tests.

Submit Balance Report and arrangement of adjusting blocks; submit Balance Report a minimum of seven days prior to Functional Testing.

T465-3.3.12. Dynamic Strain Gauge Testing

Dynamic Strain Gauge Testing includes, at minimum, the following items:

A. Description of experimental procedure including type and method of installation of strain gauge rosettes, method of transmission of low level signals, data acquisition equipment and strip chart recorders.

B. Location plan of span drive equipment showing proposed location of strain gauges, amplifiers, cable or radio links, data acquisition equipment and all associated cabling.

C. Details of method of transmission of signals from shafting to data acquisition units.

D. Elementary wiring diagrams of interconnection of strain gauges, amplifiers, data acquisition equipment and strip chart recorders.

E. Description of electrical and mechanical factors including sample calculations for obtaining shaft torque from measured strains, span imbalance and curve fitting and basis for friction correction.

F. Mount adhesive bond foil strain gauge rosettes on the shafts of each rack pinion. Sufficiently clean the areas of the shafts where the gauges are to be mounted to remove all contaminants. Mount two rosettes on each main pinion shaft at 180° from each other. Connect the two gauges such that any direct shear forces in the shafts are neglected and true torsional shear is measured.

G. Connect the gauge leads on each shaft to a four arm amplifier securely mounted to the shaft. Transmit the signals from the shafts to the data acquisition equipment either through cable links wound on spring operated cable reels with sufficient capacity and torque or through wireless transmitters.

H. Connect the output loads from each channel of the amplifiers in each shaft to a strip chart recorder with at least ten inch wide chart paper. Provide the strip chart recorder with an event marker connected to sensors on the pinion shaft such that increments of pinion shaft revolutions are recorded. Interpret each increment as opening angle utilizing the gear ratios of the machinery. Provide a step-wise adjustable chart speed and include a setting of at least 10 inches per minute.

I. Record the strains in both main pinion shafts versus leaf angle simultaneously during opening and closing to a suitable scale. Ensure the readings for all main pinions are at the same strain scale and chart speed and recorded during the same span opening.

J. Numerically convert the strains induced in the rack pinion shafts to torque for at least 10 points at equal intervals along the strain plots for both opening and closing. Process this data to give a curve of torque for the full travel of the leaf versus opening angle, corrected for friction.

K. Submit a full report documenting the results of the strain gauge tests. The reports shall contain as a minimum the following:

1. Description of experimental procedure and equipment used.

2. Span drive diagram showing location at which strain gauges and event markers were attached and all applicable gear ratios.

3. Photocopies of original strip charts for both leaf opening and leaf closing for all rack pinion shafts.

4. Description of relationships and sample calculations for obtaining rack pinion shaft torque from strains, span imbalance moment from pinion shaft torque and curve fitting and basis for friction correction.

5. Fitted curves of torque versus opening angle during opening and closing for each rack pinion shaft.

6. Curve of shaft torque versus opening angle corrected for friction.

7. Discussion of probable error.

Include in the report an introductory section incorporating the name of the bridge, the shafts tested, the date of the test, weather conditions during testing, and any other information requested by the Engineer.

T465-4. MOVABLE BRIDGE FUNCTIONAL CHECKOUT

T465-4.1. General Requirements

Thoroughly checkout and test the movable bridge operation as defined herein, to determine compliance with the requirements for construction, safety, maintenance, and operation of the facility as required in the contract documents. Include in the tests verification of all functions related to leaf operation, maintenance, and safety whether specifically defined herein or required of the contract.

Collect and assemble full documentation of the test requirements and provide in booklet form meeting the requirements of FDOT Specification 5-1.4.4.2.

Detail and submit in shop drawing format, for approval, test procedures for specific tests to be performed and the acceptance criteria for each test. Each procedure will be reviewed before and after testing by the Engineer.

Ensure this testing demonstrates the functionality of the bridge components as well as the complete operation of the constructed facility. Shop test individual systems prior to this procedure as required herein or under individual item specification.

Verify all mechanical, electrical and structural systems integration requirements.

T465-4.2. Material Requirements

Functional Acceptance Test Books: Integrate and assemble information required for Functional Test books meeting the requirements of FDOT Specification 5-1.4.4.2.

T465-4.3. Construction Requirements

T465-4.3.1. General

A. The Functional Acceptance Tests consists of three parts.

1. Preliminary Checkout.
2. Functional Tests
3. Operational Testing Period

B. Engineer Notification: Provide adequate notice (20 working days minimum) prior to all tests so that the Engineer can witness and accept the method and result of the testing. Perform all testing after all required submittals are reviewed and approved by the Engineer.

C. Manufacturer Representatives: Arrange to have at the site, for each test, appropriate representatives of the bridge drive and electrical control equipment. These representatives must be prepared to make adjustments to the equipment, of locating faults or defects and correcting them, and of obtaining from the manufacturers, without delay, new parts or replacements of apparatus which, in the opinion of the Engineer, do not perform satisfactorily.

D. Field Tests: Arrange for and provide all necessary field tests, as indicated herein and as directed by the Engineer, to demonstrate that the entire modified or reworked area is in proper working order and is in accordance with the approved Plans and Special Provisions.

T465-4.3.2. Tests

The Functional Acceptance Tests: Present specific, step by step procedures to demonstrate and provide data for evaluation of each function of the movable bridge. Include for each test quantitative measurements including torque, amperage, watts, pressure, temperature, speed, RPM, and other parameters required by the Engineer to evaluate functionality. Include method of measurement, and their method of recording. Refer to the testing requirements of TSP Sections T468 and T508.

Acceptance Criteria: Present Functional Acceptance criteria that is concise and void of ambiguities. State specific performance of each component or function with regards to the requirements of the design and each unique condition of performance. Include all normal and emergency operating conditions as defined in the Contract documents and design specifications and all maintenance modes of operation.

T465-4.3.3. Preliminary Checkout

A. Prior to scheduling the Functional or Acceptance Test, perform preliminary checks and make adjustments on the new work, such that the system is in general working order. Ensure that all control wiring has been completed and properly labeled. Coordinate this work with the maintenance of traffic plan such that any failure of the system being tested would not interfere with the scheduled use of the bridge.

B. Perform drive system tests during periods in which the span (or leaf) being tested is normally closed (i.e., closed to marine traffic). Provide backup means of lowering the leaf(s) if vehicular traffic is scheduled to use the bridge.

C. Run the bridge continuously in normal mode (not manual mode) for at least five days before performing the Functional Checkout.

D. Record the following during the preliminary checkout (record using time as the base measurement):

1. Chart recorded wattmeter readings for each main drive motor and lock motor during their full cycle of operation.

T465-4.3.4. Functional Tests

Upon approval of the Engineer to proceed, conduct the Functional Acceptance Tests. The tests include the following functional tests and Acceptance Criteria:

T465-4.3.4.1. Control Functions (testing both manual and automatic operations)

A. Bridge Sequence: Demonstrate the correct operation of the bridge as described in these Technical Special Provisions and in the drawings.

B. Demonstrate EMERGENCY STOP of each leaf at or during each phase of opening and closing the bridge (phases include ramping up or down, full speed, and creep speed).

C. Interlocks:

1. Simulate the operation of each limit switch to demonstrate correct operation and interlocking of systems.

2. Demonstrate BYPASS operation for each failure for each required bypass (as listed in Technical Special Provision T508).

3. Simulate each failure for which there is an alarm message to demonstrate correct message displays.

4. Provide comprehensive testing of interlocks to demonstrate that unsafe or out of sequence operations are prevented.

D. Position Indicator: Observe readings with bridge closed and full open to assure correct readings.

E. Navigation Lights:

1. Demonstrate that all lamps are working.

2. Demonstrate the operation of the transfer relays and indicators for each light (not applicable for LED lights).

3. Demonstrate proper change of channel lights from red to green.

F. Span Locks:

1. Operate each span lock through one complete cycle and record, with chart recorder, motor power (watts) throughout the operation, record lockbar-to-guide and lockbar-to-receiver, clearances.

2. Operate each lock with hand crank or manual pump for one complete cycle.

3. Record time of operation, stroke, and maximum operating and relief pressures for each lock bar and power unit.

4. Verify lock bar to guides and receiver clearances and parallelism.

5. Verify that there is no movement of the leaf caused by the operation of the span locks, when the locks are pulled and driven with the bridge fully seated.

6. Demonstrate hydraulic power unit fluid level and containment in all span positions.

H. Bumper Blocks: Demonstrate bumper block contact points relative to leaf position and contact face parallelism. Record clearances between bumper blocks with leaf open to normal full open position.

I. Bridge Machinery (also refer to the testing requirements of TSP Section T468):

1. Demonstrate operation of all lubrication systems.

2. Demonstrate live load shoe contacts and alignment of the bascule leaf rear and center span joints.

3. Operate each leaf through six continuous cycles at full speed. During this inspect the machinery for proper function. Correct any abnormal conditions to the satisfaction of the Engineer, and retest in entirety.

J. Span Brakes Control:

1. During the span raise and lower operations, verify and record the normal automatic set and release operation of the brakes.

2. Demonstrate brake hand release, each brake, one at a time, and monitor the hand release indication through the PLC.

3. With the Span in non-permissive operation mode (span locks driven, drives not energized), manually activate the brake set and release switches and monitor their set/released indication at the control desk.

K. Emergency Power: Have test results from the tests specified in Technical Special Provision T508 available for inspection.

L. Automatic Transfer Switch:

1. Perform automatic transfer by simulating loss of normal power and return to normal power.

2. Monitor and verify correct operation and timing of: normal voltage sensing relays, engine start sequence, time delay upon transfer, alternate voltage sensing relays, automatic transfer operation, interlocks and limit switch function, timing delay and retransfer upon normal power restoration, and engine shut-down feature.

M. Programmable Controller Program:

1. Demonstrate the completed program's capability prior to installation or connection of the system to the bridge. Coordinate the arrangements and scheduling for the demonstration with the Engineer and the Engineer-of-Record.

2. Prepare a detailed field test procedure and provide to the Engineer-of-Record for approval. Provide for testing as listed below:

a. Exercise all remote limit switches to simulate faults (including locks, gates, traffic lights etc.). Ensure proper readouts appear on the alphanumeric display.

b. When the local testing of all individual remote components is completed, check all individual manual override selections for proper operation at the console. When all override selections have checked out satisfactorily, put the system in automatic (PLC) mode and exercise for a full raise and lower cycle. It should operate as diagramed on the plan sheet for the sequence of events.

c. Exercise a PLC sequence of operation interweaving the by-pass functions with the automatic functions for all remote equipment.

d. Remove the power from the input utility lines, at which time, the Automatic Transfer Switch should activate the engine-generator to supply power. Raise and lower the bridge again. Upon completion of test, reapply utility power to the ATS; load should switch over to utility for normal operation.

e. Include, in the testing, verification that all safety features are included in the program and that the program will not accept commands that are contrary to the basic sequence diagram. Include the failure mode testing in the written field test procedure submitted for approval.

N. Submarine Cables:

1. Perform the following tests, using a 1,000 volt megger, on each cable of the installed submarine cable assembly:

a. Insulation Resistance (IR): Measure and record the IR of each conductor to the rest of the conductors and to the cable armor. Measure and record the IR of each conductor to ground.

b. Calculate and record the Polarization Index (PI) for each conductor as discussed in IEEE 62-1995 Revision using the 60 second and 10 minute readings.

2. IR readings of less than 100 MΩ are unacceptable. PI readings of less than 1.0 are unacceptable.

3. If more than 10% of conductors of any cable fail the PI or the IR measurements then the cable is deemed to be defective and has to be replaced.

4. If, at any time during construction, or after the initial testing described above, the submarine cable assembly is damaged, then perform the IR and PI tests again except that the IEEE 62-1995 Revision 30 second and 60 second readings can be used to determine the PI.

T465-4.3.5. Bridge Operational Testing Period

Upon successful completion of the Functional Checkout and the repair of all items that were identified during the functional tests, open the bridge for vehicular and marine traffic, and start a 60 day bridge operational testing period.

Provide all materials and labor to operate and maintain the bridge for the operational testing period.

During this period, open the bridge a minimum of 4 times per day.

During this period, under observation by the Engineer, test all aspects of the movable bridge and its operation.

Repair or replace any mechanical or electrical component of the bridge that becomes inoperative or defective during the 60 day period, at no additional compensation.

If correction of inoperative or defective equipment requires installation of components from a different manufacturer, or reconfiguration of components, the changes will be subject to approval by the Engineer. Additional functional testing of the corrected systems may be required and the 60-day Operational Testing Period may be increased or restarted at the sole discretion of the Engineer. Perform the tests at no additional compensation.

Train railroad personnel in the maintenance and operation of the bridge during the latter 15 days of this 60-day period.