BEN FRANKLIN BRIDGE PATCO TRACK REHABILITATION PROJECT

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Abstract

The $103 million reconstruction of the Port Authority Transit Corporation (PATCO) commuter rail tracks across the Ben Franklin Bridge is still in progress with most of the disruptive work finished, allowing most trains and automobile commuters to resume normal travel over the bridge. While the majority of the civil track work is complete, the replacement of new traction power, signal and communication equipment along the two tracks will continue until late 2015.

This paper will detail the restoration of the track structure to a State of Good Repair (SOGR) over a four-month period. During two separate continuous track outages in 2014, workers replaced three miles of the 29-year old tracks in their entirety. The track beds run on the north and south sides of the 1926 suspension bridge, providing service for 35,000 daily passengers. Schedules and work windows were established to allow continuous work on one track at a time. The contractor worked 24/7 for four months to replace both tracks, including 9,000 timber ties, six miles of rail, 120 steel beams, 1,000-feet of concrete plinth direct fixation track and lead paint abatement/coating. A specially built temporary platform was installed the length of the bridge allowing access to the underside of the tracks and providing falling object protection over the Delaware River, Interstate 95 expressway, SEPTA rail line and Philadelphia and Camden surface streets/sidewalks.

During the four months, approximately 175 personnel worked daily/nightly with minimal incidents and injuries. Both tracks were returned to full service on October 22, 2014.

History of the Ben Franklin Bridge

The Delaware River Port Authority (DRPA) is a regional transportation agency that serves as steward of four bridges that cross the Delaware River between Pennsylvania and New Jersey. Through the Port Authority Transit Corporation (PATCO), the DRPA also operates a transit line between Camden County, New Jersey and Center City Philadelphia. As stewards of public assets, the DRPA provides for the safe, reliable and efficient operation of transportation services and facilities in a manner that creates value for the public it serves.

The Benjamin Franklin Bridge (BFB), originally named the Delaware River Bridge, was opened to traffic on July 1, 1926. It connects Camden, New Jersey to Philadelphia, Pennsylvania. The bridge carries seven lanes of vehicular traffic, two PATCO transit tracks, and has two walkways for pedestrians and bicyclists. Railroad transit service across the bridge began on June 7, 1936 as an extension to Philadelphia’s Broad Street/Ridge-8th Street Subway. PATCO later began operation on February 15, 1969 on this 14.2 mile commuter transit line with nine stations in southern New Jersey and four in center city Philadelphia. The BFB carries more than 100,000 vehicles a day and the PATCO trains carry 35,000 rail commuters a day.
Figure 1: Ben Franklin Bridge under construction, circa 1925

Bridge and Track Components

The bridge is primarily comprised of two structure types: pier supported steel truss and girder spans within the Camden and Philadelphia approaches, and steel suspension between the Philadelphia and Camden anchorages (spanning the Delaware River). See Figure 2.

Figure 2: Ben Franklin Bridge elevation

The track structures include open deck construction on the approach and suspension spans, and direct fixation (DF) construction within the Philadelphia abutment and Philadelphia and Camden bridge anchorages. The open-deck track structure is supported by steel stringers, which in-turn is carried by cantilevered steel floorbeams. Within the anchorages, the DF track system is built on a concrete deck and is supported by a similar steel floorbeam-stringer system. The Philadelphia abutment DF track section is built on a concrete deck, but is supported by reinforced concrete beams and columns. Although the north track structure (Track No. 2) typically carries westbound trains and the south track (Track No. 1) eastbound trains, both tracks can accommodate bi-directional train traffic, if necessary. Figure 3 below shows typical examples of open deck and DF cross-sections.

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Project Scope of Work

The track rehabilitation project includes the complete replacement of the track structure across the bridge, reconstruction of the Camden Yard (hi-rail vehicle siding) beneath the bridge in Camden, replacement of the railroad electrical systems, including traction power, signal and fiber optic communication and rehabilitation of the bridge’s structural steel system that directly supports the tracks across the bridge. The track rehabilitation encompasses the replacement of 9,000 timber ties, more than six miles of running rails and associated other track material (OTM). Structural steel rehabilitation includes replacement of 450,000 pounds of deteriorated steel members, as well as abrasive blast cleaning and application of the three-coat zinc rich paint system. Electrical improvements include nearly 40 miles of new power, signal and communication cables, as well as new signal cases, transformers, conduit carrying structures, messenger lines, impedance bonds and miscellaneous supporting equipment. The PATCO train cars receive power through a contact rail supplied 750V DC traction power system. Although only intermittent sections of the existing contact rail were replaced with new, all supporting components, including the rail heater system were replaced in their entirety.

Existing Conditions

Since its inception, the track system across the BFB has been replaced several times, with the last track replacement project completed in 1985. By the time the track rehabilitation project began in 2013, the track system had reached the end of its useful life and was in need of replacement. Some examples of the diminishing conditions included deteriorating 29-year old timber ties, worsening track fixation zones and steel stringers that exhibited rust and section loss. The DRPA and PATCO maintain a rigorous maintenance program, and applied interim repairs to the tracks to keep them safe and reliable for service. However, the repairs were not meant to withstand long-term use, and it was inevitable the tracks would eventually need replacement.

Design Challenges

The project included rehabilitation of four existing track types: ballasted (5%), open deck (89%), precast DF (4%) and a hybrid DF system of dapped timbers bolted to precast concrete plinths (2%). To reduce the number of track types, the two DF systems were replaced with a single design. The precast construction of the existing DF track made direct survey of the underlying structural slab impossible. Through careful review of as-built drawings and survey of exposed structural elements, slab elevations were determined with enough confidence to finalize the DF design. With the incorporation of continuous track outages, plinths of a conventional design with bonded DF fasteners were constructed in a top-down manner. The top-down construction of the DF allowed a uniform profile to be built at the transitions.
between track types. Survey and design of the girder and truss supported approach spans preceded in
the usual manner where the steel elevations were surveyed, a track alignment and profile was designed
and timber dapping tables were produced.

On the suspended spans, survey and design of a profile using absolute elevations in a fixed
datum was not practical. The original bridge design arranged the track stringers on a uniform profile
consisting of 3.5% grades connected by a 1750-foot long compound parabolic curve main span. The
approximate rate of change in grade was 0.4% per 100 feet. Throughout each day and each year, the
shape of the bridge and track constantly varies with changes in the live load and temperature. To design
the dapping of the bridge timbers on the suspended span, a relative profile was designed based on a
fixed height above each floorbeam. Measurements from the top of the floorbeams to the top of the
stringers were used to design the timber dapping based on this relative profile. Each of the 9,000 new
timber ties across the bridge required individual custom dapping to accommodate the fluctuating lateral
and vertical position of the stringers relative to the track profile and alignment. The track design
incorporated a combination of “e” clip and ZLR track fasteners to allow the tracks to expand/contract
independently from bridge thermal and live load movements.

Track Occupancy
Track occupancy for the BFB project presented significant challenges. The longest track occupancy work
block is 2.8 miles in length, and extends from the NJ tunnel across the bridge and into the PA tunnel.
Single tracking across the BFB would adversely impact commuters and would also increase risk to the
operations of the system. PATCO has a total of 14 stations over the course of 14.2 miles and on an
average day moves 35,000 passengers. The original planned track occupancy for the project was based
on 90-hour extended weekend outages, which would equate to about 66 hours of productive time on
track. Based on this approach, the project key elements would take more than 14 months to construct.
The project team discussed a continuous 60-day outage on each track as a way to reduce project costs
and minimize disruption to commuters. It had never been done before on the PATCO line that operates
on three minute headways during morning and evening rush hours. In order to determine if this was
feasible, we evaluated maximum train load capacity and fleeting of rush hour service while minimizing
adverse impacts to return trains in and out of Philadelphia. We prepared an RTC train model and
evaluated passenger loadings by stations along the line. The model showed it was possible to run the
service by adding various operating enhancements and risk mitigation measures.

- The infrastructure track that was to remain in service was inspected in detail to provide assurance
  of reliability. Spot repairs were made to strengthen the infrastructure.
- Standby maintainers and track forces were strategically placed to respond rapidly should an
  interruption in train service occur.
- Supervisors were placed at the station platforms to expedite loading and unloading of crowded
  trains safely and efficiently.
- Turn operators were placed in Philadelphia at the final station stop.
- Fleeted directional train service was implemented for the rush hour periods.
- A detailed communication plan and advanced schedule was communicated to the commuters
  and news media.

Ultimately, two single track continuous outages were performed one after the other during the summer of
2014, one 60-day outage for the south track and one 50-day outage for the north track. Both single track
continuous outages were implemented successfully with the collective help and support of many
stakeholders.

Constructability Challenges and Detailed Planning
The project exhibited an array of constructability challenges, such as access to work areas, staged
construction, coordination with adjacent DRPA/PATCO projects, weather sensitive operations, close
proximity to residential and commercial properties, coordination with outside stakeholders and transit
agencies, fluctuating bridge movements and coordination with train operations on the opposite in-service
bridge track.
Access to work areas served as the primary constructability challenge throughout the project. Hi-rail vehicles can get on/off the track at only one location, under the bridge in Camden Yard. Once on the bridge tracks, hi-rail vehicles have no place to pass one another. Although the bridge accommodates seven lanes of traffic, only one outside lane was allowed to be constantly closed during the 110 days of continuous track outages. Workers were unable to pass back and forth between the closed track and the bridge lanes within the Camden and Philadelphia approaches due to the grade separation between the roadway and tracks. Within the suspended spans, the concentration of vertical bridge members allowed only small materials and equipment to pass between the bridge lanes and track work area.

A 20-foot wide temporary platform was erected under the tracks for the entire length of the bridge. The platform allowed workers to safely access the underside of the tracks and served as a protective barrier to catch all material and debris from falling to areas below. This allowed watercraft, railroad, pedestrian and vehicular traffic under the bridge to be unencumbered by track replacement operations.

The 21-E project required close coordination with other DRPA and PATCO projects, such as paving of the bridge approach lanes, electrical upgrades within the PATCO stations, rail grinding within the PA tunnel and maintenance upgrades on adjacent tracks. Additionally, various items of work required coordination and permitting through outside stakeholders, such as City of Philadelphia, City of Camden, Southeastern Pennsylvania Transportation Authority (SEPTA), United States Coast Guard (USCG), Pennsylvania Department of Transportation (PennDOT) and various utility companies.

The Camden and Philadelphia approaches collectively span through ¾ of a mile of residential and commercial properties. Within the Philadelphia approach, several bridge spans are within five-feet of local businesses. Construction noise presented a significant disturbance to the people in close proximity to the bridge. Although track rehabilitation activities were performed 24-hours per day, seven days per week during the two continuous track outages, quieter operations were scheduled during nighttime hours while noisier operations were performed during the day. The noisier operations were controlled to the furthest extent possible. Mobile cranes and abrasive blast cleaning equipment were staged within the bridge lanes away from businesses and residences when permissible, rather than on surface streets or under the bridge. The tracks were deconstructed in the largest pieces possible in an effort to limit the use of loud demolition equipment. Steel bridge rivets were removed with carbon arc torch cutting tools when appropriate in lieu of pneumatic rivet busters.

Public Outreach

The DRPA embarked on an extensive public outreach campaign to inform the traveling public and bridge neighbors of the track rehabilitation project. The Authority organized three “town-hall” meetings in the months prior to the continuous track outages where they explained the project and fielded questions from the public. The Authority performed numerous presentations to Camden and Philadelphia neighborhoods and community groups to inform the bridge neighbors of the construction scope, schedule and impact. During the first few days of each train schedule change, DRPA and PATCO provided additional employees at train stations to assist commuters and answer questions. Six variable message boards were placed at the bridge and at key PATCO stations informing the public of changes to train schedules and bridge lane closures. DRPA mailed construction update flyers to Camden and Philadelphia stakeholders, and hand delivered the flyers to residences and businesses in close proximity to the bridge. DRPA monitored a telephone “hotline” and email account 24-hours/day and promptly responded to questions or comments from the public. The DRPA also maintained a project information website where they updated construction photos on a weekly basis to keep the public informed of progress.

Temporary Maintenance and Protection of Traffic

The BFB spans 30 lanes of roadways, including six lanes of Interstate 95, 16 pedestrian sidewalks, two SEPTA commuter railroad tracks and the Delaware River. Temporary maintenance and protection of traffic (MPT) was constantly coordinated with various transportation agency stakeholders to facilitate work for the project. Rolling slowdowns were coordinated with PennDOT to provide short gaps in traffic along I-95, whereby the temporary underbridge platform could be installed and removed. Similarly, late night weekend track outages were coordinated with SEPTA to allow for the installation and removal of the underbridge platform. The contractor performed daily lane closures across the BFB for nearly two years to support the track rehabilitation work. Multiple surface street lane closure configurations were coordinated.
with the cities of Camden and Philadelphia to provide access to the work. On occasion some surface streets were temporary closed and local traffic was detoured to adjacent streets. MPT for road closures required additional coordination with local businesses, hospitals, Police and emergency response.

Figure 4: Typical lane closure across the Ben Franklin Bridge

River Impacts
The BFB spans 3,200-feet across the Delaware River. The river serves a vital link to Philadelphia and provides transportation for an array of goods and services for the entire region. Although the track rehabilitation project did not reduce the clearance of the bridge over the water, the temporary underbridge platform did reduce the navigable air gap below the bridge for the duration of the project. For this reason, the design of the temporary underbridge platform was coordinated with the USCG, as well as the Philadelphia Regional Port Authority. Although the bridge provides a clearance of approximately 135-feet over the water, the large container ships that serve the Philadelphia ports need every inch of space when navigating under the bridge. For this reason, the temporary platform was specially designed to reduce the clearance over the navigation channel by only 27-inches.

Safety Considerations
The Authority, construction monitor and contractor collectively emphasized a safety first approach to all work activities throughout the project. Job Safety Analysis meetings were held daily to brief workers on the day’s activities, identify hazards and make certain adequate protection measures were employed. A safety boat was staffed in the river at all times when work was performed over water. Train protection was communicated to personnel any time operations took place on or adjacent to active or inactive tracks. A 20-foot wide temporary underbridge platform was erected under each track for the full length of the bridge to provide access, afford fall protection to workers and provide falling object protection the public under the bridge. Proper personal protective equipment was provided and utilized as required. Temporary lighting was provided at night to illuminate work areas. During the height of construction, approximately 175 personnel were working 24-hours per day, seven days per week, at multiple areas across and under the bridge. As a result of the project team’s thorough attention to safety, accidents and incidents were greatly minimized throughout the course of the project.
Environmental Precautions

When the BFB was constructed in 1926, lead based paint was used as a primer on all steel members, including faying surfaces. During the track rehabilitation process, lead paint was abated from steel members within the track envelope, and from the faying surfaces at all steel member replacement locations. The workers built Class 1A containments for all abrasive blast cleaning operations, and utilized recyclable steel grit blasting equipment to collect and separate the lead waste from the blast media. All lead waste was properly contained, collected, transported and disposed in accordance with applicable regulations to prevent any harmful effects on the environment or workers. All paint products complied with VOC regulations, and painting operations were performed in the same containments. The existing creosote timbers were dismantled, collected and properly disposed. The temporary underbridge platform helped prevent construction debris from entering the river or areas below, and ensured all waste was collected for proper disposal.

Construction Staging

Track rehabilitation operations required extensive planning and coordination to make certain each activity did not interrupt predecessor and successor activities. Each stage of work had to be completed efficiently and accurately in order to prevent delays to the schedule. The primary track rehabilitation activities were ordered in the following sequence: track demolition, replacement of deteriorated steel members, abrasive blast cleaning, application of the three-coat paint system, timber tie placement, construction of rails and OTM followed by installation of traction power and signal equipment. All stages moved progressively over the bridge in an east to west direction. Each work disciple required specialized equipment and materials and were expertly coordinated through the limited access points to avoid delays to adjacent activities. Back up equipment was brought to the project to limit delays in the event of equipment malfunction. In the event of poor weather, resources were reallocated to different work shifts and/or to different locations to minimize adverse effects on the schedule.

Figure 5: Construction Staging – installation of new timber ties (foreground), cleaning and painting containment (background)
Key Elements and Methodology during the Continuous Track Outages

Girders/Steel

The contractor used a combination of as-built drawings and field verification survey to confirm the proper dimensions of all new steel members to be replaced on the bridge. Existing rivets were typically removed with pneumatic rivet removal tools or carbon arc torch cutting tools. Prior to the two continuous track outages, workers spent weeks removing existing rivets and replacing them with fully tensioned temporary fasteners. By the time the track outages began, this allowed workers to replace multiple members each day since the temporary fasteners could be removed in seconds rather than taking several minutes for a rivet. Considering the tens of thousands of rivets that were removed for the track rehabilitation process, the cumulative saved time during the two continuous track outages was significant.

Figure 6: Workers installing a new track support stringer beam

Cleaning and Painting

Following the steel member replacement process, workers erected Class 1A containments and abrasive blast cleaned all existing steel surfaces that still retained the original lead based paint. Supporting equipment, such as the recyclable grit machines and air filtration units, were staged within the outer lane of the bridge, which in-turn was continuously closed for the duration of each continuous track outage. Bulkheads were erected within the containments to sectionalize one area from the next. As the abrasive blast cleaning operation moved across the bridge, painting operations followed in the successive sections. The steel was blast cleaned in accordance with SSPC-SP10 Near White Blast Cleaning, and then painted with a three-coat zinc rich epoxy paint system. Once the finish coat of paint was allowed to dry, workers began placement of the new timber ties.
Timbers Ties

New and existing timbers ties were lifted on and off the track area is similar methods. Within the Camden and Philadelphia approach spans, the ties were bundled and hoisted with cranes that were staged in the roadway. Within the suspension spans, the ties could not be hoisted into place due to the close spacing of the bridge suspender ropes. Instead, steel roller conveyors were positioned transversely between the track area and the roadway. Ties were loaded onto the conveyors and rolled into position. Once the ties were in the track area, small excavators operated across the ties while progressively setting new ties in place on the stringers.
Continuous Welded Rail (CWR)

After the timber ties were placed, workers began installation of the running rails. Each new piece of running rail was delivered to the jobsite in 80 foot lengths. The rails were transported to the Camden abutment, at the east end of the bridge, where they were hoisted from the roadway to the track area. A mobile welding unit utilized the flash butt welding process to fuse the 80 foot rails together into 400 foot strings of continuous welded rail (CWR). The 400 foot strings were then dragged up the tracks and placed at the leading edge of the rails. Once enough strings were in place the mobile welding equipment would travel up the bridge and weld the strings together to form the final continuous welded running rails. Prefabricated insulated joint sections were integrated into the CWR through flash butt welding. The prefabricated expansion joint assemblies were incorporated into the tracks through bolted joints in lieu of welding, so they can be easily removed and replaced if required in the future.

Contact Rail Traction Power System

The train cars receive their power through an energized 750V DC contact rail supplied traction power system. During each continuous outage, the contact rail was de-energized for the entire length of the bridge. Since much of the contact rail was to be salvaged and reused, workers kept the rail intact as much as possible. The contact rail was lifted off the existing insulators, moved laterally two or three feet and rested on temporary supports that were secured to the bridge. This allowed the tracks to be replaced in their entirety and the salvaged contact rail to be re-installed at the end of the outage. When it was time to re-install the rail, the rail was lifted back into place and set on new insulators. All new contact rail appurtenances were supplied to supplement the salvaged rail, including new contact rail coverboard, brackets, heater system, expansion joint jumper cables and anchors.

Concrete Direct Fixation Systems

There are three separate concrete DF systems across the BFB, they exist at the Camden anchorage, Philadelphia anchorage and Philadelphia abutment. Within these zones the running rails are not supported by timber ties on steel stringers, instead they are supported by new cast-in-place concrete plinths. At each zone, the existing timber ties were removed and the underlying concrete sounded and repaired. In the ensuing weeks, new reinforced concrete plinths were formed and poured. The running rails were secured to the plinths through an anchored Pandrol plate system.

Figure 9: Forming of new concrete DF zone at Camden anchorage
Dovetailing Multiple Contract Elements Seamlessly

Dovetailing multiple contract elements seamlessly across the BFB was key to meeting the project schedule. Careful planning and workshops were held to identify and prepare a blueprint that would enable maximum productivity of the work crews. Installation of CWR, new bridge timbers, renewal of bridge stringers, concrete plinth work, bridge painting, contact rail rehabilitation, walkway grating and demolition were all sequenced in a manner that allowed individual work crews to work unobstructed by others. The material staging, equipment types and construction methodologies employed were major factors in the contractor’s ability to construct the project seamlessly. All of this work on and off track, including highway traffic lane closures and flagman protection coordination, were challenges that were met with a collaborative one team, one goal approach.

As part of this process, construction inspectors utilized hand held tablets (iPads) to create electronic daily reports that were linked to a centralized data system which enabled plan reviews at the site and real time project reporting. The construction monitor also maintained a proprietary secure website (DashPort) where project stakeholders could electronically exchange project information documents including submittals, RFIs, shop drawings, meeting minutes and various contract documents. The DashPort website site allowed secure, instantaneous exchange of information and provided a record copy of project documents.

![Figure 10: Screenshot of DashPort website homepage](image)

**Final Product**

The BFB project is representative of what agencies can do when they have the right team, right focus, technical knowhow and motivated leadership. Finding a way to balance multiple priorities, safely serve the traveling public and to inspire a one team approach with shared goals have made this unique and complex project a success. It is a legacy project and a blueprint for future projects that will serve the next generation of PATCO riders in the states of New Jersey and Pennsylvania. It is also fitting that in the 21st century, innovation and team work led to the successful rehabilitation of this complex bridge. A bridge that was named after an innovator, “Ben Franklin” so long ago.
Lessons Learned/Summary

The DRPA’s model of stewardship, service and community. Their employees operate, maintain, improve and protect transportation infrastructure for the benefit of the citizens they serve throughout the Greater Philadelphia region. This important stewardship model was carried through on this challenging project by a committed team.

From the initial stages of the project, the team had a clear vision of what success would look like, both for the single-track outages and on the completed project. It was quickly recognized that we needed an outstanding effort from everyone associated. To tackle the inevitable challenges, we encouraged innovation and creativity.

One significant key to success was the establishment of clear lines of communication. Through regular project meetings, the team was able to solve problems and overcome obstacles. Effective communication provided a positive avenue to collaborate without assigning blame. This approach improved all aspects of the project, including safety, scheduling and coordination.

The significant challenges of single–track operation required the “one team” approach. The DRPA, PATCO, HNTB, and Railroad Construction /Iron Bridge Joint Venture established a relationship built on trust and mutual respect, recognizing that each of our roles was critically important to the project’s success. The “one team” approach required valuing different perspectives and opinions, as well as embracing the opportunity to give and receive feedback. Like all major projects, the Track Rehabilitation project encountered problems. When it did, the team kept the dominant energy focused on responding in a positive manner.

Single-tracking across the BFB was a new challenge for the DRPA/PATCO and their customers. Making the schedule work required significant input and flexibility from PATCO Operations, Bridge Operations, and loyal PATCO riders and bridge customers. DRPA/PATCO established public outreach in a variety of ways, including pre-outages and readiness meetings. Even through difficult times during the track outages, the project team remained optimistic, because our dedicated and motivated team was well prepared.

The project approach was successful due to the hard work and commitment of all involved. The PATCO track system across the Benjamin Franklin Bridge was rehabilitated, and this asset will remain safe and reliable for future generation of PATCO riders.
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John Parola is a senior vice president with HNTB Corporation and currently serves as the East Coast Rail Leader with responsibilities for rail projects from Maine to Florida. John has more than 46 years of experience within the rail industry. He has been with HNTB for 13 years serving in various capacities from Market Sector Leader, District Leader, Division Sales Officer and High Speed Rail Campaign Leader. Prior to joining HNTB John held various positions within the rail industry, including Division Engineer for Conrail, Chief Engineer for D&HRR, Executive Director Re-Engineering/Chief Engineer for Canadian Pacific Railroad and Chief Engineer of Track for Amtrak. John currently resides in Pennsylvania.
Ben Franklin Bridge PATCO Track Rehabilitation Project
Overall Map of Project

PATCO System
- 13 stations across 14.2 miles of double track
- 120 train cars
- Subway, surface and elevated tracks
- Electrification: 750V DC third rail
- PATCO operates 24hrs/day, 365 days/year

Ben Franklin Bridge
- Opened: 1926
- Length: 1.8 miles
- Main Span: 1,750 ft.
- Tower Height: 382 ft.
- Clearance over water: 135 ft.
- 7 vehicle lanes
- Moveable barrier
- 2 railroad tracks (PATCO)
- 2 pedestrian walkways
- 100,000 vehicles/day
- 35,000 PATCO riders/day

Project Description
- Construction cost: $103 million
- Contract duration: 27 months
- Continuous track outages: 110 days
- Track replacement: 2.9 miles
- Timber tie replacement: 9,000 ea.
- Concrete DF rehabilitation: 9,000 sq.ft.
- Steel rehabilitation: 450,000 lbs.
- New steel stringers: 120 ea.
- Cleaning/Painting: 2.7 miles
- Replace signal, power and communication systems: 47 miles of new cable and supporting equipment

Key Project Challenges
- Safety and reliability
- Project constructability
- Project staging
- Single track train operations
- Bridge traffic management
- Painting and platforms
- Complexities of the work
- Right team to deliver
- Public outreach
- Customer support

Animation Video
Rendering of track rehabilitation during projected 55-hour weekend outage
Single Track Operations
- Planning and scheduling
- Shift coverage/operating crews
- Fleeted train service plan
- Test schedule live runs
- Reliability of the single track
- Managing public outreach
- Dispatching and supervision

Making it Work
Two significant schedule changes for continuous track outages
- May 30, 2014
  south track closed for 60 days
  26-minute headway between trains
- August 22, 2014
  north track closed for 50 days
  15-minute headway between trains

Public Outreach
- Three public forums
- Four informational sessions at stations
- Multiple community meetings attended by DRPA/PATCO and HNTB
- Social Media staff provided continuous coverage
- Station posters and seat drops
- Palm cards at Ben Franklin Bridge toll plaza
- Project website and 24/7 toll free number

Support for the Customers
- Managers from all PATCO and DRPA groups at station platforms to provide information to riders
- Installed fans in underground stations
- Increased DRPA Police presence at peak-flow stations
- Way & Power and equipment personnel staged at the bridge for rapid response
- Transit services supervisors at all turn locations to expedite movements

Management and Protection of Traffic
- Continuous bridge single lane closures during continuous track outages
- Bridge dual lane closures during off-peak hours
- Various surface street lane closures
- I-95 lane closures and rolling slowdowns
- Multiple stakeholder coordination: US Coast Guard, SEPTA, PennDOT, City of Philadelphia, City of Camden, Bridge Facilities, Police, Fire, Rescue

Existing Conditions
Deteriorated Track Ties (29 years old)
-existing-conditions-
crumbling-concrete,-missing-track-fasteners

deteriorated-lead-paint-within-track-area

deteriorated-power,-signal-&-comm-equipment

track-rehabilitation-during-continuous-outages
- south-track: 60-day outage
- north track: 50-day outage
- order of work
  - track demolition
  - steel repairs
  - paint rehabilitation
  - concrete df rehabilitation
  - track construction
- work performed 24hrs/day, 7 days/week
- multiple disciplines working concurrently at numerous locations
- 175 workers per day

-track-demolition,-rail-removal

removal-of-track-fasteners-and-components
Timber Tie Removal (9,000 ties)

Track and Concrete Demolition at Anchorages

Concrete Repairs at Anchorages & Abutments

Track and Concrete Demolition at PA Abutment

Remove Deteriorated Steel Members (450,000 lb.)

Installation of New Steel Members
Completed Steel Beam Repair (120 each)

Working from the Temporary Under-bridge Platform (2.5 miles / 300,000 sq.ft.)

Containment for Abrasive Blasting and Painting

Equipment Staging for Abrasive Blasting & Painting

Completed 3-Coat Paint System

Concurrent Work Disciplines
Timber Tie Installation (9,000 ea.)
each custom dapped and numbered for specific location

Material Staging Area (Camden, NJ)

Electric Flash Butt Welding
80-ft rails welded together in 400-ft strings

Positioning 400-ft rail strings onto bridge via rollers, strings flash butt welded together in-place

Setting Rail Alignment, Install Non-Metallic Grating between Ties

Track Fastener Installation
36,000 track fasteners (clips)
- zero longitudinal restraint (ZLR)
  ~ 90% of track
  zero pound toe load
- full load clip (‘e’ clips)
  ~ 10% of track
  2,500 pound toe load
- 6 separate expansion/contraction zones per track
Forming Concrete Plinths, Installing Rebar and Rail Anchors at DF Zone

Placing New Concrete for Plinths at Anchorage

Application of Waterproofing Membrane at Anchorage

Typical Track Expansion Joint System provides 15-inches of rail expansion/contraction movement

Completed Track (open deck)

Completed Track (concrete DF area)
Teamwork and Technical Know How

- DRPA/PATCO leading
- One team – one goal
- Design that works (HNTB)
- Advanced planning
- DRPA/PATCO operations support
- Right contractor (Railroad Constr. Co./Iron Bridge JV)
- Right construction monitoring team (HNTB)

Project Summary
The project has been safely constructed on-schedule and under-budget. The rehabilitation of the PATCO railroad system and supporting structure across the bridge will preserve safe and reliable train service for the next generation, and is a testament that project success can happen when teams align themselves on common goals.

Train ride over the bridge on new track

Questions?