Infrared diagnostics of distribution line fuse problems

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ABSTRACT

Mississippi Power Company, being a leader and trendsetter in finding new and better ways to improve dependability and increase customer satisfaction, has been developing and expanding the use of IR thermography as a predictive maintenance tool.

We have implemented a program of annual infrared inspection of all our substation feeders along with our industrial, commercial customers and padmount transformers. A large percentage of our IR "findings" relate to line fuses.

During the infrared inspection of substation feeders, I have detected numerous line fuse problems, an average of 10% of the 40 problems found per substation. By classifying these problems I identified them and put them in four categories. They are: 1.Overlatching; 2. Loose Fuse Caps; 3. Improper Seating of Fuse in Hinge; 4. Cable Clamping Nut Loose

By finding, identifying and correcting these problems we will be able to greatly reduce the outages and blinks to our customers, Therefore improving dependability and customer satisfaction.

This paper will describe the program and the findings and explain the diagnostics of the problems found during infrared scanning substation feeders.

Keywords: Proactive, Customer Satisfaction, Fuses

1. FINDING THE PROBLEMS, IDENTIFYING THEM AND FIXING THE PROBLEM

By implementing a program of infrared scanning our substation feeders Mississippi Power Company has gone the extra step to give our customers the best possible uninterrupted power service we can supply. By finding an average of 40 problems per substation, I identified the problems and put them into four categories. They are "Hot" Lightning Arresters, Cutout Fuses, Connections and Compression Crimps. This paper addresses problems with fuses.

This method of identifying the problems helped me track the problems and discover we had a major fuse problem. Of all the problems found about 10% of the problems were identified as being fuse problems. Even though fuses were only 10% of the total problems found they impacted the most customers. One fuse could affect as many as 1500 customers. Fuse problems were broken down into five categories. 1. Fuse Caps 2. Latching, 3. Hinges, 4. Clamping Nuts, 5. Connections

By using infrared to find these problems we were able to fix the problems before they caused an outage. Most of the problems found would have resulted in major outages to our customers if they had not been found and fixed in time. By identifying and correction the problem before it occurred most of our customers never knew there was a threat of an outage.

Through awareness, training, and using the proper tools, we have been able to greatly reduce the problems on our feeders and greatly improve our customer satisfaction. By letting the customer know what we are doing this, we have a better working relationship with them.

2. FUSE CAPS, LATCHING, HINGES, CLAMPING NUTS AND CONNECTIONS

1. Fuse caps

Fuse caps being installed improperly is the most common problem found with fuses, through investigations I have discovered that most of the caps were loose due to human error. When replacing a blown fuse, or installing a new fuse, the fuse caps were replaced with the person wearing leather gloves, which is a common practice to do. By holding the fuse barrel in one hand and tightening the fuse cap with the other hand the fuse cap would twist or slip in the glove appearing to be tight, and the fuse would be put into service. Fuses with loose caps that have been in the field for a while and have had several faults, on them will cause arcing inside of the fuse cap. This will cause heat and eventually cause the fuse to melt out and the fuse barrel to fall open, causing an interruption to the customer.

Arcing causes pits and spurs to form on the fuse due to loose caps. When the fuse is replaced due to being blown from a fault or melting out and opening up, the fuse cap will not seat properly if the spurs are not removed and the pits or not buffed up with a file or sandpaper. When this occurs the fuse will melt out if enough current is applied on the fuse. **Figure 1** illustrates two examples of loose fuse caps as seen with infrared.

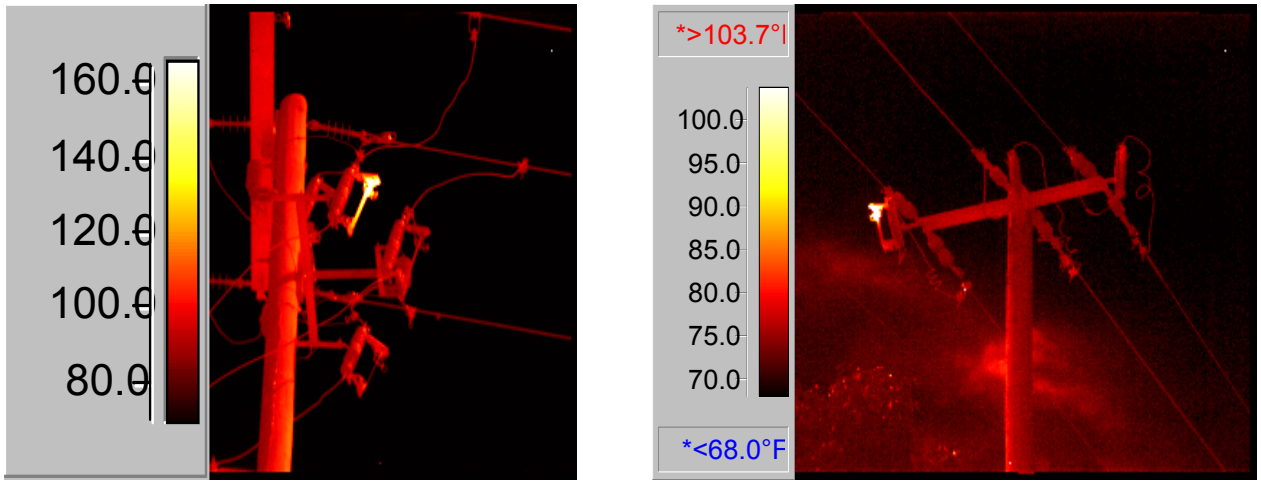

Figure 1. Two examples of overheating due to loose fuse caps

2. Latching

Latching some of the 200amp-fused cutouts had a design problem; the mechanical stop was not properly set. The mechanical stop was set too far back, therefore letting the fuse barrel travel past the proper stop for the fuse cap. This caused the fuse to overlatch and to make contact on a small portion of the fuse cap, instead of making contact on the complete top of the fuse cap, which greatly reduced the amount of current carrying capability of the cutout. This resulted in the fuse cap overheating and causing the fuse to melt out.

By making the manufacture aware of this problem, the problem was corrected, by moving the manual stop toward the fuse barrel one fourth of an inch. Thus eliminating this particular problem.

Other latching problems were due to several other things such as bad contacts, that have been pitted due to arcing, bent mechanisms which caused misalignment and the contacts would not align properly, damage to parts of the cutouts, such as lightning. All of these problems were found and corrected before the customer power was interrupted. **Figure 2** illustrates two examples of latching problems

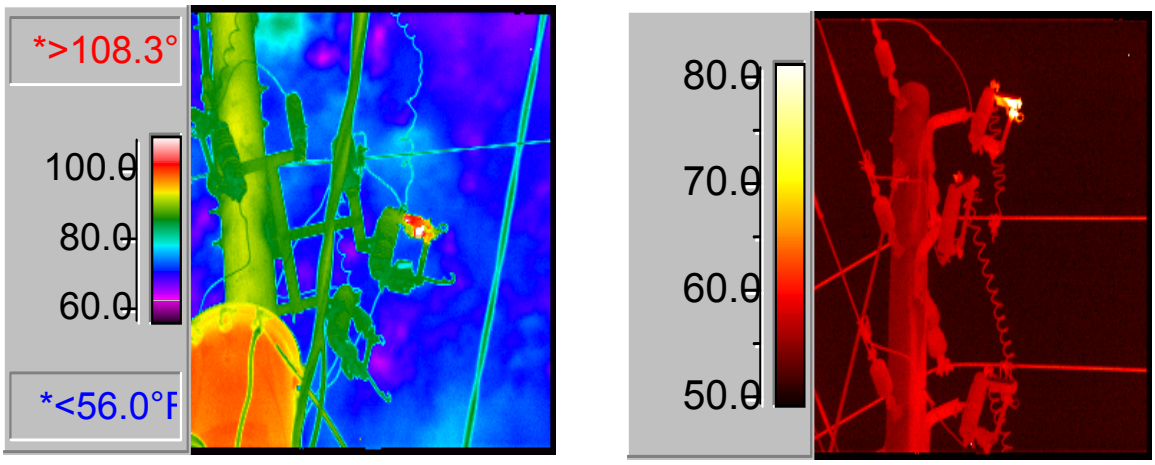

Figure 2. Examples of heating due to improper latching

3. Hinge problems

Hinge problems, were caused by several different things. When the hinge is bent from rough treatment, such as cutouts being hauling around on line trucks for an extended period of time before installation, and lightning strikes. Trying to close the fuse when it is not properly seated in the hinge or if the ears are damaged on the fuse barrel, this will cause a bad connection in the hinge. These problems are mostly due to human error and can be greatly reduced with proper training and awareness. **Figure 3** illustrates two examples of hinge problems.

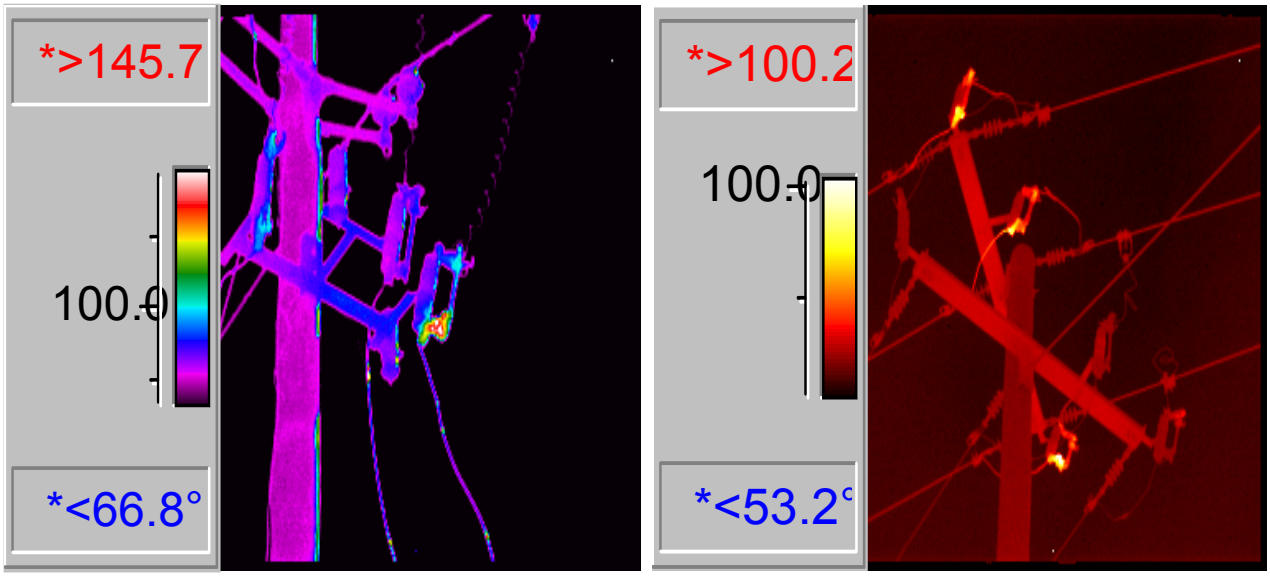

Figure 3. Illustrations of hinge problems

4. Clamping nuts

The Clamping Nut that holds the tail of the fuse tight around a stud on the trunnion, which in turn is essential for the fuse cutout to work proper, must be tightened properly. Failure to do this will result in a loose connection and as a result the fuse will heat up and melt out causing an outage. **Figure 4 I**llustrates two examples of loose clamping nuts.

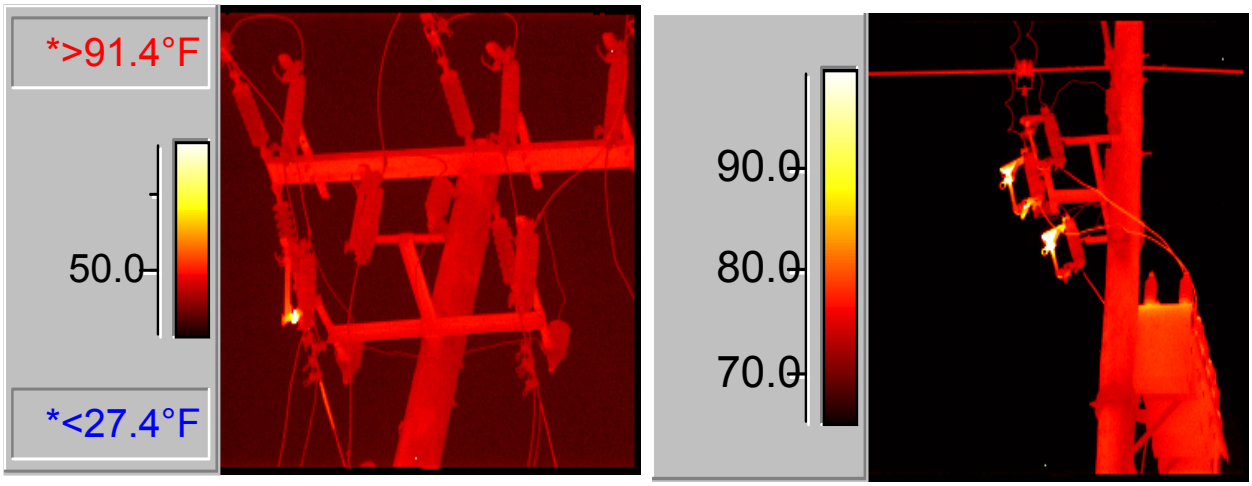

Figure 4. Illustrations of loose clamping nuts

5. Connections

Connections were a big portion of the problems found. These were bad connections due mostly to human error. Some of the reasons were weather, heat, improper tools for the job, and rushing to get power restored as soon as possible to the customer. Making people aware of these improper connections and through training, we have been able to greatly reduce this problem. If a connection is not made properly it will eventually cause an outage or interrupt power service to our customers, which in turn cost our customers and us. The severity of the problem can be seen in **Figure 5** where overheating due to improper connections exceeded 20°F.

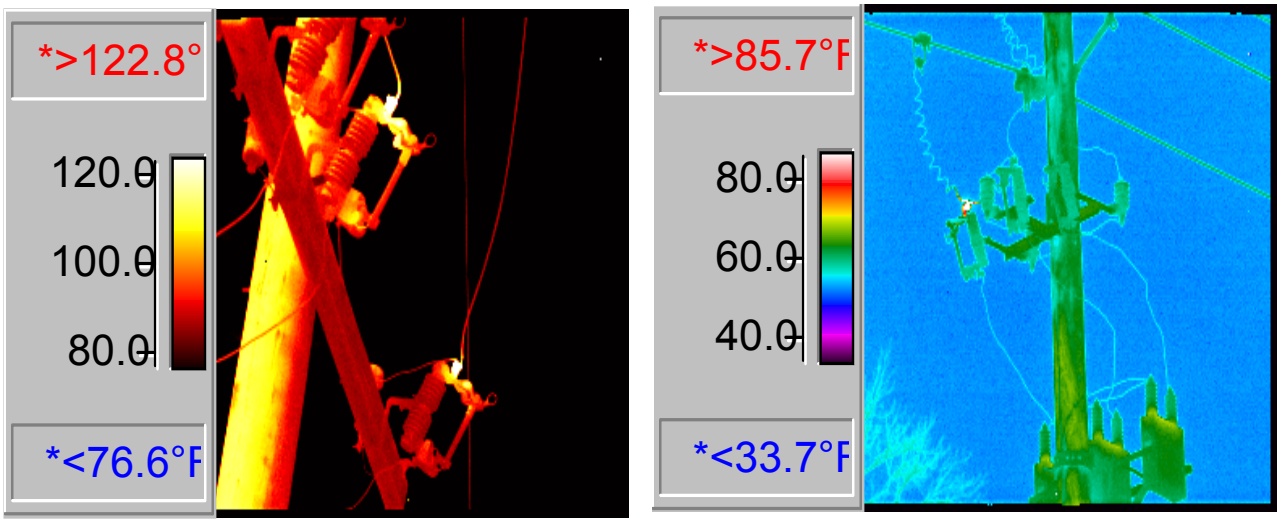

Figure 5. Two examples where poor connections due to human error caused overheating

3. SUMMARY

Line fuses effects more of our customers than any other single piece of distribution equipment. By being proactive we can prevent most of the human error problems from occurring, however we cannot prevent mother natures will. Through training and awareness we can greatly reduce the number of problems that would have been. The infrared camera plays a large part in keeping power to our customers uninterrupted. Cutout problems have the potential to cause an outage lasting several hours or an interruption for a short period of time. These interruptions could affect one of our customers or several hundred of our customers. The dollar loss is kept to a minimum by finding these problems and setting up an interruption to repair the problem or fixing the problem without an interruption, to our customers. By repairing these problems at scheduled outages not only is there a saving in outage time, but also a savings in overtime call-outs for someone to repair the job after an outage has occurred. Mississippi Power Company has taken the initiative to be the best provider of electricity to our customers and a trendsetter for the future. By finding these problems, identifying them and having trained and informed people doing the job, we can reduce our potential outages and problems to a minimum. Therefore resulting in great customer satisfaction and a win-win for all involved.