

CASE STUDY

Empire District Electric Company—Joplin, Missouri

SEL Protective Relay Withstands EF5 Tornado

Substation equipment must withstand extreme weather conditions, but no one expected that when an EF5 tornado destroyed an entire utility substation, an SEL protective relay would remain standing and operational.

Joplin, MO—Electric utilities traditionally design their substations to withstand damage from significant weather events, including wind storms, ice storms, and tornadoes.

Over its hundred year history, Empire District Electric Company has gained considerable experience dealing with severe weather events. It is located adjacent to Tornado Alley, aptly named for the region’s tendency to form supercell thunderstorms, which can produce violent (EF2 classification or greater) tornadoes.

The majority of tornadoes are considered weak (EF0 or EF1, with wind speeds of 65–110 mph), and about 95 percent of all U.S. tornadoes are below EF3 intensity. Of these violent twisters, only a very small percentage (0.1 percent of all tornadoes) achieve EF5 status, with estimated wind speeds in excess of 200 mph that result in nearly complete destruction in their paths. (Note that EF5 tornadoes were classified as “F5” tornadoes prior to February 2007.)

In the late afternoon of May 22, 2011, a catastrophic EF5 multiple-vortex tornado struck the city of Joplin (Figure 1). Nearly one mile wide and carrying wind speeds in excess of 200 mph, the tornado killed 162 people, making it the deadliest tornado to strike the U.S. in more than fifty years. A local meteorologist described the scene as Joplin having been put into a blender.



Figure 1—Aftermath of the Joplin EF5 tornado

The damage to Empire’s system was extensive. The Joplin 26th Street Empire substation, directly in the path of the tornado, was completely leveled, and two other substations sustained minor damage. Ten transmission lines and approximately 3,900 power poles were damaged, leaving about 20,000 customers without power.

The incredible force of the EF5 tornado completely destroyed the brick substation at Joplin 26th Street (Figure 2). Fortunately, the Empire crew was not present at the time the tornado struck.

When Empire’s crew began to assess the demolished substation, they discovered an SEL-501 Dual Overcurrent Relay that was part of a free-standing 12 kV breaker. Amazingly, the SEL relay appeared undamaged—it had survived an EF5 tornado!



Figure 2—Empire’s Joplin 26th Street substation after the tornado (Jace Anderson/FEMA)

The Empire team placed the relay (Figure 3) in their stores area for use as a spare and turned their attention to the substation restoration process. SEL rolled up their sleeves to help. Construction on the new substation began in early March 2012 and was completed in late October 2012.



Figure 3—SEL-501 Relay that survived an EF5 tornado

During that time, SEL worked tirelessly, expediting delivery of new SEL relays to Empire’s panel manufacturers. And, keeping with SEL’s natural disaster policy, they supplied equipment and services at a considerable discount.

Within ten days of the tornado, power was restored to approximately 12,000 customers (the remaining 8,000 customers were unable to receive power because their homes were damaged or destroyed). As a result of their restoration efforts, Empire was honored with the Edison Electric Institute’s Emergency

Recovery Award, which recognizes efforts made by electric utilities to restore service breached by severe weather conditions or other natural events.



Figure 4—Empire’s newly rebuilt Joplin 26th Street substation (Google)

According to David Boren, manager of substation operations for Empire, SEL was extremely helpful in getting Empire and the Joplin community back on their feet. “We’re thoroughly happy with our selection of SEL as a partner. Their quick turnaround, technical support—from settings questions to device programming—was invaluable. SEL stepped up when other vendors were pulling back.”

Several years after the new substation was commissioned, Empire needed a spare relay and retrieved the EF5 tornado survivor (SEL-501) from its stores.

Empire tested the relay, and found that it was still working! They elected to send it back to SEL to “test and clean it up” and convert the phase rotation. The relay was still working fine despite being in a substation that was completely demolished by a tornado!

This amazing example of product durability is the result of design. Each SEL product is designed, built, and tested to be utility-grade standards, i.e., to operate under rigorous environmental conditions for more than twenty years.

This rigorous approach creates SEL products that operate reliably while mounted in a

breaker cabinet in a substation yard, even under extreme weather conditions.

Longstanding Partnership

Empire and SEL have partnered for more than twenty years, including pioneering the annual I-44 Interactive Seminar, which provides valuable hands-on technical training on a broad number of power system topics. The success of the I-44 seminar has led to the creation of six additional SEL interactive seminars across the U.S. and Canada.

More recently, Empire has deployed SEL-300 and SEL-400 series relays and fiber-optic communications to provide power system protection and automation in their substations.

Going forward, Empire plans to further expand their communications, deploying SEL ICON® Integrated Communications Optical Network wide-area network multiplexers in their substations.

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About Empire District Electric Company

Empire is an investor-owned utility founded in 1909 and based in Joplin, Missouri. A member of the Southwest Power Pool, Empire provides electric service for approximately 166,500 customers in southwest Missouri and adjacent parts of Arkansas, Kansas, and Oklahoma (see

Figure 5). Empire also provides natural gas and fiber-optic services to its customer base. A vertically integrated utility, Empire has over 1,200 miles of transmission lines, 5,500 miles of distribution lines, and 175 substations.

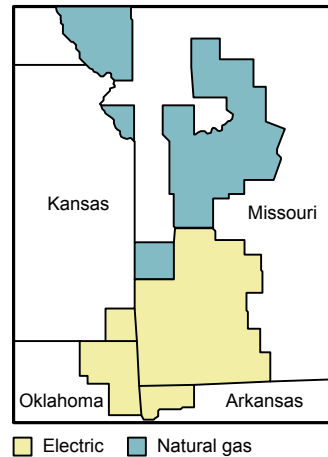


Figure 5—Empire service area map

About SEL

Schweitzer Engineering Laboratories, Inc. (SEL) has been making electric power safer, more reliable, and more economical since 1984. This ISO 9001:2000-certified company serves the electric power industry worldwide through the design, manufacture, supply, and support of products and services for power system protection, control, and monitoring. For more information, please contact SEL at 2350 NE Hopkins Court, Pullman, WA 99163-5603; phone: +1.509.332.1890; fax: +1.509.332.7990; email: info@selinc.com; website: www.selinc.com.

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