Berkley Bridge – General Information

The Berkley Bridge is a vital crossing in the heart of Norfolk, carrying 97,000 vehicles per day, the threshold for operational risk is low, since a failure of the bridge to operate could create major delays for Norfolk motorists.

The Berkley Bridge is actually two separate bridges, one carrying westbound traffic (built in 1952), and the other carrying eastbound traffic (built in 1990). Both bridges are double leaf bascule bridges. Bascule bridges open by rotating a leaf (or leaves) from the normal horizontal position to a point that is typically nearly vertical, providing an open channel of unlimited height for marine traffic. The width of the channel is limited by the length of the leaf. If the channel is narrow, one leaf may be sufficient, in which case the bridge is called a “single-leaf bascule” bridge. For wider channels, two leaves are used, one on each side of the channel, and such bridges are known as “double leaf bascule bridges”. When the leaves are in the lowered position they meet at the center of the channel. Double-leaf bascule bridges employ a locking mechanism that connects the ends of the two leaves when they are in the lowered position. This mechanism keeps the leaves together for vehicular traffic.

There are three basic types of bascule bridges: trunnion, rolling-lift, and heel-trunnion. These types have slight variations in configuration and gear mechanisms. The trunnion bascule is by far the most common of the three, but the Berkley Bridge is a rolling-lift bascule. The accompanying schematic diagram and photographs are included to provide a better understanding of how such structures function.

Schematic Diagram of a Typical Rolling Double Leaf Bascule Bridge

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1Schematic and description from AASHTO
### Risk Tolerance:

The Westbound leaves have undersized motors that have caused bridge opening delays during snow and ice conditions. This has impacted marine traffic. Future incidents could affect Department of Defense ships or vessels carrying Certain Dangerous Cargoes, which require bridge openings “upon demand” per United States Coast Guard regulations.

The control and power conduit system for the Westbound Bridge is in critical condition.

Westbound North Leaf Submarine Room Ceiling – Control and Power Conduit System

### Movable Bridges - Major Projects in 30-Year Plan

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<th>Project Number</th>
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<th>Cost (2018 Dollars)</th>
<th>Reason for Importance/Potential Consequences of Inaction</th>
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| 1              | Full Mechanical and Electrical Rehabilitation    | 1                     | $94M                | • Drive & Machinery Rehabilitation: Drives and machinery are both critical to the function of the structures and in high need of rehabilitation  
|                |                                                  |                       |                     | • Generator Replacement: Required to open and close bridge during (frequent) power outages  
|                |                                                  |                       |                     | • Building and Submarine Cables: Submarine cables are necessary for operation. Building is currently minimally functional  
|                |                                                  |                       |                     | • Structural Repairs to Primary Framing: Corrosion to beams has inhibited their load-carrying ability  
|                |                                                  |                       |                     | • Replace Traffic Gates: Risk that motorists will attempt to drive on structure during opening |
| 2              | Deck Rehabilitation                              | 17                    | $8M                 | • Damage to deck could damage car or truck tires, leading to impact to truss or to other vehicles |
| 3              | Fender Repair and Rehabilitation                 | 21                    | $41M                | • Risk of vessel impact to piers |

Berkley Bridge 30-Year Plan Total in 2018 Dollars $143M
Berkley Bridge: I-264 over Elizabeth River (#3)

Project #1 - Full Mechanical and Electrical Rehabilitation - Start Year 1 in 30-Year Plan

The full mechanical and electrical rehabilitation of the Berkley Bridge is a very high priority project, as certain bridge components are in urgent need of repair or replacement. This project is fully designed and can be readily advertised. It has been awaiting funding for several years. The project addresses five major systems:

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Notes on the primary systems for EB and WB bridges:

The electrical systems typically require the most maintenance and are most vulnerable to failure. They are comprised of three primary subsystems: the electrical power supply system, the control system, and the drive system.

- The power supply systems include both normal and backup power supply. Normal supply is provided by a direct (wired) feed from the power grid. The backup power supply is provided by a backup generator. The generator has had maintenance issues with difficulty obtaining spare parts and will require replacement. The new generators will be placed off of the bridge so that they can be readily accessed and serviced.
- The control systems regulate the operation of the bridge. Both the EB and WB bridges have relay-based control systems. The system on the EB Bridge is 30 years old and in Fair condition. The WB Bridge has both 60 year old and 30 year old elements. The 60 year old system is in critical condition. Control systems become obsolete as they age, and they become difficult to service as parts become increasingly scarce. The control systems are in need of standardization and upgrade.
- Each of the four leaves primary drive system is an antiquated thyristor drive that regulates the AC power supplied to its two drive motors which translates into speed control of the leaf. The thyristor drive systems are obsolete. Each leaf has a primary and emergency drive system. The 30 year-old primary and emergency drive systems on both bridges are in poor condition and require replacement.

The mechanical systems that are used to open and close the bridge are antiquated and in need of immediate upgrade. These include the following elements:

- Primary (normal) dual 25 horsepower motors on each of the WB Bridge (30 years old) leaves and dual 30 horsepower motors on each of the EB bridge (30 years old) leaves. Failure of any one of these elements would require use of the emergency drive motors.
- Emergency 5 horsepower drive motors on WB and EB Bridges (30 years old). Failure of this element would require manual (hand cranking) to open and close the bridge.
- The total leaf cycle time for Eastbound and Westbound bridge openings on all primary drives is ten minutes.
- The total leaf cycle time for one leaf on emergency drive is sixty minutes and requires a minimum of three trained VDOT movable bridge personnel.
Berkley Bridge: I-264 over Elizabeth River (#3)

Project #1 cont. - Full Mechanical and Electrical Rehabilitation – Year 1 in 30-Year Plan

- Brakes. Failure of any brake on the WB span would prohibit the associated leaf from remaining open and could cause impact damage to the span lock. The EB span could remain open in the event of a brake failure due to an “E-stop” backup. Brakes on both EB and WB bridges are 30 years old and in Fair condition. They WB brakes are part of the rehabilitation project but the EB brakes are not.
- Reducers. The 70-year old reducers on the WB structure require replacement. They are specialty parts that can only be provided by a specialty manufacturer, making the lead time for their replacement a major concern.
- Structural repairs to steel beams and other support members are required for the safe operation and functionality of the bridge. The bridge is fracture critical, so the loss of a major structural member could lead to collapse of the movable span.
- Building repairs are urgently needed to protect bridge systems from the elements and for the proper functioning of the bridges

Project #2 – Deck Rehabilitation – Year 17 in 30-Year Plan

Movable bridges employ very light weight bridge decks (driving surfaces) in order to minimize the loading on the machinery and power systems. The bridge decks on the Berkley Bridge are open-grid steel decking, which has a very limited life span. These decks must be scheduled for replacement on a regular basis, as they become vulnerable to cracking and localized failure toward the end of their life spans. Failure of any portion of a steel grid deck could lead to serious safety risks for vehicles and the structures.

Project #3 – Fender Repair and Rehabilitation – Year 21 in 30-Year Plan

A major rehabilitation of the fender system at the Berkley Bridge could be readily justified today. However, due to a prioritization process that recognizes the limitations on resources, this project has been delayed until the 21st year of the program. In each year there is a risk of vessel impact that could damage the structure, but it has been estimated that the existing timber system can be stretched into another 20 years of service through regular repair, until the deterioration caused by the marine environment will force a major repair/rehabilitation project.