CASE STUDY

G&W Electric Enhances Chesapeake Bay Bridge

with an Advanced Self-Healing Power System

Aging electrical cables, switches and distribution infrastructure are prone to multiple failures every year, resulting in traffic disruptions, which back up vehicles for multiple miles. These disruptions are not only financially costly due to lost toll revenues, but also carry substantial reputational and political risks—particularly when the infrastructure is located on a primary traffic artery.

For its Bay Bridge project, MDTA required a reliable system to power the infrastructure. Any fault on the miles of power cables needs to be quickly and automatically isolated and power quickly restored to all the loads. Any loss of power from one of the substations must be automatically identified and power restored to the bridge from the alternate substation while utility crews work to fix the issue. Moreover, the facilities staff needs to be immediately notified when an event occurs and be able to control the switchgear remotely.

The opportunity: Advanced electrical infrastructure solutions for the Chesapeake Bay Bridge

The Chesapeake Bay Bridge is a critical part of an integrated transportation system that serves both the local and national population. The bridge spans 4.3 miles without a single stop sign, traffic light or intersection. Electrical infrastructure on such bridges typically powers traffic control gantries and signage, license plate cameras, suspension span cable dehumidification equipment and other ITS systems and components. On longer bridges like this one, voltage loss management requires higher distribution voltages in the medium-voltage range of 5kV-15kV classes.

The challenge: Maintaining the bridge power infrastructure

The structure of the Chesapeake Bay Bridge is under constant vibration due to traffic flow and wind—meaning that the power infrastructure spanning the bridge is constantly exposed to forces that can be quite destructive over long periods. Additionally, the highly corrosive nature of salt water often results in the premature corrosion of cable lashing materials and equipment.

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Cables are at risk at any point where they can rub against fixed structural components, such as conduit ends or expansion joints, and cable failures are the most common source of service interruptions in bridge electrical systems. When a cable does fail, traditional radial power systems must be de-energized until maintenance personnel can be deployed to locate, repair and re-energize the cables, typically resulting in several hours of outages for each repair. During these repairs, traffic control systems heavily rely on uninterruptible power supplies (UPS).

Traditional radial power distribution systems do not permit de-energizing a section of cable without impacting all downstream loads, as these designs are suitable for single bridges.

So, with the goal of being able to effectively isolate any problematic section of cable, while restoring all possible loads using the two available utility sources and/or the diesel generator, the G&W Electric team had to answer the following questions when considering the right solution for these challenges:

- How do we design a resilient electrical system built to withstand the unique salt water environmental factors?
- How do we design an electrical system capable of restoring service in the event of electrical disturbances, significantly reducing outage times?
- How do we ensure that bridge inspections can be performed safely on a regular basis?

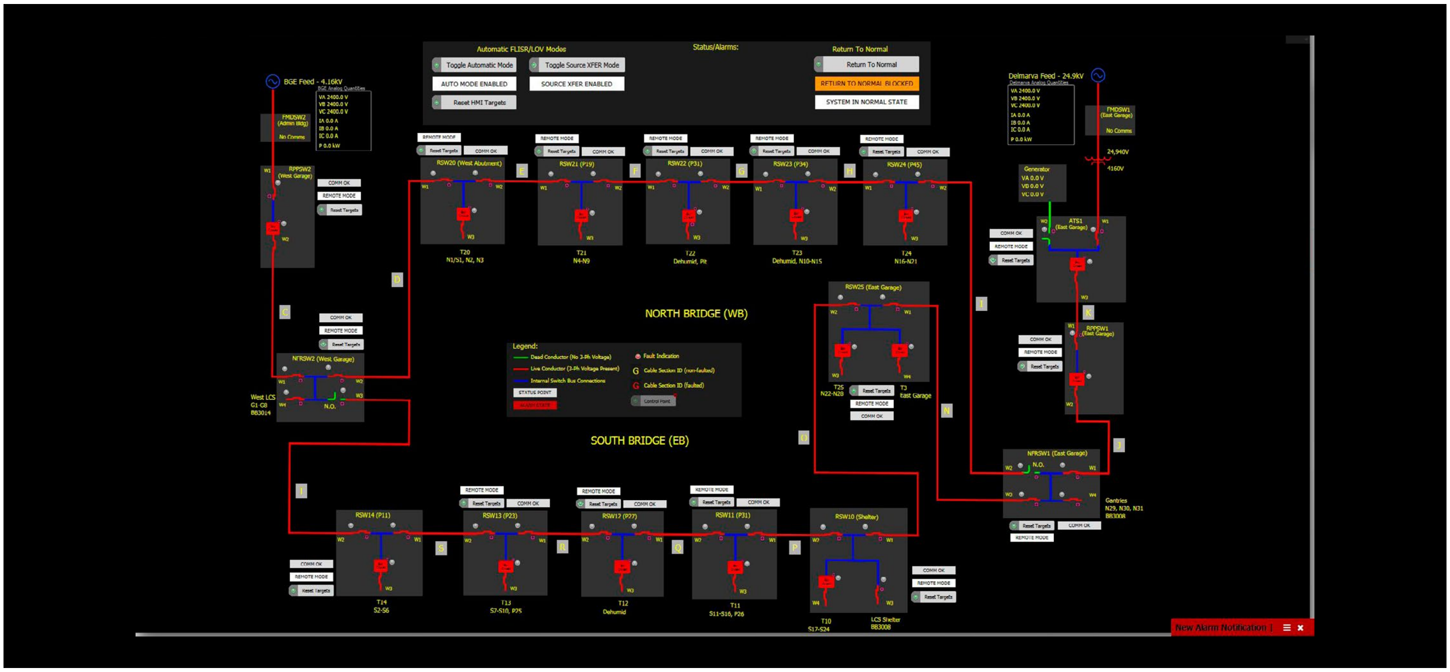
The solution: An advanced self-healing power system solution from G&W Electric

G&W Electric has been installing Fault Location, Isolation and Service Restoration (FLISR) and Loss of Voltage (LOV) systems for over 20 years, and they had the perfect fit for the Chesapeake Bay Bridge. Using FLISR and LOV, G&W Electric custom designed the switchgear and control to be able to identify and locate a fault on the loop; configured the switch relays to send peer-to-peer signals between each other to quickly isolate a fault and restore power; and created central HMI/monitoring screens for them to be alerted of events and control the switchgear remotely.

Moreover, because shutting down the bridge for a long period of time to accommodate commissioning was not an option, G&W Electric tested the entire solution from switchgear, to relays, to the central control with its comprehensive factory acceptance test (FAT) capabilities. With the solution proven and tested in the controlled environment of the factory, the switchgear was installed and G&W Electric was deployed to the site to verify the controls were communicating and that all systems were operational after shipping.

The final distribution system put into place is a self-healing power system with a central monitoring device and control workstation that allows MDTA to:

- Remotely analyze an event using data from the switchgear on the loop
- Remotely control the switchgear for planned outages and maintenance
- Toggle between manual and automatic modes



Fault Location, Isolation, and Service Restoration (FLISR)

How the solution works in the event of a fault:

I. The head-end medium voltage switch (Reverse Power Protection Switch) will trip to interrupt the fault current.

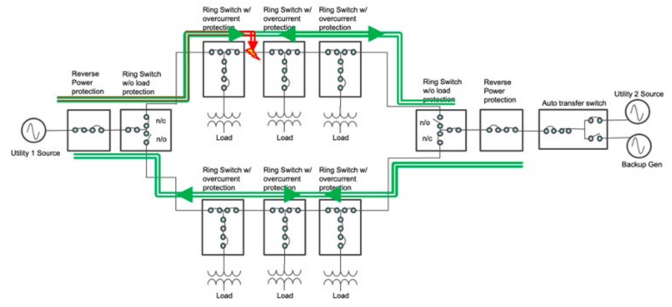
II. Simultaneously, the central controller collects data from the field devices (relays) to properly identify the problematic section of cable using fault indication.

III. Once the problematic section is properly identified, the central control will command the field devices to open switch ways to isolate the faulted cable.

IV. The controller also moves the open point in the system to a pre-defined location to balance the load across the two utility sources, rather than transferring the full load to either utility source.

V. Once the faulted cable is isolated and there is a new open point in the system, the controller will command the head end switch to close back in and restore service to all connected loads.

In the event of a fault on the load connected to any of the medium voltage switches, time-overcurrent coordination will allow the local fault interrupter to trip and clear the fault prior to the head end switch tripping or the central control making any decisions.



Loss of Voltage (LOV)

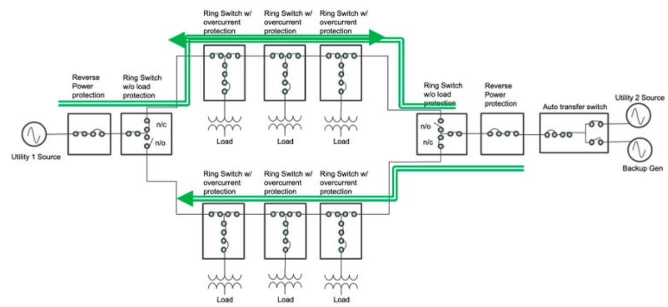
How the solution works in the event of loss of voltage:

I. The central controller will isolate the dead source at the head end switch (Reverse Power Protection Switch).

II. Once the dead source is isolated, the controller will close one of the normally open points in the system to restore service to all effected loads. In the event of a loss of both utility sources, the central controller will isolate both utility sources.

III. Once both sources are isolated, a start signal is sent to the generator control.

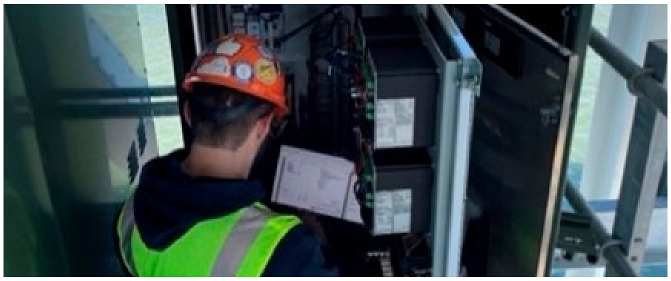
IV. Once healthy voltage is detected at the generator, an Automatic Transfer Switch (ATS) will close into the generator way to restore all loads connected on the loop. The generator is sized to handle the full nominal load of all connected devices.



The results: Enhanced efficiency, safety and long-term insights

The new system can detect and locate faults, isolate the faulted cable and restore service in a manner that will balance the load across two utility sources. It will also transfer the entire load of multiple spans of bridges to one utility when the other experiences a loss of voltage. And, if neither utility is available, the system can start a generator, sized to power the entire load of the bridge.

A remote monitoring and control system provides users the ability to monitor and control all devices, control the automation functionality, and perform a test to automatically transfer all live loads to the generator.



Benefits realized from the new system:

I. **Enhanced automation and control:** Systems are configured to automatically recognize and react to cable faults and loss of voltage events.

II. **Efficient fault isolation:** Automatic fault location and isolation functionality saves time for maintenance personnel, while the resilience of a ring design keeps traffic control systems powered to maintain uninterrupted traffic flow.

III. **Reduced repair time pressure:** The system saves time for maintenance personnel and reduces the urgency for immediate repairs.

IV. **Remote control and isolation:** Maintenance staff can isolate cable segments remotely without disrupting power to traffic control systems.

V. **Increased safety:** Provides a safer environment for bridge inspections and maintenance near medium voltage cables.

VI. **Ongoing insights:** Data collection, analysis and archiving can aid in the development of trend curves and identification of component degradation over time. Monthly dashboards can also be developed

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