Delta T Alert: Wireless Monitoring of Electrical Enclosures

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Abstract

Thermography is a proven technology for detecting elevated temperatures within operating electrical distribution systems. Typically performed on an annual basis, infrared inspections can detect evidence of overheating caused by loose/deteriorated connections, overloaded circuits, and imbalanced loads.

While infrared inspections can be valuable in helping to prevent unexpected failures, they provide a single "snapshot", leaving the subject components unmonitored for the balance of the year.

Recent advances in technology have resulted in wireless sensors that monitor for the same types of defects that are detectable by thermal imaging. When permanently installed on electrical enclosures, these sensors can provide year-round monitoring of electrical system components and can immediately alert personnel when problems arise.

This paper will discuss the theory and application of the Delta T Alert monitoring system and how it can be used to complement and enhance the effectiveness of an existing infrared inspection program within commercial office buildings. A few case studies showing the effectiveness of Delta T Alert will also be presented within this paper.

Introduction

In the highly-competitive world of commercial building management, your success depends on high tenant occupancy, controllable expenses, and trouble-free operation. That means no unexpected shutdowns, no major equipment or service failures, and no expensive emergency repairs.

The heartbeat of any commercial building is its electrical distribution system, which regulates water pressure, climate, communications, and lighting. Without this heartbeat, all services stop - along with your business. Facility downtime is not an option if you want to keep your tenants.

According to Hartford Steam Boiler Inspection and Insurance Company (HSB), (www.hsb.com), electrical system malfunctions are the leading cause of commercial building fires. These fires have increased in frequency and severity over the past two decades, due primarily to increased demand on existing electrical systems. Even newer buildings are not immune to electrical failures, as businesses demand an ever-increasing stream of power, placing more and more pressure on overloaded systems.

According to Hartford Steam Boiler, The number one cause of such failures is a lack of proper maintenance - or no maintenance at all. HSB reports that 75% of all electrical failures are due to human error or carelessness, deficient or delayed maintenance, unqualified personnel, and/or budget cuts. According to the Institute of Electrical and Electronics Engineers (IEEE) in New Jersey (www.IEEE.org), the failure rate of electrical systems is three times higher for those that have not had preventive maintenance than for those that have.

So Many Points - So Little Time

In a typical one-million square foot high-rise commercial office building, there are literally hundreds of electrical power and distribution panels, along with just as many disconnects. This equipment may receive an infrared scan once per year, at most, or an occasional “clean and tighten”, which is conducted during off hours. The “clean and tighten” procedure requires both an electrical shutdown and significantly higher electricians’ wages (time and a half or double time). It is a major expense and inconvenience for both building owners and their tenants.

Meanwhile, some experts do not recommend routine tightening of electrical connections. In many cases, over-tightening can deform the bolts and/or the contact faces, decreasing the surface contact area and producing greater resistance. Greater resistance can cause heat buildup, potentially damaging insulation and components.

Commercial facilities’ infrastructures typically have many safeguards in place such as: pump gauges, water tank level alarms, and smoke detection. In many cases, a property may have a Building Management System (BMS), which controls and monitors the building’s mechanical equipment, such as air handling and cooling plant systems, as well as lighting, fire extinguishing, and security systems.

Electrical distribution systems, however, are often overlooked because most of the facility's electrical enclosures are inaccessible. Since many electrical enclosures cannot and should not be opened in the "on" or "energized" position, maintenance personnel usually enter an electrical switchgear room or electrical closet limited to their senses - sound, sight and smell - to detect signs of overheating. But, once a worker smells something burning or hears something arcing, significant damage has already occurred, and the level of danger has increased significantly.

Delta T Alert: A Safe, Reliable Solution

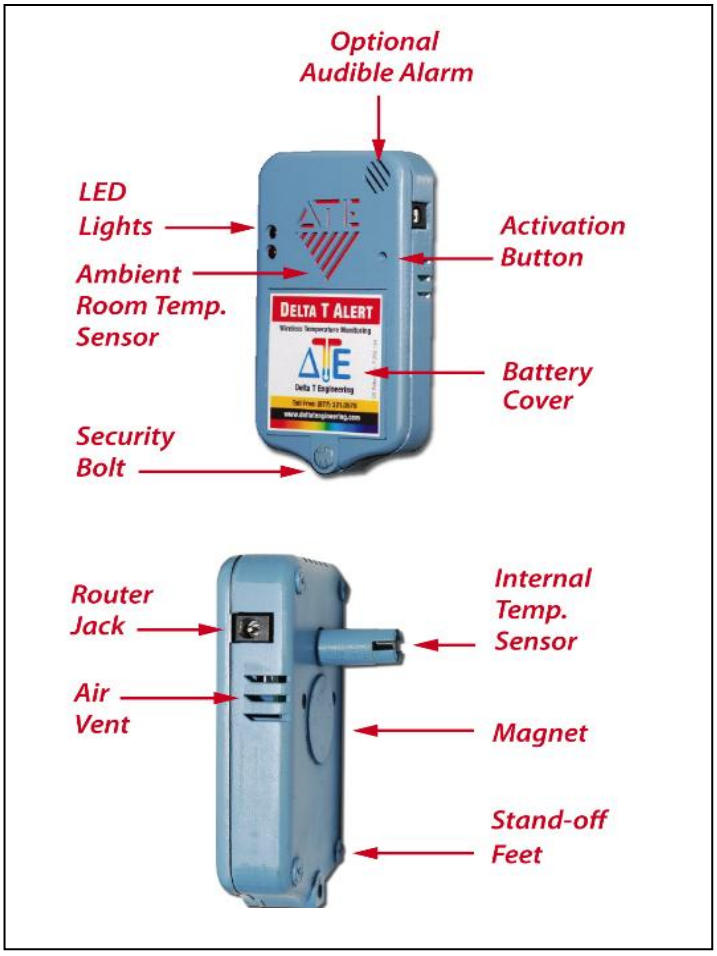
You can avoid a major electrical breakdown - and significant financial loss - with the "Delta T Alert". Developed by Delta T Engineering, LLC, this patented device magnetically attaches to your electrical equipment covers, monitoring the Delta T (temperature differential) between the interior of an electrical enclosure and the ambient temperature of the room that enclosure is in.

You can adjust the Delta T to collect data on a daily basis, at specific time intervals. The information is then transmitted wirelessly to an onsite computer for analysis. Whether your panels are located in a 20° warehouse in Alaska, a 100° switchgear room in NYC, or a 65° data center in Tuscaloosa, the Delta T Alert can warn you of excessive temperature rise within your electrical enclosures before more serious problems arise.

How it Works

A Simple Device with Staggering Results. Delta T Alert is a self-contained temperature-monitoring sensor that attaches magnetically to electrical enclosure covers. This sensor is designed to work on NEMA 1 enclosures which are constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection against falling dirt.

Delta T Alert is comprised of two temperature sensors - one to monitor the electrical enclosure's interior temperature and the second to monitor the room's ambient temperature where the enclosure is located. To monitor the enclosure's internal temperature, a 15/32" hole is drilled into the cover of the enclosure after the cover is removed. Delta T is then magnetically attached with the interior sensor protruding into the panel 7/8 of an inch. Both the size of the hole and the length of the interior sensor conform to protection classification NEMA IP20. This classification protects against access to hazardous parts with a finger.



Delta T is then configured to collect data on a daily basis, at specific time intervals. The information may then be transmitted wirelessly to an onsite computer for analysis and trending. Delta T Alert will warn you of temperature rises within your electrical enclosures - well before more serious problems arise.

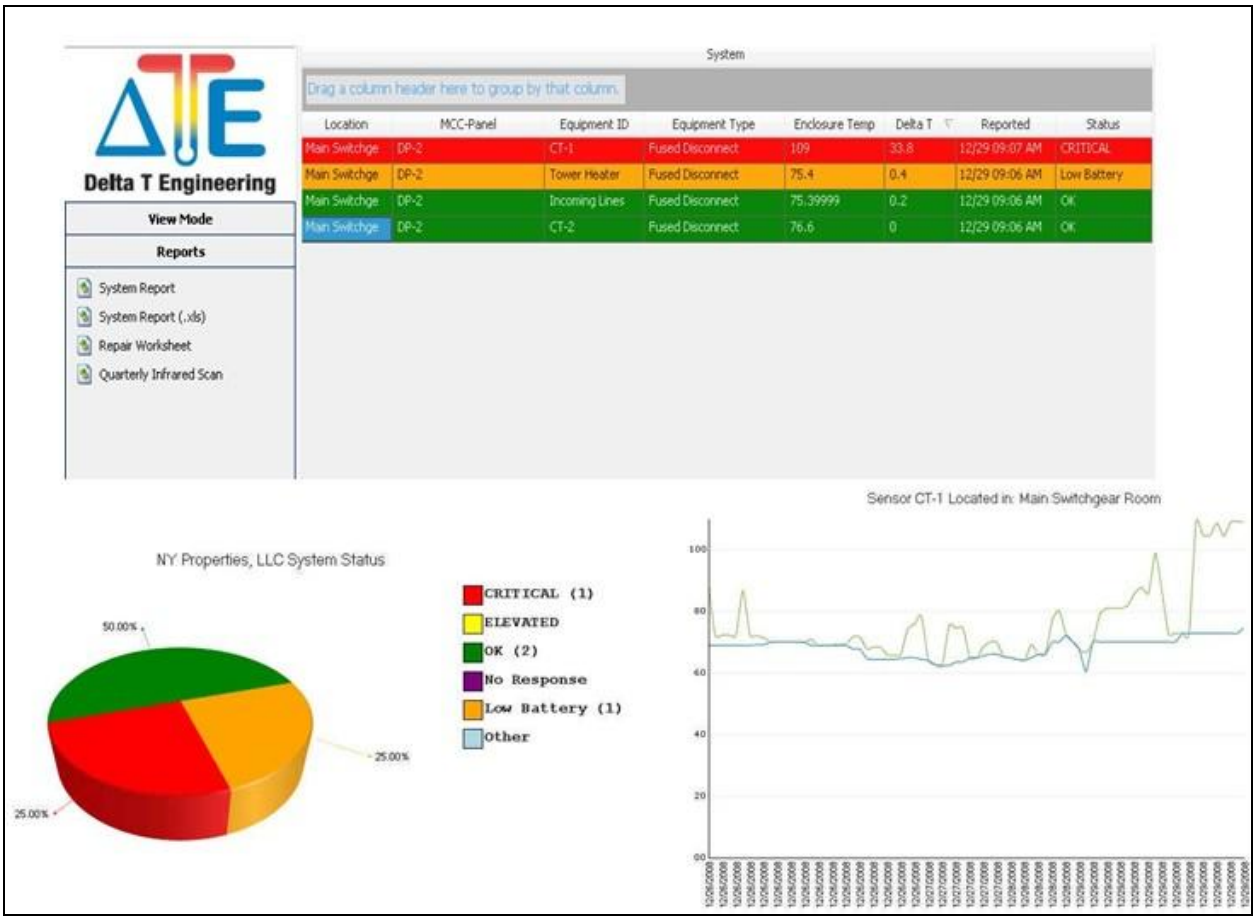
Software

Our proprietary software will allow you to print reports and trending graphs, as well as scheduled repair logs for maintenance. Reports include the following:

- Total System Report
- Test Status Pie Chart
- Delta T Trending Graphs
- Repair Worksheets
- Infrared Scan Worksheets

Delta T Engineering is currently in the process of integrating our software with the most popular Building Management Systems (BMS) on the market today.

Report Samples



CASE STUDY

Commercial Office Building

Jersey City, NJ

Client Profile

A multi-tenant 1,000,000 square foot office building located in Jersey City, NJ.

Challenge

This pro-active client was interested in monitoring the heartbeat (electrical distribution system) of his facility on a daily basis versus an annual basis.

Solution

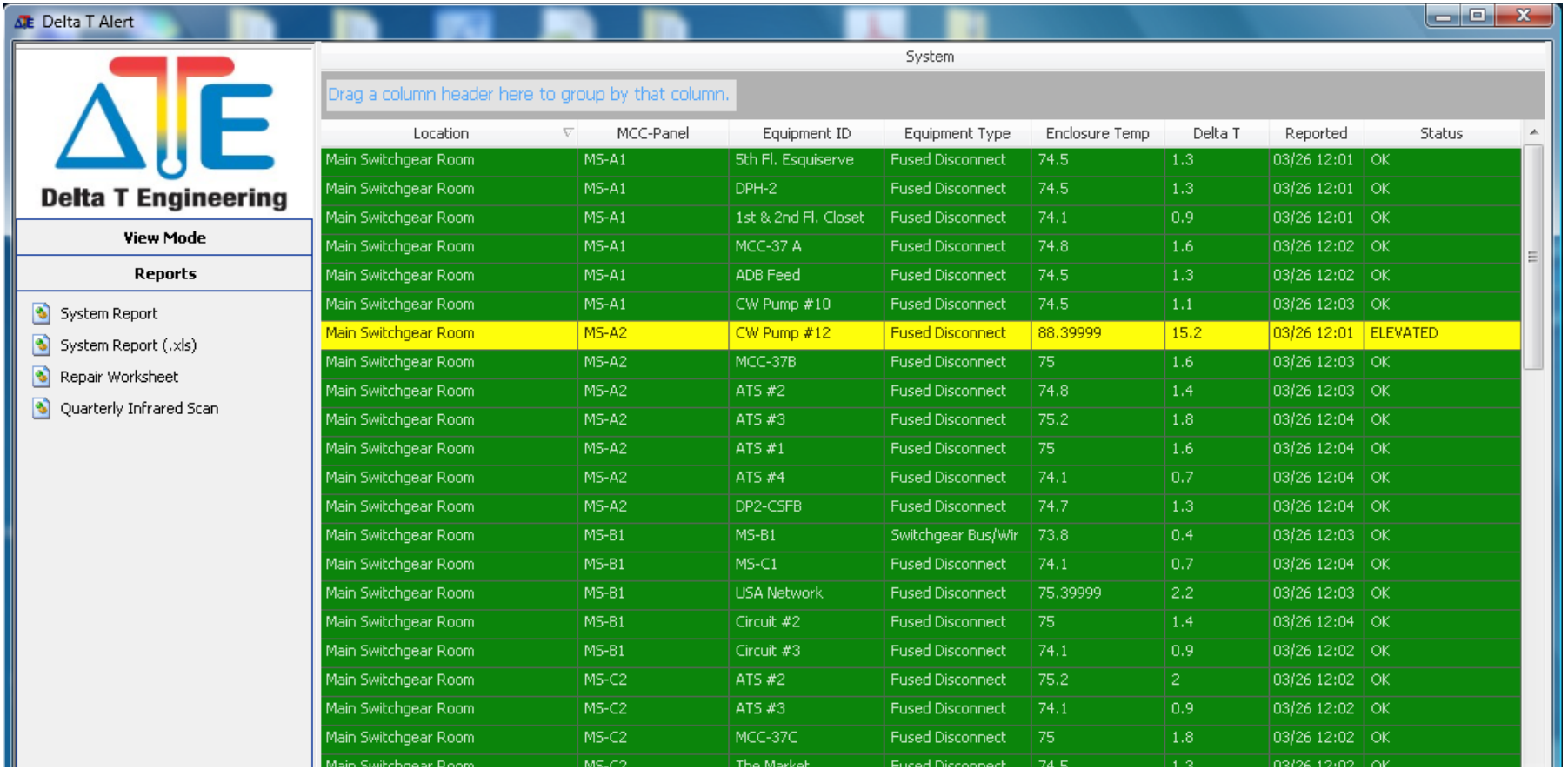
Delta T Engineering, LLC installed Delta T Alert's on all critical enclosures located within the main switchgear room. The Delta T units were programmed to record temperature rise within the enclosures three times per day. This data was transmitted wirelessly to the Chief Engineer's computer for analysis and trending.

Delta T Engineering

Results

On March 1, 2009, twenty-four Delta T units were installed within the main switchgear room and programmed to send the Delta T data to the Chief Engineer's computer at 9:30 am, 12 noon and at 3:00 pm. All enclosures where the units were installed were operating within the normal temperature range until March 26, 2009. On this date, the Chief Engineer received an "Elevated" alarm on the Condenser Water Pump #12 fused disconnect. This alarm was observed within the opening page of the Delta T Alert Software. Please see Figure #1.

The trending graph in Figure #4 on the next page illustrates the increasing Delta T over a one month time frame of monitoring.



Location	MCC-Panel	Equipment ID	Equipment Type	Enclosure Temp	Delta T	Reported	Status
Main Switchgear Room	MS-A1	5th Fl. Esquiserve	Fused Disconnect	74.5	1.3	03/26 12:01	OK
Main Switchgear Room	MS-A1	DPH-2	Fused Disconnect	74.5	1.3	03/26 12:01	OK
Main Switchgear Room	MS-A1	1st & 2nd Fl. Closet	Fused Disconnect	74.1	0.9	03/26 12:01	OK
Main Switchgear Room	MS-A1	MCC-37 A	Fused Disconnect	74.8	1.6	03/26 12:02	OK
Main Switchgear Room	MS-A1	ADB Feed	Fused Disconnect	74.5	1.3	03/26 12:02	OK
Main Switchgear Room	MS-A1	CW Pump #10	Fused Disconnect	74.5	1.1	03/26 12:03	OK
Main Switchgear Room	MS-A2	CW Pump #12	Fused Disconnect	88.39999	15.2	03/26 12:01	ELEVATED
Main Switchgear Room	MS-A2	MCC-37B	Fused Disconnect	75	1.6	03/26 12:03	OK
Main Switchgear Room	MS-A2	ATS #2	Fused Disconnect	74.8	1.4	03/26 12:03	OK
Main Switchgear Room	MS-A2	ATS #3	Fused Disconnect	75.2	1.8	03/26 12:04	OK
Main Switchgear Room	MS-A2	ATS #1	Fused Disconnect	75	1.6	03/26 12:04	OK
Main Switchgear Room	MS-A2	ATS #4	Fused Disconnect	74.1	0.7	03/26 12:04	OK
Main Switchgear Room	MS-A2	DP2-CSFB	Fused Disconnect	74.7	1.3	03/26 12:04	OK
Main Switchgear Room	MS-B1	MS-B1	Switchgear Bus/Wir	73.8	0.4	03/26 12:03	OK
Main Switchgear Room	MS-B1	MS-C1	Fused Disconnect	74.1	0.7	03/26 12:04	OK
Main Switchgear Room	MS-B1	USA Network	Fused Disconnect	75.39999	2.2	03/26 12:03	OK
Main Switchgear Room	MS-B1	Circuit #2	Fused Disconnect	75	1.4	03/26 12:04	OK
Main Switchgear Room	MS-B1	Circuit #3	Fused Disconnect	74.1	0.9	03/26 12:02	OK
Main Switchgear Room	MS-C2	ATS #2	Fused Disconnect	75.2	2	03/26 12:02	OK
Main Switchgear Room	MS-C2	ATS #3	Fused Disconnect	74.1	0.9	03/26 12:02	OK
Main Switchgear Room	MS-C2	MCC-37C	Fused Disconnect	75	1.8	03/26 12:02	OK

Figure #1 **Condenser Water Pump #12 shows an elevated Delta T of 15.2 degrees F**

Identification of Problem - After the Chief Engineer reviewed the Delta T Alert data, he employed his thermographer to conduct an infrared scan on the Condenser Water Pump #12 fused disconnect. Thermography results showed an almost 13 degree temperature rise on the "A" phase fuse connection. See Figure #3.

Event #	Date:	Location:	MCC or Panel	Equipment Label:	Priority
1	03/30/09	Main Switchgear Room	MS - A2	CW Pump #12 Fused Disconnect	3

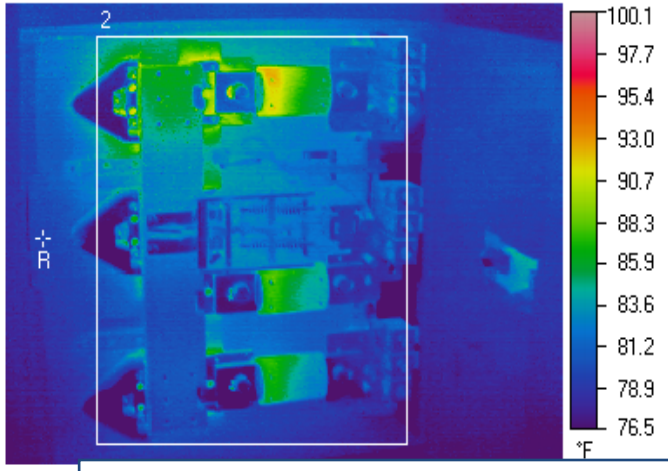
Apparent Temperatures:	Image Date 3/30/2009 Image Time 11:35:55 AM	Reference Photo:
Problem Temperature: 92.4 °F Reference Temperature: 79.7 °F Temperature Rise: 12.7 °F		

Figure #3

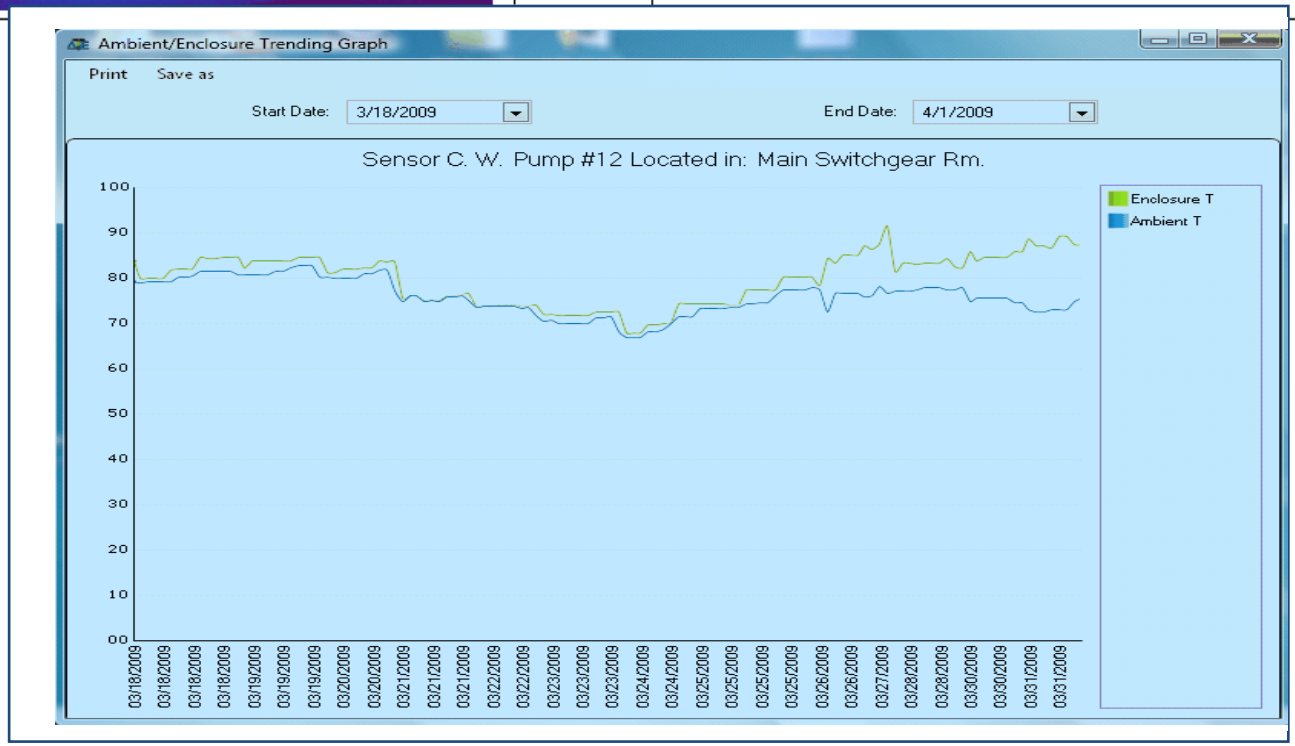


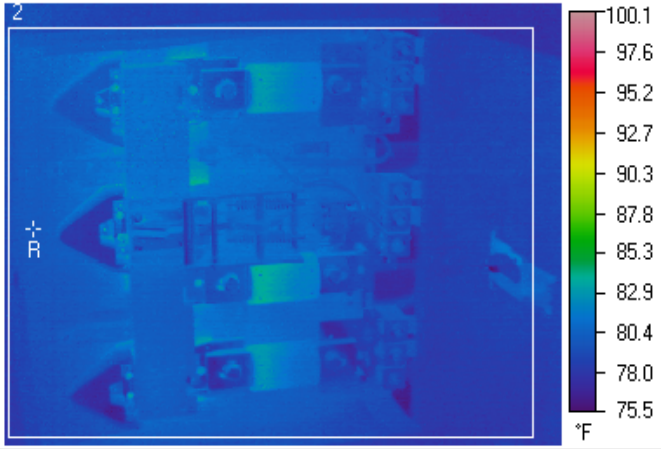
Figure # 4 – This graph compares the enclosure temperature to the room ambient temperature in which the enclosure is located. Notice how the two temperatures are spreading over time.

Figure #4

Corrective Action

The Chief Engineer submitted the infrared survey findings to his electrician. CW Pump #12 fused disconnect was de-energized and corrective action was performed on phase “A” fuse connection by his electrician. Phase “A” connections were disassembled, contact surfaces were cleaned and re-assembled to the proper torque values. Figure #5 illustrates a thermogram after corrective action was completed. **Both before and after thermograms were recorded under the same load conditions.**

Event #	Date:	Location:	MCC or Panel	Equipment Label:	Priority
1	04/05/09	Main Switchgear Room	MS - A2	CW Pump #12 Fused Disconnect	Repaired

Apparent Temperatures:	Image Date 4/5/2009 Image Time 12:54:16 PM	Reference Photo:
Problem Temperature: 84.2 °F Reference Temperature: 82.1 °F Temperature Rise: 2.1 °F **Figure #5**		

Benefits/Conclusion

- Delta T Alert records three readings per day/365 days per year versus one infrared snapshot once per year
- Delta T Alert identified a loose connection on Phase “A” of a Condenser Water Pump disconnect at the beginning stages of failure, possibly preventing downtime during the peak of the Air Conditioning season in June, July and August.

Cost/Benefit

Approximate price of the Delta T Alert unit is $250.00 depending on the number of units purchased. This price equates to .23 cents per reading if three readings are recorded per day. A small price to pay for the benefit of preventing downtime or possible catastrophic failure.

Conclusion

There has never been an easier, more cost effective way to keep your electrical enclosures operating safely. The Delta T Alert system will enable customers to Monitor – Report – Diagnose & Repair problems prior to downtime or even catastrophic failure. Your building's maintenance personnel and/or electricians will have an enormous safety advantage if they are warned, prior to any type of routine maintenance or troubleshooting, of possible electrical anomalies prior to accessing electrical enclosures.

By utilizing Delta T Alert as a proactive maintenance tool, it is possible to extend the service life of your electrical infrastructure as well as reducing the overall maintenance cost and associated downtime.