Replacement of Amtrak’s Thames River Movable Bridge

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ABSTRACT

Amtrak is currently replacing the Thames River movable bridge at New London, CT, located on Amtrak’s electrified high speed passenger rail corridor between New York and Boston. This two track bridge carries 36 Amtrak and 2 to 3 freight trains daily. The drawbridge opens over 1600 times per year for passage of US Navy submarines, US Coast Guard craft, commercial, and recreational vessels. The existing heel trunnion bascule drawspan was put into service in 1919 and for the last twenty five years has exhibited increasingly serious operational problems. The drawspan is being replaced with a 188’ span driven vertical lift on the same alignment. Towers reaching a height of 220 feet were constructed on the existing piers on either side of the existing bridge which permitted operation of the bascule draw throughout the construction.

This paper will discuss the unique engineering features of this three year project, and will explore obstacles presented by unanticipated pier settlement (resulting in extensive foundation grouting), pier modifications including drilled piles and post tensioning, fabrication of five million pounds of structural steel, machinery fabrication and installation, erection of lift towers over electrified catenary, lift span truss erection on barge, removal of existing four million pound counterweight, span change out using float out/float in method during four day rail shutdown, and restoration of operations for both rail and marine traffic.
INTRODUCTION

The Thames River Bridge carries Amtrak’s Northeast Corridor at Milepost 124.09 (midway between New York City and Boston) across the Thames River between New London and Groton Connecticut near its confluence with Long Island Sound. Located upriver from the bridge are the United States Navy Submarine Base, the United States Coast Guard Academy, a coal-fired power plant, a chemical manufacturing facility, and various shipyards. Downriver is New London harbor with intermodal shipping piers and the Electric Boat division of General Dynamics submarine assembly and launching facility. Amtrak operates 36 passenger trains across the bridge daily, carrying more than 2 million passengers annually, and the Providence and Worcester Railroad operates 2 freight trains daily. In recent years, the movable span has opened between 1600 to 2000 times annually.

Figure 1 - Location Map
HISTORY

The first railroad bridge across the Thames River at New London was completed in 1889, consisting of a double track swing span, 503 ft in length and the longest such span in the world at that time. Shortly after it was built, the bridge piers began to settle. The settlement of the piers progressed to the point that in 1908 traffic was restricted in weight and reduced to a single track while plans were underway to replace it. Upon completion of the 1919 structure, the 1889 bridge was converted for highway use.

The existing Thames River Bridge was constructed by The New York, New Haven, and Hartford Railroad approximately 150 ft north of the 1889 swing bridge, which involved sequential construction and modification of the swing bridge due to its close proximity. This two track bridge has a total length of 1389 ft and consists of 4 through-truss approach spans; 2 on the west approach of 185 ft (Span A) and 328 ft (Span B), and 2 on the east approach of 327 ft (Span D) and 324 ft (Span E). The Strauss heel trunnion bascule span (Span C) is a through-truss of 188 ft span length and allows for a clear channel of 150 ft. The bascule span’s 4 million pound counterweight rotates about a pair of 2 ft diameter trunnion bearings which are nested between the top chords of Span B. The masonry piers and abutments were constructed to accommodate 4 tracks, but the bridge was never widened beyond the original double track configuration. The substructure was completed in 1918, and the superstructure was completed by The American Bridge Company in 1919.
Over its 89 years of operation, the bridge was upgraded and partially rehabilitated a number of times. In the early 1980’s portions of the bridge were rehabbed under the Northeast Corridor Improvement Project, including replacement of broken counterweight trunnion retainer bolts. These retainer bolts, which are 2 ¼ in. diameter by 56 in. long, hold the counterweight trunnion bearing assemblies together, with 8 bolts per assembly. In 1982, 10 of the 16 retainer bolts in both of the trunnion assemblies were found to be broken. These were replaced, but bolts continued to break during the next several years in spite of various methods of repair, none of which offered any long term remedy.

PLANNING AND DESIGN

In 1996, Amtrak commissioned a study to determine the long term solution to the trunnion bearing problem. This study postulated the consequence of a complete trunnion failure and concluded that there was a significant risk that the bridge could be stuck in a partially opened position which would block the crossing for both rail and marine traffic. Emergency repairs could take months.
This was deemed an intolerable risk. The options investigated to prevent such a failure included replacement of the counterweight trunnions and retain the existing bascule span, replacement of the movable span with a new bascule span, and replacement with a vertical lift span. All options retained the existing substructure and approach spans. Consideration was given to initial cost, life cycle costs, constructability, impact to rail and marine traffic, and the environment.

The vertical lift span option was deemed to be the most feasible. After submittal and review of the Environmental Assessment and discussions with the local governments, the US Coast Guard, the US Navy, and the Connecticut Department of Environmental Protection, Amtrak chose to proceed with design of the new vertical lift span. After requesting and evaluating proposals from several engineering design firms, HNTB was selected to perform the design for the replacement of the bascule span with a new vertical lift span.

Design was done in accordance with AREMA Recommended Practice and Amtrak requirements, and was completed in 1998. The design plans included the following features:

- Suggested construction sequence which included method of temporarily supporting the existing 4 million pound counterweight, removal of the existing bascule span, and installation of new vertical lift span, within a 10 day marine outage and 4 day rail outage.
- Enlarging the 2 existing channel piers to support the lift towers. Utilize existing approach spans, including existing lift span bearing supports for the new lift span.
- Span driven vertical lift through truss span with twin 75 HP AC flux vector drive electric motors, twin 40 HP auxiliary drive motors, and emergency generator.
- 200 ft high lift towers providing 135 ft maximum vertical clearance.
- Four 16 ft diameter tower sheaves with roller bearings; 64 each 2 ¼ in. diameter steel wire counterweight ropes.
Figure 3 - Rendering of New Lift Span

PRECONSTRUCTION

In 1999 Amtrak requested proposals for construction. Bids came in higher than expected and due to Amtrak’s financial situation, the project was placed on hold. The existing bascule bridge continued to cause grave concerns due to loud metallic banging noises emitted from the counterweight trunnions and the increasingly frequent breaking of main and counterweight trunnion retainer bolts during operation.

Renewed efforts to program the bridge replacement were successful in 2003. Amtrak solicited proposals from several construction management firms to perform a constructability review, assist with construction proposals, and help manage the construction. Washington Group International (WGI), which is a Division of URS Corp., was selected in 2004.
WGI performed a constructability review of the contract plans and specifications and forwarded their comments to Amtrak and HNTB for review. Several meetings were held to review comments and determine changes to plans and specifications. Revisions were made by HNTB while the prequalification process took place for prospective construction contractors. Additional input was received by the prospective contractors and some items were the basis for additional revisions to the plans and specifications. The construction contract was developed in accordance with Amtrak requirements and AREMA Recommended Practice. Two additional scope items were added to the construction contract; installation of C&S submarine cables and fender system replacement using material manufactured from recycled plastic, which was designed by Hardesty and Hanover.

Amtrak received technical and financial proposals from five pre-qualified contractors. Among the key issues addressed in the technical proposals were methods for demolition and removal of the existing counterweight, removal of the existing bascule span, fabrication and erection of the structural steel towers and new lift span. Each contractor’s technical and financial proposals were analyzed with greatest weight based on the merits of the technical proposal. Of the five proposals received, that which best addressed both the technical and financial aspects of the project was submitted by Cianbro Corporation, Inc., and they were awarded the Contract with a Notice to Proceed date of November 15, 2005.

\[ P + C^3 = T \]

In March 2006 a partnering session was held with key project team members from Amtrak, HNTB, WGI, and Cianbro to establish project expectations, participant roles and responsibilities, define success, and kick off the effort with Purpose + Commitment, Communication, and Collaboration = Teamwork. Monthly meetings were held throughout the project to discuss design
and construction issues and resolve engineering problems. As the project progressed, and as challenges were faced, P+C^3=T was constantly in practice among the team members.

**MOBILIZATION**

Fortunately there was property available for lease a short distance away from the bridge that had formerly been a steel fabrication facility with direct access to rail and the Thames River. Cianbro began mobilization to this property in January 2006 and a steady flow of equipment and materials commenced.

**DOCUMENT CONTROL AND CONTRACTOR PAYMENT**

The contract specifications contain many requirements for timely submittal of documents. The coordination of submittals and requests for information (RFIs) is critical to successful execution of a complex project. Expedition software was used in the document control process. Cianbro sent all submittals and RFIs to WGI, who handled with the appropriate parties and then provided the answer back to Cianbro. As of June 26, 2008, a total of 445 RFI’s were submitted and responded to. Draft requests for payment were developed by Cianbro in conformance with the approved payment schedule and reviewed with WGI and the Amtrak Project Manager. Finalized requests for payment were received by WGI and forwarded to Amtrak’s Contracting Officer for processing. Change orders and invoices for work performed by WGI were reviewed with the Amtrak Project Manager and forwarded to Amtrak’s Contracting Officer for review and processing.

**SUBSTRUCTURE CONSTRUCTION**

Unconfined in-water work was restricted by the project environmental permit to the period between October 1 and March 31. In January 2006, Cianbro began the excavation of the riverbed required to install the submarine cable necessary to complete the C&S improvements that had been added to the project scope.
Shortly after the Notice to Proceed, Cianbro submitted a value engineering proposal to alter the construction method for the pier extension support. The original specifications called for sheet pile cofferdams driven into a layer of organic silt and muck to elevation -22 from the water surface, with pipe piles spun to bedrock followed by 10 foot deep drilled rock sockets. Cianbro noted that the elevation of the mud line in the substructure extension area would probably conform to the navigable channel depth of -40 rather than -22 and would thus afford less stability at the toe of the sheeting. Combined with the reduced sheet pile toe, the organic sediment layer would likely be insufficient to adequately support the proposed tremie concrete and crushed stone and concrete layer. Instead, Cianbro proposed to use temporary cofferdams and 48 in. diameter steel pipe piles as casing shells around 36 in. diameter steel pipe piles drilled to rock rather than the permanent cofferdams and 36 in. pipe piles driven to rock. This approach eliminated both the crushed stone and tremie concrete; the cost savings for which were applied to the longer required sheet piling.

The pier extension foundation work commenced with the construction of the temporary cofferdams and the pile template, which were completed in March 2006.

Cianbro subcontracted Case Foundations to install the 48 inch diameter casings and 36 inch diameter pipe piles spun to rock and proofed with a 30,000 lb hammer. The casings were installed to elevation - 82 and the piles to elevation – 180. During proofing of the piles, it became evident that Pier 2, which supported the bascule span and counterweight, was settling to the south (downriver). This movement resulted in track misalignment, reaching the point where the span locks at the toe end of the bascule would not engage the receivers. Pile operations were halted with 7 of the 8 pipe piles completed and proofed. Span D, upon which the misaligned span lock receivers and centering device socket were attached, had to be horizontally re-aligned to meet the new position of the bascule span.
Mueser Rutledge Consulting Engineers (MRCE) was retained to study and assess the movement of the piers and provide recommendations for stabilization. As recommended by MRCE, Amtrak directed Cianbro to perform exploratory borings to better determine the subsurface conditions. Clarence Welti and Associates performed the boring work and MRCE installed inclinometers through the substructure caissons to ascertain the cause of the settlement. Based on this investigation, MRCE recommended a program of grouting the sand bed to stabilize the piers. The execution of this additional work was a major impact to the complexity, schedule, and cost of the project. A thorough discussion of this effort is detailed in the AREMA paper titled “Thames River Piers Stabilization” presented by Richard Kolsch, Walter Kaeck, and Frederick Rhyner.

The original design for the extension of Piers 2 and 3 consisted of drilling and epoxy grouting reinforcing dowels and bars and placement of 4000 psi concrete. During review of the conditions of the existing substructure, MRCE raised concerns about the capacity of the existing piers to accommodate the forces and loads that would be applied by the new lift bridge given the original design parameters and the behavior of grouted soils. MRCE recommended modifications to the original design to include a significant increase in the reinforcing steel and adding lateral and longitudinal post tensioning, with a hoop system embedded in the pier extension concrete. Additionally, the concrete strength requirements were increased to 4500 psi. Preparatory work consisted of roughening the surfaces of the existing piers to obtain a surface profile with amplitude of ¼ inch. Cianbro subcontracted Concrete Cutting Services to core drill holes through the existing piers for installation of post tensioning ducts and the new tower anchor bolts. To address interferences between reinforcing steel and the post tensioning components, an HNTB representative was onsite to provide direction. Cianbro installed the reinforcing steel and post
tensioning components, and placed concrete concurrently with the performance of the grouting program.

**FABRICATION AND DELIVERY**

Fabrication commenced in May of 2006 of the tower structural steel by Oregon Iron Works in Oregon and the lift span structural steel by G&G Steel in Alabama. Cianbro secured a number of storage yards adjacent to the bridge site for storage of the structural steel as it was delivered to the site. The new end floorbeams for Spans B and D, the new counterweight boxes, miscellaneous steel for stairs, platforms, and ladders were fabricated by Cianbro Fabrication and Coating Corporation at their facilities in Maryland and Maine. Cianbro faced some challenges in shipping portions of the main tower legs by rail from Oregon to the project site, as the member dimensions exceeded the limitations of a railway tunnel in Lisbon, CT. Cianbro was ultimately successful in procuring an alternate route.

G&G Steel provided the majority of the main machinery components including the sheaves, reducers, line and cross shafts, and operating drums. G&G Steel procured the reducers from Steward Machine. To transport the sheaves via rail, Cianbro fabricated a cradle that was mounted to a lowboy rail car. Each sheave was shipped separately, with a round trip for the lowboy car and cradle taking approximately 5 weeks. The 64 main counterweight ropes and the 8 uphaul and downhaul ropes were fabricated at The Wire Rope Corporation of America in Missouri. Cianbro contracted with Panatrol to fabricate and assemble the bridge operation and control system. WGI handled fabrication inspection.

Cianbro contracted with Kobyluck Concrete to mix and deliver the heavyweight concrete, utilizing heavyweight aggregate from Canada. The approved mix design had a density goal of 235 pounds per cubic foot.
ERECION

During erection of towers and counterweights it was anticipated that a small amount of additional pier movement would continue to occur during the grouting program so Cianbro set the tower anchor bolts in sleeves to allow for horizontal adjustment. Cianbro also placed shim packs and jacking systems under the tower bases to allow for tilt adjustment. Cianbro commenced erection of the tower at Pier 3 on August 2, 2007, while the grouting program continued at Pier 2. Tower erection at Pier 2 commenced on November 7, 2007 utilizing their Manitowoc 4100 ringer crane (with boom lengths varying between 240 and 280 feet) mounted on a barge. Cianbro set up areas to pre-assemble a number of the larger structural components such as sheave hoods, counterweights, lifting girders, and portions of the tower framing, as well as platforms, stairways, and ladder assemblies. Cianbro assembled the lift span on a flexi-float barge positioned along the shoreline adjacent to their staging area utilizing a Manitowoc 4000 crane mounted on a concrete pad.

Figure 4 - Lift Span Erection
As erection of the new tower steel progressed, Cianbro expressed concern over the potential wind loads and eccentric loading from the new counterweights that the piers may experience during construction prior to float in of the new lift span. The existing piers below the new pier extensions are composed of five rows of granite block in the tidal zone between Elevation + 4.75 and – 5.25 and unreinforced concrete with a width of 12 feet between Elevation - 5.25 and – 20.00. WGI contracted with Ocean and Coastal Consultants of Trumbull, CT, to perform an underwater inspection of Pier 3. The inspection found no indications of tensile cracking in the dimension stone or unreinforced concrete. To lower the potential wind loads, Cianbro opted to defer erection of the sheave hoods until after the float in and connection of the lift span to the counterweight ropes. As Cianbro completed assembly of the lift span, their preliminary weight calculations indicated that the lift span weighed significantly more than had
been anticipated. Additionally, the heavyweight concrete was not as dense as anticipated in the mix design. Cianbro placed a significant amount of steel billets in the counterweight to overcome these differences.

The original contract included the replacement of the end floorbeam assemblies at both Spans B and D. Field investigations revealed that other approach span members exhibited significant section loss and warranted replacement. Of concern regarding the repair of existing steel was that most of the work had to be performed during the 96 hour rail outage, subsequent to the removal of existing trackwork, but prior to float in of the new lift span. Cianbro removed all rivets that were accessible and replaced them with temporary high strength bolts to reduce the amount of work required during the outage.

**TRACK ALIGNMENT**

The original intent of the contract was for the contractor to perform the trackwork on the new lift span to best match the alignment of the existing approach spans. However, the movement of Pier 2 necessitated revisions to the plan, with the lift span trackwork becoming fixed, with jacking of spans B and D to the north to match. Span B became misaligned due to Pier 2 settlement, and Span D was intentionally misaligned to line up with the bascule C during the Pier 2 settlement to keep the bascule span operable. Vertical jacking of both Spans B and D was also required to achieve the proper top of rail elevation. Additional vertical adjustments were anticipated in Span B trackwork to compensate for rebound in Span B after removal of the existing counterweight.

**COUNTERWEIGHT REMOVAL**

Although the issue of pier settlement was satisfactorily mitigated with the grouting program, there was some concern that the suggested temporary counterweight support pile methodology depicted in the original contract drawings could aggravate the stability of Pier 2. As an alternative, Cianbro proposed to cut the counterweight in place with diamond wire saws into five sections weighing
approximately 300 tons each and remove them with a 1000 ton capacity fixed boom barge crane, named the Chesapeake 1000, which was the largest crane available on the East Coast. This would be done prior to the rail outage and change out of the movable spans, but required that the bascule span be inoperable for an additional ten days, so an extension of the original ten day channel restriction was submitted to the Coast Guard and approved. The removal of the existing bascule span would also be performed with the Chesapeake 1000. Upon acceptance by the Coast Guard of the revised channel restrictions of twenty days, the four day rail outage schedule was finalized for June 14-17, 2008. Although planned from the project’s beginning, a four day rail outage was unprecedented at Amtrak and it required significant effort to publicize to the traveling public that no Amtrak service would be provided between Boston and New Haven, CT during the bridge change out. Plans were also made to piggyback an Amtrak maintenance blitz between Boston and New Haven to take advantage of the rail outage.

On June 1, 2008, the channel restriction began and bascule span was made inoperable. Cianbro erected a waterproof platform over the catenary to support the wire sawing operation. The wire sawing contractor began saw cutting on June 6 and immediately encountered problems. The counterweight contained an area consisting of heavyweight concrete comprised of steel punchings in a cement matrix. This heavyweight concrete proved not to be a homogenous mass but consisted of concentrations of steel punchings not fully consolidated within the cement. As the wire saw passed through this area, the steel punchings became loose, causing the saw to jam. By June 8, Cianbro abandoned the wire sawcutting operation in favor of hoe ram demolition. The original schedule was abandoned and the scheduled rail outage was postponed.

Now began the fast-tracking of an alternate method to make possible the disconnection of the counterweight from the bascule span so that the old span could be removed and the lift span erected as soon as possible. The change in demolition method required Cianbro to quickly develop
plans for the temporary support of the counterweight on Span B. It was determined that approximately 60 percent of the counterweight could be supported by the existing Span B truss, requiring the removal of 285 cubic yards of concrete and steel weighing about 1.4 million pounds. At first the hoe ram demolition rate was too slow to afford a span change-out much before early July. Given that the navigation channel was now height restricted, impacting commercial marine traffic, US Navy vessels, and recreational craft, a July 4th weekend float-in was out of the question. Cianbro would have to step up their demolition and debris removal methods. Employing a larger hoe ram and devising a chute large enough to convey the extracted material to a barge below, Cianbro doubled the demolition rate. At the same time, Cianbro engineers completed the design and procurement of necessary support beams to affix to the top chord of Span B to support the counterweight remnant and allow the bascule span to be disconnected and removed.

By the morning of June 14, over 25% of the targeted amount of concrete had been removed and the production rate was rising. By June 18, 70% of the targeted concrete had been removed and on that day a meeting was held with the Thames Harbor Safety Working Group to discuss the progress of the job. In attendance were representatives of Amtrak, WGI, and Cianbro to present to the Coast Guard, US Navy, marine users and the public the latest information and to obtain concurrence on a revised marine and rail outage schedule. A new rail outage schedule of June 24-27 was established. Amtrak immediately contacted those rail passengers with reservations affected by the change. Amtrak was able to offer some alternate service during the outage including New York to Boston via Springfield.

By June 19, 90 percent of the targeted concrete had been removed and Cianbro began installing the counterweight support beams on the top chords of Span B. The installation of the temporary supports was completed on June 21. That Saturday evening, using four 430 ton hydraulic jacks, Cianbro began the load transfer of the counterweight from the counterweight link
to the Span B support frame. This process was carried out with meticulous precision, with careful monitoring of the dial indicators to ensure that the anticipated loads were properly removed from the link between the counterweight and the bascule span. Within two hours, the counterweight load had been transferred. On June 22 the counterweight link and upper portions of the counterweight frame were removed in preparation for the start of the four day rail outage on June 24.

Figure 6 - Temporary Support of Existing Counterweight
SPAN CHANGE OUT

The US Coast Guard issued a temporary deviation from the regulations governing operation of the Thames River Bridge, allowing it to remain in the closed position from June 28 through June 30 and to operate on a restricted schedule from July 1 through July 9. Provisions were made within the revised schedule after the removal of the old bascule span and before the installation of the new lift span for navigation windows to allow high priority marine traffic through the channel. On June 23, at 11:25 PM, Amtrak Train #67 was the last train to cross the old bascule bridge. When #67 cleared the block, the four day rail outage began.

The Chesapeake 1000 was mobilized in the channel and after top truss bracing was removed from the bascule span, shackles weighing 600 pounds attached to a 4 part sling were lowered onto the deck level and attached to lifting eyes that had been previously installed into the floor system. As the crane picked up the load of the 1.2 million lb bascule span, the main trunnion bearing cap bolts were removed with a lance, and slowly the span was freed up from its home for the last 89 years. A barge was positioned so that the span could be lowered onto it. By 4:00 PM on June 24th, the channel was cleared for several marine vessels that had been impacted by the delayed outage.
Work on replacement of the end floorbeams on approach Spans B and D commenced immediately after the span was removed. Span B had the end panel stringers replaced as well. Modifications to the support bearings for the new lift span followed. Span D was brought into proper alignment, but Span B could not due to the existing counterweight still in place, so the new centering device for the lift span had to be installed in a temporary alignment on the new end floorbeam of Span B to line up with the new lift span, which was being installed in the correct permanent alignment. Cianbro also installed the Pier 2 tower portal strut and cross bracings, which could not be performed prior to removal of the existing bascule span due to operating interferences.

With the existing bascule span removed, the channel users were provided with a period during which the channel was open and they were able to pass on June 25th. The new lift span was floated from its erection site into the channel after the last marine vessel passed at 5 PM June 25th.
In consideration of the small swing in the tides at the site and to provide vertical adjustment, Cianbro designed and constructed a vertical jacking system with four towers and 1000 ton strand jacks that were used to raise the lift span about 30 ft from the deck of the flexi float barge to clear float in interferences, and then lower the span onto its bearing supports.

![Figure 8 - Float-In of New Lift Span](image)

Cianbro utilized wire rope winches mounted on two spudded crane barges located on both ends of the lift span barge to maneuver the new lift span into position. At 6 PM June 26th, the new lift span landed on its bearings. Work began immediately to install the rail lock assemblies, and connect Track 1, including installation of miter rails, with catenary and signal system work being done by Amtrak forces. Cianbro focused on completion of droop cable connections and alignment of the track on Spans B and D, completion of the remaining tower and approach span.
structural connections, as well as begin hooking up the main counterweight ropes to the new span lifting girders.

At 5:15 AM on June 28th, Track 1 was put into service and a locomotive ran across the new span four times. Amtrak Train #66 was the first train to cross the bridge at 5:59 AM, which began normal weekend rail service.

After initial span balancing by removal of several counterweight balance blocks during a night time rail outage, Cianbro was successful in making several test lifts using the auxiliary drive. The lift span was put into limited operation for scheduled openings using the main drive system on July 1. The bridge operated with no significant problems during the July 4th weekend, and was put into normal operation on July 10th. Additional fine tuning with balance blocks was done prior to the first full lift for 135 ft clearance on July 15th.

Figure 9 - New Lift Span at Elevation 75
POST CHANGE OUT

During the months of July through September 2008, remaining work included further demolition and removal of the old counterweight, realignment of Span B, restoration of Track 2, installation of the sheave hoods at the top of the towers, completion of the fender system, refurbishing the operator’s house, training of Amtrak operators and maintenance personnel, and project closeout.

CONCLUSIONS

The replacement of the Thames River movable bridge proved to be a challenging and complex construction project. By practicing Purpose + Commitment, Communication, and Collaboration = Teamwork (P+C^3=T) the project team overcame many significant issues and obstacles, pulled together, and successfully completed the substantial portion of the project at this writing. Given all the hazards of heavy bridge construction, at elevated heights and on the water, active railroad operation with catenary, active movable span operation, and significant marine traffic, the project had only one reportable injury during the nearly 3 years of construction.
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United States Coast Guard
TABLE OF FIGURES

Figure 1 - Location Map
Figure 2 - Existing Bascule Span (Span C)
Figure 3 - Rendering of New Lift Span
Figure 4 - Lift Span Erection
Figure 5 - Tower Steel Erection
Figure 6 - Temporary Support of Existing Counterweight
Figure 7 - Removal of Bascule Span C
Figure 8 - Float-In of New Lift Span
Figure 9 - New Lift Span at Elevation 75