James River Bridge Movable Bridge: General Information

The James River Bridge (JRB) Approach Bridge conducts traffic over the James River between Newport News and the town of Bartlett near the southern shore of the James River. The highway is part of a hurricane evacuation route. The bridge serves Newport News Shipbuilding, the Port of Virginia, and the economy of the Hampton Roads region. Unfortunately, there are few alternative routes, as is evident from the 25 mile detour. The current 4.4 mile crossing was built in 1980. It is located in the mouth of the James River, which is a highly aggressive environment due to the salinity of the water.

The movable portion of the James River Bridge is a vertical lift bridge. The span on a vertical lift bridge is lifted up and down just like an elevator. These bridges have a tower on each end, each of which encloses counterweights that offset the weight of the lift span. There are two main types of vertical lift bridges: Span Driven vertical lift bridges and Tower Driven vertical lift bridges. The James River Bridge is a “tower-driven vertical lift bridge”, the operating machinery is located at the tops of each tower, with the lift span and counterweights located on either side of the operating drums. A schematic diagram of a tower driven vertical lift bridge is shown below:

![Schematic Diagram of a Tower-Driven Vertical Lift Bridge](image)

**Schematic Diagram of a Tower-Driven Vertical Lift Bridge**

1. Lift Span Truss
2. Approach Span Truss
3. Pier (Concrete Support)
4. Tower
5. Counterweight Trunnion Bearing (Support)
6. Counterweight Trunnion
7. Counterweight Sheave
8. Counterweight Ropes
9. Main Counterweight
10. Span Guide
11. Upper Span Guide
12. Lower Span Guide
13. Centering Bar and Span Lock Socket
14. Span Lock Actuator and Lockbar (Retracted)
15. Air Buffer

**Maintenance history:**

This bridge has experienced several emergencies that have impacted vehicular traffic and marine traffic to the Port of Richmond. In the summer of 2018, major operational issues impacted river navigation. The advanced age of the drive system made it extremely difficult to obtain additional parts.
Movable Bridges - Major Projects in 30-Year Plan

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Description</th>
<th>Start Year in 30-Year Plan</th>
<th>Cost (2018 Dollars)</th>
<th>Reason for Importance/Potential Consequences of Inaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temporary Drive</td>
<td>1</td>
<td>$2M</td>
<td>• Bridge may fail to operate in either the open or closed position</td>
</tr>
<tr>
<td>2</td>
<td>Mechanical and Electrical Rehabilitation</td>
<td>2</td>
<td>$61M</td>
<td>• Risk that bridge will be unable to open or close. May be stuck in either position</td>
</tr>
<tr>
<td>3</td>
<td>Deck Rehabilitation</td>
<td>18</td>
<td>$12M</td>
<td>• Localized deck failures could damage car or truck tires, leading to impact to truss or to other vehicles</td>
</tr>
<tr>
<td>4</td>
<td>Superstructure Rehabilitation</td>
<td>21</td>
<td>$32M</td>
<td>• Corrosion to beams will have inhibited their load-carrying ability</td>
</tr>
</tbody>
</table>

James River Bridge 30-Year Plan Total in 2018 Dollars $107M

Project #1 – Temporary Drive - Start Year 1 in 30-Year Plan

The existing drive systems are in critical need of replacement. They are obsolete, and the frequent malfunctions have led to emergency repairs that have affected both vehicular and marine traffic.
Project #2 – Mechanical and Electrical Rehabilitation - Start Year 2 in 30-Year Plan

The full mechanical and electrical rehabilitation of the James River Bridge is a high priority project, as certain bridge components are in urgent need of repair or replacement. The project consists of the following:

- Utility and Roadway Lighting Distribution Equipment
- Bridge Electrical Equipment
- Bridge Control System
- Electrical Systems
- Grounding and Bonding Systems
- Lightning Protection System
- Span Drive Machinery
- Span Balance
- Ballast Material
- Buffer Replacement
- Wire Rope Replacement
- Rehabilitate Mechanical Systems
- Remove Asbestos
- Elevator Replacement
- Operations and Maintenance Manuals
- Architectural Upgrades

The electrical systems 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 electrical power supply systems include both main and generator 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 main power supply is 38 years old and in Fair condition. The generator is 6 years old and in excellent condition.

- The control systems regulate the operation of the bridge. The bridge has a relay-based control system that is 38 years old and in Fair 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. Failure of the control system could cause a two-day outage of the bridge. Recently, both the normal and alternate drive system failed at the same time, causing delays for marine traffic.

- The drive systems regulate the power supplied by the AC system so that they can provide the variable voltages required by the DC drive motors. The bridge has a primary and alternate drive system. The 38 year-old primary and alternate drive systems are in both poor condition and require replacement. If both drive systems failed, the repair time could be extensive, as the replacement parts are custom and difficult to procure. While several backup “control cards” have been procured, their functionality is always in doubt until they have been actually tried. This is because these systems have become obsolete. The new drive system will be a “flux vector” drive, which is both more robust and easier to maintain (parts are readily available).
James River Bridge: Route 17 over James River (#5)

Project #2 cont. – Mechanical and Electrical Rehabilitation - Start Year 2 in 30-Year Plan

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

- Primary (normal) 150 horsepower wound rotor motor is 38 years old and in Fair condition. Failure of these elements would require use of the alternate drive system.

- Alternate (emergency) 150 horsepower wound rotor motor is 38 years old and in Fair condition. Failure of these elements would require use of the alternate drive system. If both the primary and alternate motor were to both fail, either the main or alternate could be replaced on an urgent basis with a spare motor that the department currently has in storage.

- Wire ropes consist of 2 1/8 inch diameter, fiber core ropes. The 38-year old ropes are in critical condition and in need of immediate replacement. Failure of one rope would force an emergency analysis to determine if the bridge could be operated safely on a temporary basis. Failure of more than one rope would cause an extensive outage (18 weeks or longer).

Project #3 – Deck Rehabilitation - Start Year 18 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 James River 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 #4 – Superstructure Rehabilitation - Start Year 21 in 30-Year Plan

The proximity of the steel support members to saltwater leads to corrosion, which must be addressed periodically. 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.