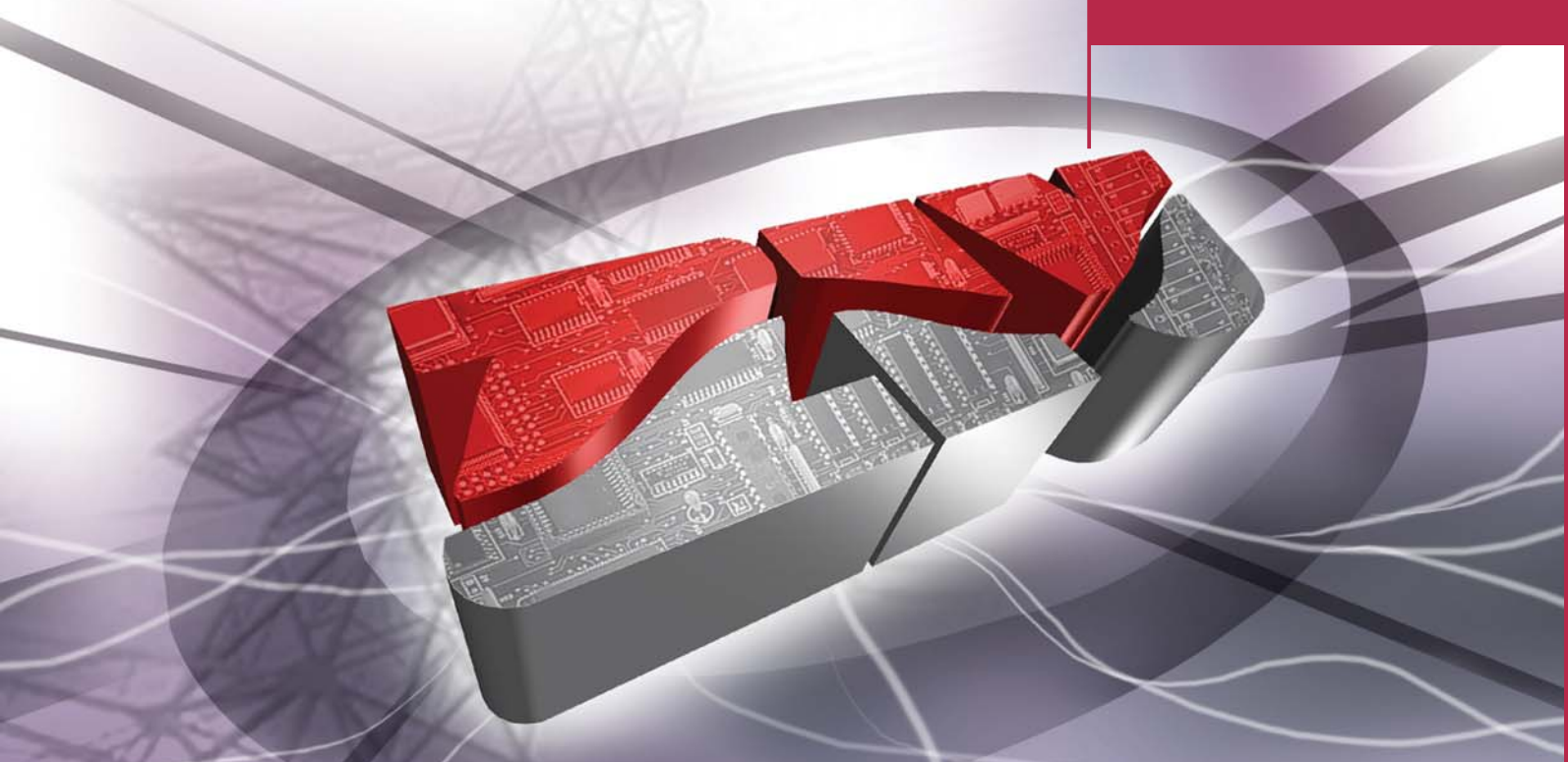
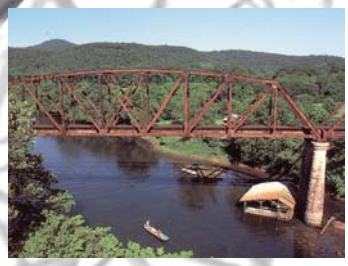


Distribution Load Restoration System: A Case Study



Keeping Amusement Park Guests Amused in Silver Dollar City

White River Valley Electric Cooperative, Inc.
Your Touchstone Energy Cooperative

Background

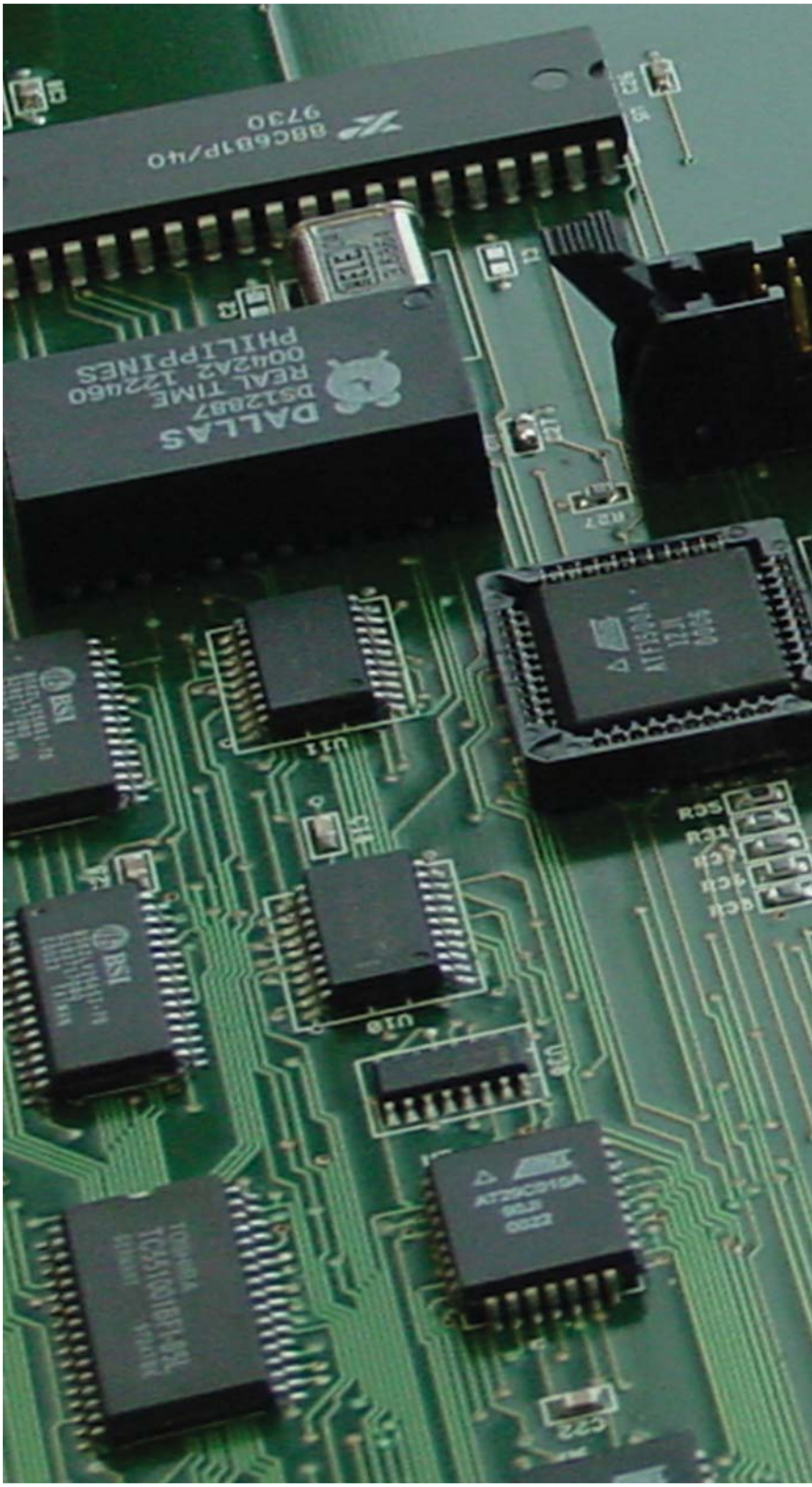
Advances in technology are providing utilities with more information, more functions and more features to better manage their systems. Innovative utilities are capitalizing on these advances by making their systems more reliable and focusing on the number one priority in a competitive market: customer satisfaction.

Located in the Ozark Mountains in southern Missouri, the city of Branson is one of the country's most popular tourist destinations. Although Branson has a population of only 3,706, the city hosts nearly 7 million tourists per year. While Branson offers a countless number of performance theatre shows, picturesque views of the Ozark Mountains, championship golf courses, and a wide variety of family entertainment, the lure of Branson has it ties to the yesteryear themed amusement park, Silver Dollar City (www.silverdollarcity.com).

Distribution Load Restoration System: A Case Study

Statement of Problem

On paper, the distance between White River Valley Electric Cooperative, a Touchtone Energy company (www.whiteriver.org), and Silver Dollar City is only several miles. However, due to the terrain of the Ozark Mountains, there are only a few viable routes between the utility's headquarters and Silver Dollar City. These routes are lined with theatres, restaurants, shopping and other attractions. As a result, it could take several hours for a crew to drive to the amusement park during the peak of the tourist season. An outage during the peak of their season could mean up to half of the park would be out of service for several hours, and consequentially Silver Dollar City would have to close the park and issue refunds for the day. As Silver Dollar City's service provider, White River Valley Electric began considering several options to improve their level of service reliability with their customer.



Solution

In cooperation with ZIV USA, Inc. (Chicago, www.zivusa.com) and S&C Electric Co. (Chicago, www.sandc.com), White River Valley Electric devised a fully automated distribution system comprised of pad mounted switchgear and ZIV model MCD Digital Control Units, plus a Central Unit (CPD) which houses the Restoration Logic for the distribution system. To provide local and remote access to system diagnostics, metering and control, the system is also equipped with two Engineering Desk platforms (PCDs) that provide the control and monitoring tools for remote supervision and operation of the system.

System Description

The distribution system at Silver Dollar City (see Figure 1) is comprised of seven motor operated, pad-mounted switchgear, which provides the switching and primary protection of the system.

The switchgear are arranged in a ring with two (2) normally open points. Each half of the distribution ring is fed by a 13.2kV feeder.

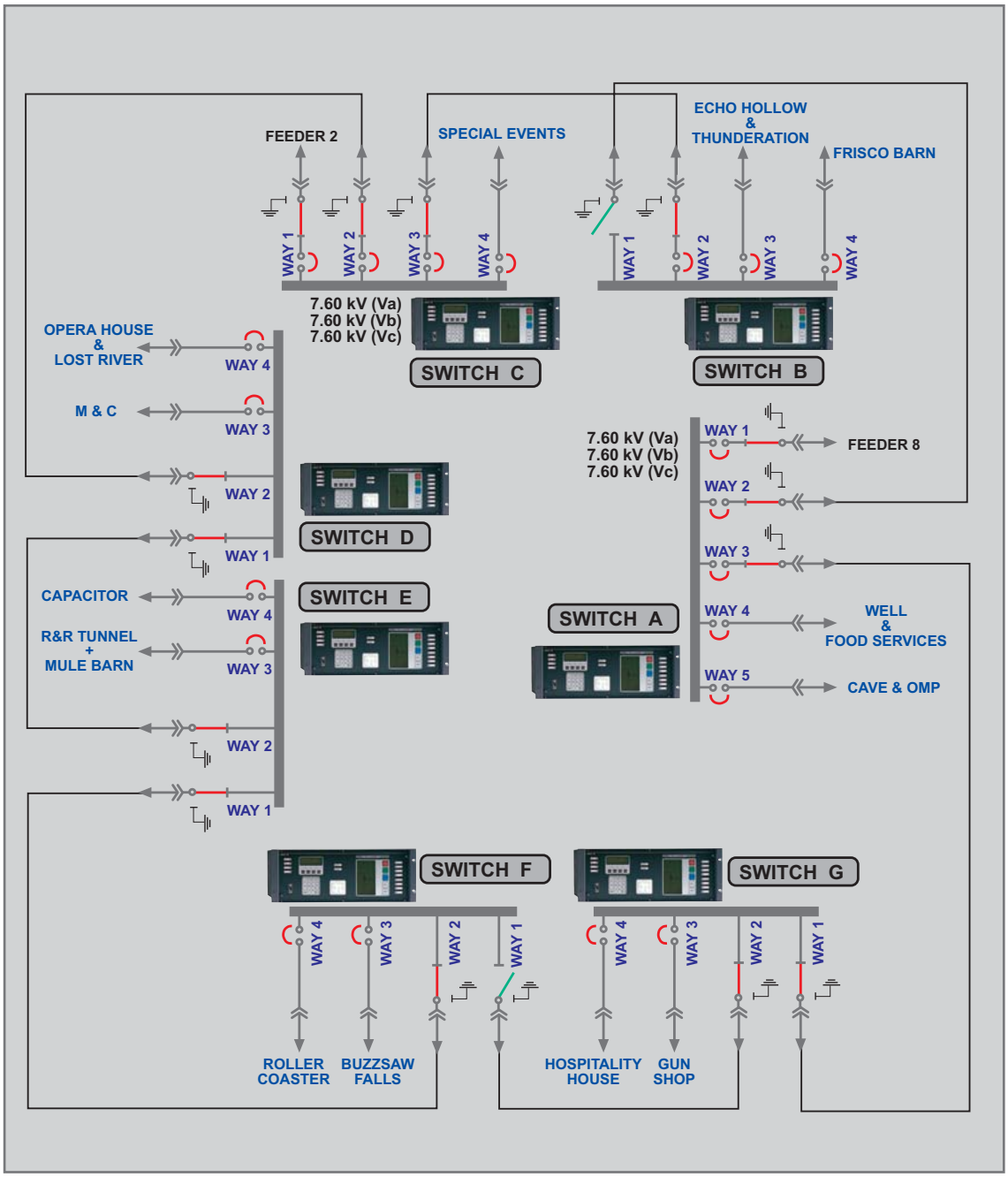


Figure 1. Silver Dollar City Distribution System (Single Line Diagram)

Distribution Load Restoration System: A Case Study

Each switchgear is integrated with a ZIV model MCD Digital Control Unit. The MCD units are microprocessor-controlled devices that combine PLC functionality with RTU capabilities. Each unit is provided with a series of opto-isolated digital inputs (40 per unit) that are hardwired to the status and alarm points of the switchgear. They also have analog metering inputs to monitor the phase voltage and line currents at the switchgear bus VTs and the switch way CTs respectively. An array of contact outputs (17 per unit) is available to interact with the switchgear.

The MCDs are responsible for:

- Collecting local metering information.
- Collecting switchgear position and alarm status.
- Monitoring of the protection devices.
- Sending collected information to the Central Unit for implementation in the Restoration Logic.
- Activating the motor operators and other features of the switchgear when commands are received from the Engineering desk or the Restoration Logic.

The signals collected by the MCD are utilized by the logic programmed in the microprocessor. The MCD monitors the switchgear SF6 gas pressure, the battery charger input and output voltage levels, and the battery voltage levels. The logic is programmed with interlocks to prevent grounding the switches from the closed position or sending unnecessary commands (i.e. an open command to an already open switch). Also, the switchgear overcurrent protective devices are provided with blocking inputs. The logic will inhibit operation of the relays depending on distribution system configuration to properly maintain the coordination of the protection scheme.

Another feature included in the switchgear is a set of status contact inputs to perform battery testing. The MCD activates the switchgear input that disconnects the AC power supply. The voltage supplied by the batteries is then monitored. Once the test is completed the MCD activates the second contact, reconnecting the AC supply.

The MCDs are programmed with the required logic functions to verify that the batteries are capable of providing backup power for a minimum period of time. In the event that the battery voltage supplied during the test falls below the minimum level required for proper operation of the switchgear, the test is automatically halted, and an alarm is generated. Provisions are also made to halt the test if fault conditions appear in the distribution system. In the case of no contingencies, after the defined testing time, the MCD will reconnect the AC supply and report a "Test Passed" signal.

The Central Unit (CPD) is housed in the electrical room of one of the amusement park buildings. A cabinet encloses the CPD and the following components:

- A 48 Vdc battery pack to supply back-up power in case of AC outages in the building.
- An AC/DC battery charger that acts as the system power supply. The charger switches without interruption to the batteries in case of an AC outage.
- A leased line modem to provide a connection between the CPD and the control room.
- A DC/AC power inverter to feed the modem from the battery charger.
- A laptop PC functioning as the local Engineering Desk.
- A simple terminal block consisting of 4 fiber optic terminations to both loops interconnecting the switchgears, the leased line telephone connection and a standard 120 Vac outlet to power the system.

- *The **MCD** units are microprocessor-controlled devices that combine PLC functionality with RTU capabilities.*

- *The **CPD** is a processing unit for communications and applications running over a real-time operating system, which supports the central system database.*

Distribution Load Restoration System: A Case Study

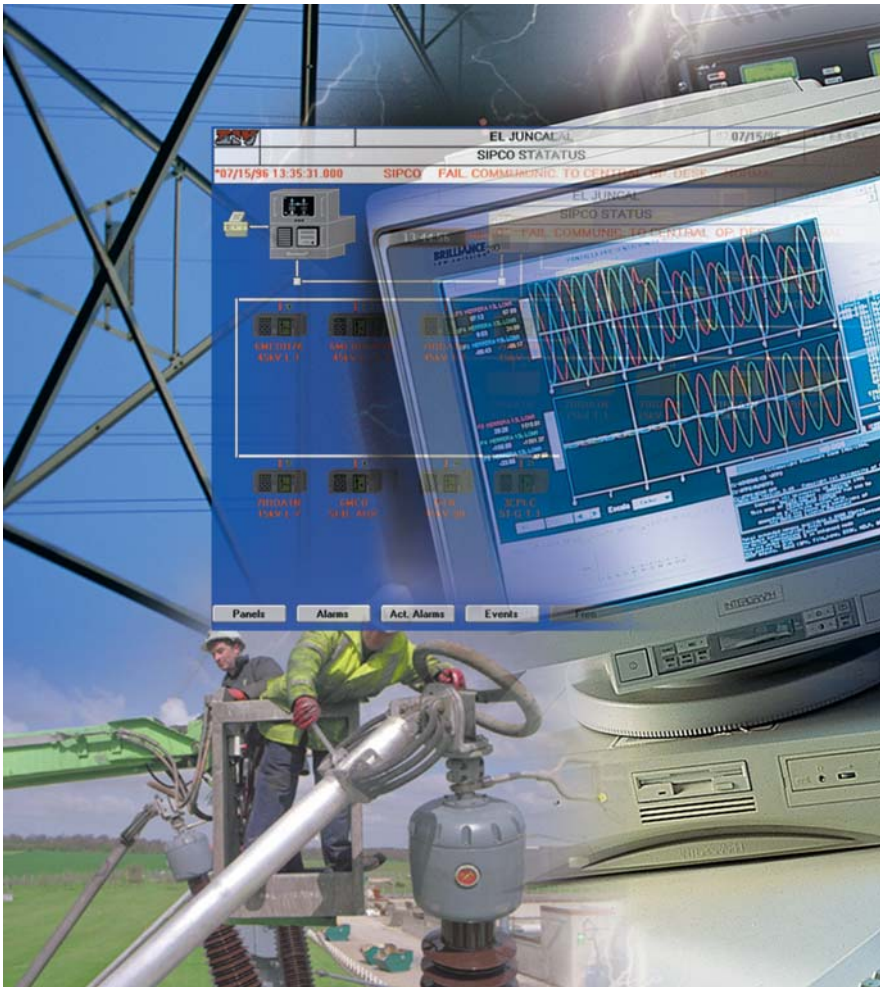
The CPD is a processing unit for communications and applications running over a real-time operating system, which supports the central system database. The CPD contains a proprietary DC power supply, data acquisition modules and a fiber optic concentrator/diffuser module to handle communications with the MCD network. All communication ports are isolated to provide reliable operation of the internal components.

The CPD gathers all the information from the MCDs. This information is utilized by the Restoration Logic to analyze disturbances and reconfigure the distribution system by performing the appropriate switching operations to:

- Recover power to the entire distribution system in the event of a feeder loss.
- Restore power to the entire distribution system in the event of a fault in the lines between adjacent switchgear units.
- Isolate a piece of switchgear in the event of an internal fault, and restore power to the remainder of the distribution system.

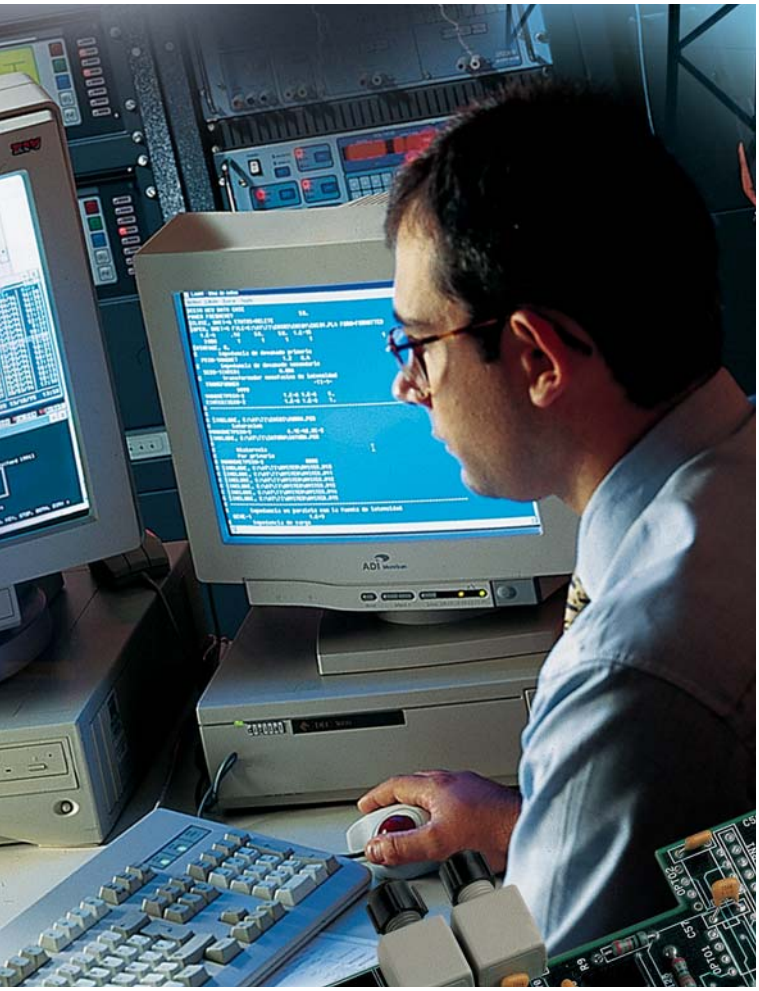
Utilizing the Restoration Logic, White River Valley Electric can now guarantee Silver Dollar City that the longest outage time in a worst-case scenario will not exceed 2 minutes. Additionally, in case of a fault inside of a piece of switchgear, the largest outage after reconfiguration will be limited to the portion of the load tied to the faulted switchgear.

The Central Unit (CPD) is also responsible for monitoring internal system communications as well as providing a connection to the Engineering Desk. As an added safety measure, the MCDs and the CPD are connected via fiber optics in a self-healing, counter-rotating double ring. In the event of losing a communications segment, the system will rely on the redundant communications segment, while generating an alarm to alert the user of the communication system status.



The CPD is connected to two Engineering Desks (PCDs). A local area network (LAN) connection is used for the PCD located in the amusement park electrical room. The second PCD is connected to the utility's control room via a leased telephone line. The engineering desks are standard PCs running ZIVerdesk®, a powerful Windows™ based software tool, customized to the specific application and with the appearance and capabilities of a SCADA system.

The Engineering Desk (PCD) provides real-time conditions of the system including: switch and interrupter status, metering, alarms, and events log. It also performs remote operations to the system, such as



Conclusion

The Restoration Logic implemented in the Central Unit provides White River Valley Electric with the knowledge of the situation before arriving to the site and provides the utility the advantage of better coordinating their crews. Additionally, the Restoration Logic detects and isolates faults and restores power to the amusement park in a short time period.

An outage in the past could mean that Silver Dollar City would have to close the park for the day and issue refunds to their guests. Now, due to the Restoration Logic integrated into their distribution switchgear via ZIV Digital Control Units, Silver Dollar City can operate the park after a brief outage without interrupting their guest's experience while maintaining a healthier bottom line.

opening and closing of switches or activating the battery test for the switchgear.
The software has several interlocking functions to avoid burdening the communications system with unnecessary data. For added security, the software can be password protected to restrict access to the control functions, yet still function as a monitoring tool.

If the PCD is disconnected, the CPD will store the system event log. Every event logged during the time that the PCD is disconnected will be retrieved by the PCD when a connection is reestablished. This data storage in the CPD allows a utility to periodically monitor system behavior without the need for a permanent connection.

- *Utilizing the Restoration Logic, White River Valley Electric can now guarantee Silver Dollar City that the longest outage time in a worst-case scenario will not exceed 2 minutes.*

Authors:

- **Ron Wills**
  Project Coordinator
  White River Valley Electric Co-Op
- **Tyson J. Salewske**
  Application Engineer
  ZIV USA, Inc.

For information on how ZIV can implement Integrated Protection, Control and Automation solutions for your utility, please contact our dedicated sales and applications engineers at the address below.

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Technical Assistance Around the Clock
ZIV
(877) ZIV-USA 1
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Aplicaciones y Tecnología, S.A.

ZIV USA, Inc. 2340 River Road, Suite 210. Des Plaines, IL 60018
Phone: 847-299-6580 / Fax: 847-299-6581 / e-mail: sales@zivusa.com