EEI 2018 Edison Award Nomination Submitted by Indianapolis Power & Light Company for IPL Fiber Optic Temperature Monitoring System

EXECUTIVE SUMMARY

After experiencing challenging media coverage and public outcry over safety concerns following cable fires and dislodged manhole covers in its downtown network, Indianapolis Power & Light Company (IPL) became proactive in discovering and employing an innovative solution that has shown remarkable success over the past two years.

By taking technology used in the oil pipeline industry, IPL partnered with Texas-based Fiber Optic Pipeline Solutions to be the first electrical utility *ever* to use a distributed temperature sensing (DTS) system to monitor external high-temperature threats in an underground network secondary grid.

We proudly submit our nomination for the 2018 Edison Award, touting the results of our Fiber Optic Temperature Monitoring System.

The following pages will demonstrate how this innovation helped IPL improve the safety and reliability of the fundamental life element we deliver: energy for 490,000 customers and more than 28 million visitors - people who expect to be able to turn on their lights and have power, while in the city of Indianapolis.

THE PROBLEM

Steam. It may seem like an antiquated heat source. But here in Indianapolis major businesses, hospitals and corporations use it each and every day. In fact, Indianapolis has one of the largest steam distribution systems in the U.S.

For many years, steam was a contributing factor in causing considerable safety issues in the heart of downtown, and near IPL's underground infrastructure and power cables.

Steam was corroding our cables, degrading their outer jackets and prematurely aging them. Steam – with its ability to deform conduit if exposed long enough to leaks, was indeed an issue we needed to tackle.

In the past, we relied on a steam company's annual thermal survey and our own crews, who would report any heat issues encountered during routine inspections. But those two tactics – though helpful – were not comprehensive, leaving heat issues to go undetected for a year or more.




THE INNOVATION

Discovery, How the DTS works and the Pilot that set vision to life.

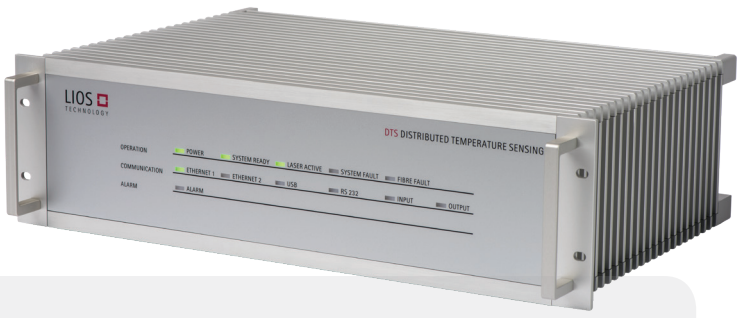
Discovery

Indianapolis Power & Light (IPL) needed to be more proactive to address steam issues in our city. We needed to look beyond the status quo and reach for an innovative solution that would improve safety for our employees, city residents and visitors.

That solution came in the form of a distributed temperature sensing (DTS) system - technology that had never before been used in the electric utility underground network space.

In late 2015, IPL partnered with FiOPS to devise a DTS system that would enable IPL to proactively monitor external high-temperature threats from the steam distribution system in real time. By June of that year, IPL and FiOPS installed and commissioned a DTS pilot to evaluate the effectiveness of the system.

Fiber Optic Pipeline Solutions (FiOps) introduced our team to its DTS system, and from there, our team's vision began the steps toward reality.



LIOS DTS Controller

How DTS Works

A typical DTS system contains three components: DTS controller, standard multimode fiber-optic cable and a server to store the data. The DTS controller turns the fiber-optic cable into a linear sensor that has a spatial resolution of approximately 3.28-ft (1-m) increments with an accuracy of ±1.8°F (±1°C).

How the DTS controller measures the temperature is based on the principle of Raman scattering. Thermal effects induce lattice oscillations in the glass fibers, which, in turn, cause light to be scattered back to the DTS controller. The DTS controller interprets two components of the backscatter, stokes and anti-stokes, to determine the temperature at any given point along the fiber. The time it takes for the backscatter to reach the DTS controller is used to calculate the precise location of the thermal event.

HOW DTS IS IMPROVING IPL'S SAFETY AND RELIABILITY

Much has been learned from the application of the DTS system. In addition to monitoring for deltas in temperatures due to possible steam leaks, we have learned that the DTS can detect secondary fires and cable faults.

On June 23, 2017, the DTS system detected a manhole fire in the downtown network. Within 7 minutes and 30 seconds, the temperature rose from 35.19°C to over 165.87°C. This rapid temperature spike, alerted us immediately of the situation and pinpointed exactly where the problem area was in our network.

IPL's mission is "Improving lives by providing safe, reliable and affordable energy solutions in the community we serve." Having the DTS system enables IPL to monitor situations in the network and proactively investigate potential high temperature events. This monitoring helps to limit potential network events and unforeseen high temperature situations.

In addition, IPL meets with the local steam company on a regular basis to discuss reports of steam anomalies within the Indianapolis Central Business District. In 2012 when the monthly meetings began there were 57 anomalies listed in a multi-page report. Currently there are 24 steam anomalies on a single-page report. Over the last 12-months this number has been as low as 19.

The DTS system has proven to be a very promising technology for use in secondary networks. Employing DTS and fiber optic cable eliminates the need for thousands of individual sensors. With this innovative approach to monitoring temperature changes throughout the underground infrastructure, IPL customers, guests to Indianapolis and our employees can live, visit and enjoy downtown Indianapolis - knowing there is a safe and reliable underground network system beneath their every step.

THE OUTCOME

Once the route was commissioned and on-line, this unprecedented system started delivering what we hoped.

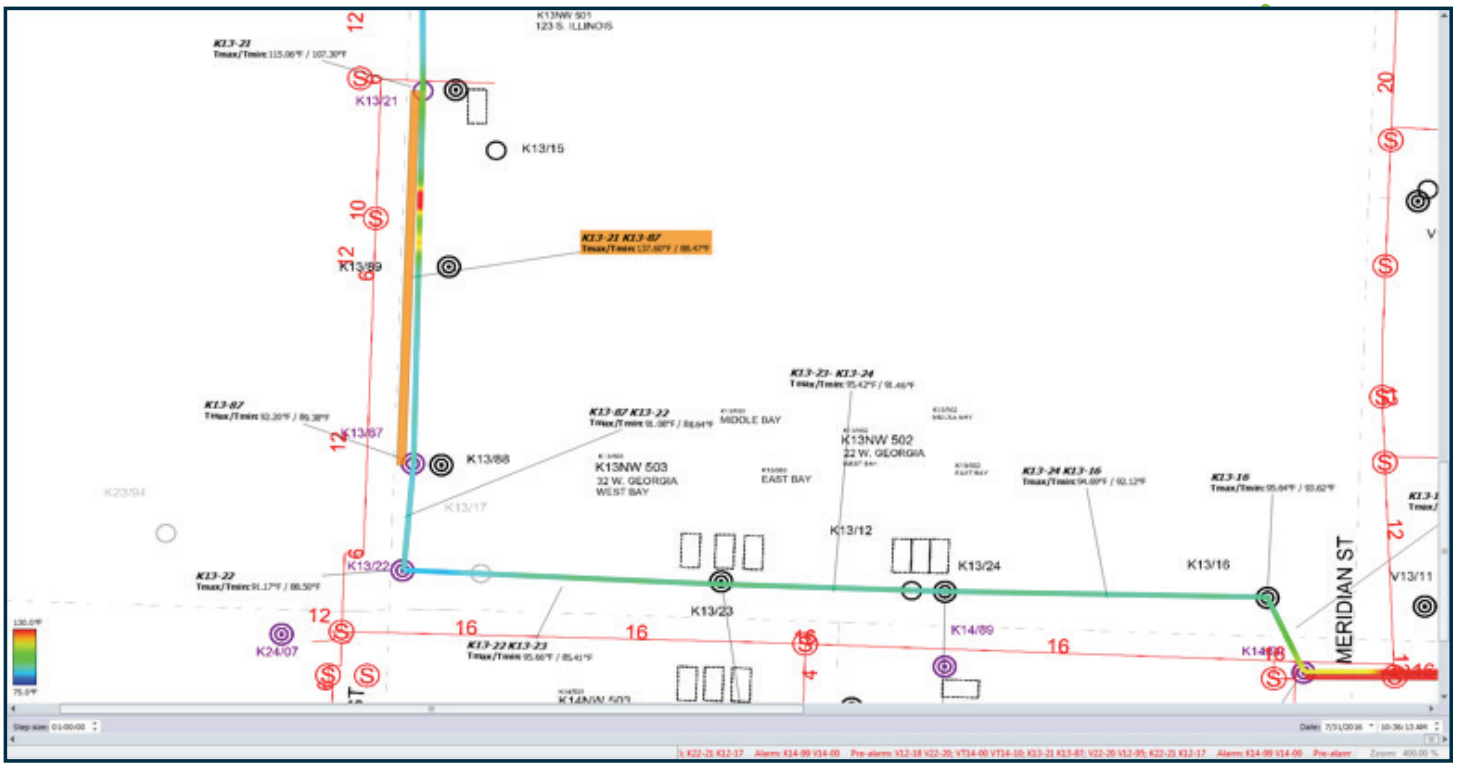
Hot spots and the beginnings of a steam leak were detected in one area in real time; issues of which both IPL and the steam company had not previously been made aware. By the end of July 2016, the temperature in one particular area had risen to more than 135F° (75.2C°) and was climbing steadily. The DTS system alerted IPL to the situation so the utility and steam company could address the issue in a timely manner before any damage was done to IPL's infrastructure and cables.

A month later, IPL's senior management gave the engineering team the go-ahead to install additional routes for the DTS system in the secondary network to monitor threats from steam.

By the close of 2017, IPL had installed four radial fiber-optic routes consisting of approximately 37,000 ft (11,277 m), which is currently monitoring about 50 percent of the steam system, as it relates to IPL's infrastructure. In addition, IPL installed a second DTS controller at a substation near the downtown network secondary grid for redundancy purposes. Data from the two DTS controllers is stored on two servers at separate locations.

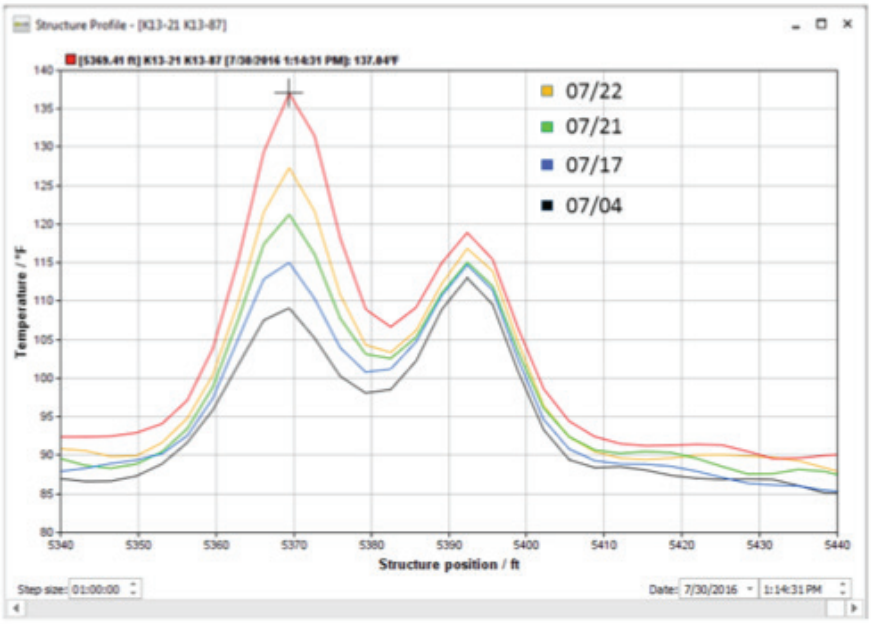
SUPPORTING DATA

Graph and table showing temperature vs. distance. Notice the large variation in temperatures over the length of the cable. The zoom in the lower right pinpoints the hottest location.



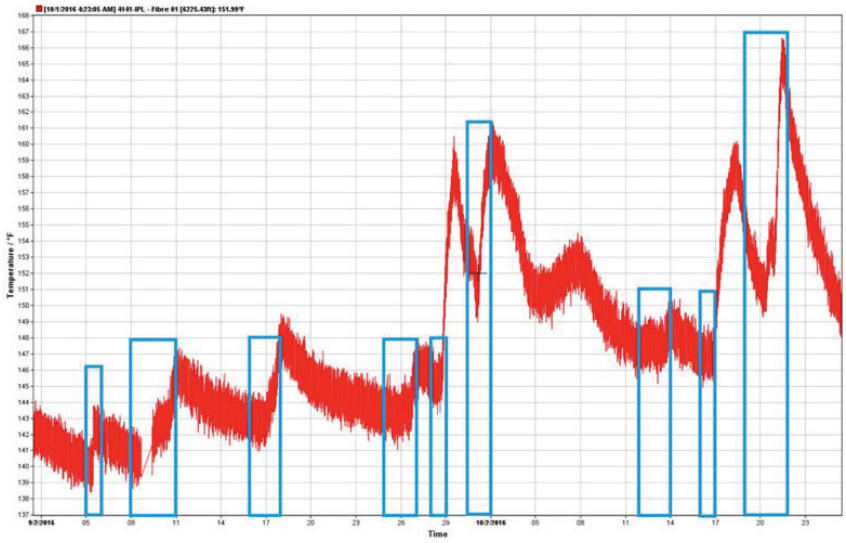
Hot spot located on map

Indianapolis Power & Light Company provides retail electric service to more than 470,000 residential, commercial and industrial customers in Indianapolis, as well as portions of other Central Indiana communities surrounding Marion County. During its long history, IPL has supplied its customers with some of the lowest-cost, most reliable power in the country. For more information about the company, visit www.IPLpower.com.



Rapid temperature increase over a few days proves value of continuous monitoring. Temperature increased 30 ˚F in only eighteen days.

Example of 350 kcmil Cu EPR 15 kV cable damaged by steam. This cable is at the end of useful life after only three years of service.



The graph above shows the temperature trace between Sept 1st and Oct 25th. The blue boxes indicates periods of precipitation. The temperature would spike shortly after each rain event.