AMP Quality Energy Services

“An Unintended Discovery”

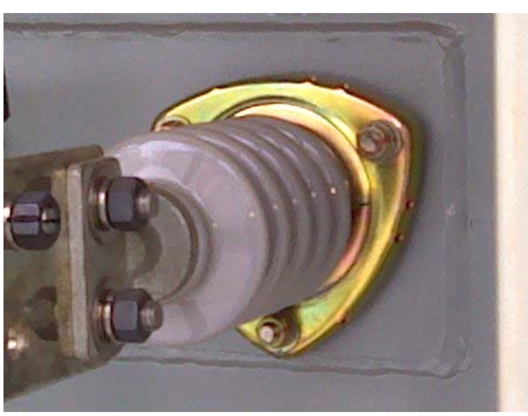
15kV Cable with Deadbreak Terminations Infrared Thermography Case Study

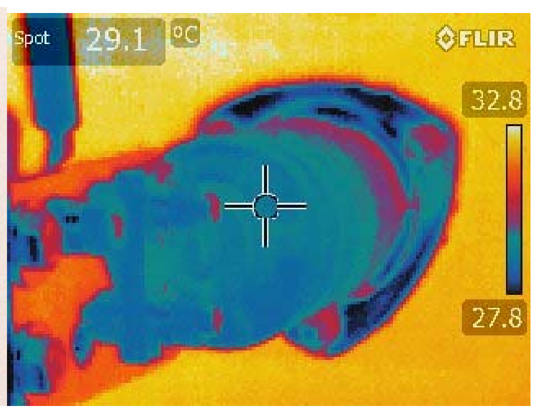
By Jeremiah Evans

AMP Quality Energy Services recently finished NETA acceptance testing at a new steel plant. The contract was completed over the course of a year and included all the electrical distribution equipment from the incoming utility, 15kV plant distribution, and low voltage system. Upon completion of acceptance testing, the plant facilities started bringing the various parts of the facility online while production personnel started all the operations checks for the various processes. It was during this start-up period that a High-side transformer bushing failed in one of the oil filled pad mount 12470/480Y-277 transformers. The manufacturer stated the cause of the failure was inconclusive and made plans to replace the failed bushing. The customer did however want a review of the acceptance tests conducted on the transformer and cables prior to energization of the new equipment, and after a review, no deficiencies were identified in the test results.

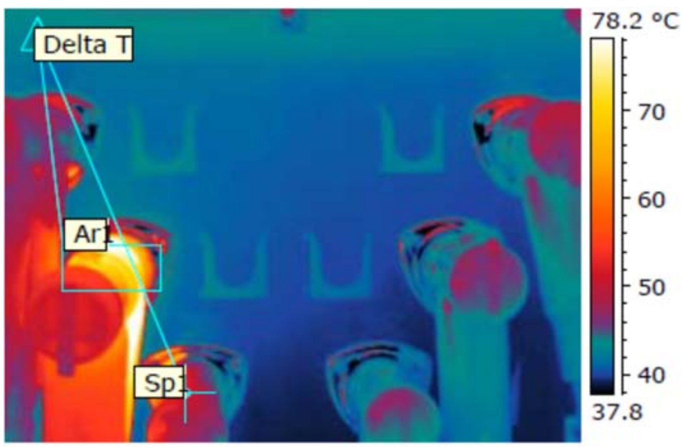
It was during this time that AMP was contracted to conduct an infrared thermographic study of the high side bushings in the 23 pad mount oil filled transformers located on site. The customer did not want to de-energize any of the transformers to conduct a closer hands on inspection for flaws in the bushings, but felt that an IR study may provide an indicator if they had another bushing close to failure. A time was scheduled to conduct the IR study when the facility was under operational load. AMP technicians arrived on site and began the investigation with the assistance of the plant maintenance personnel.

All of the IR and standard pictures taken displayed a normal temperature gradient across the three high side bushings of each transformer. An example of a Standard bushing pictures and its corresponding IR pictures are displayed below:





It wasn't until near the end of the second day of investigation that the team came across two transformers that had Cooper Deadbreak terminations instead of the two-hole lug terminations that had been present throughout the rest of the plant. The technician on site decided to go ahead and take a look at the deadbreak terminations, since they were there and the cabinet had been opened. The H1A, H2A, and H3A deadbreaks were fed from two sources and tied together via an adapter and double stacked 600A rated deadbreaks. The pictures below display what was witnessed and recorded:



Atmospheric Temperature	20.0 °C
Ar1 Max. Temperature	89.3 °C
Sp1 Temperature	50.9 °C
Delta T Value	38.3

Below is a cut-away diagram showing what a 600A Cooper Deadbreak looks like internally and how the parts connect. The Diagram shows only a single termination with a cap installed on the outer portion but the deadbreaks in service, shown in the study, have an additional deadbreak stacked and connected to the original one that mates up to the transformer H1A-H3A bushings. This drawing is included here and referenced from; _Cooper Power Systems Deadbreak Apparatus Connectors 600-50, Figure 2_.

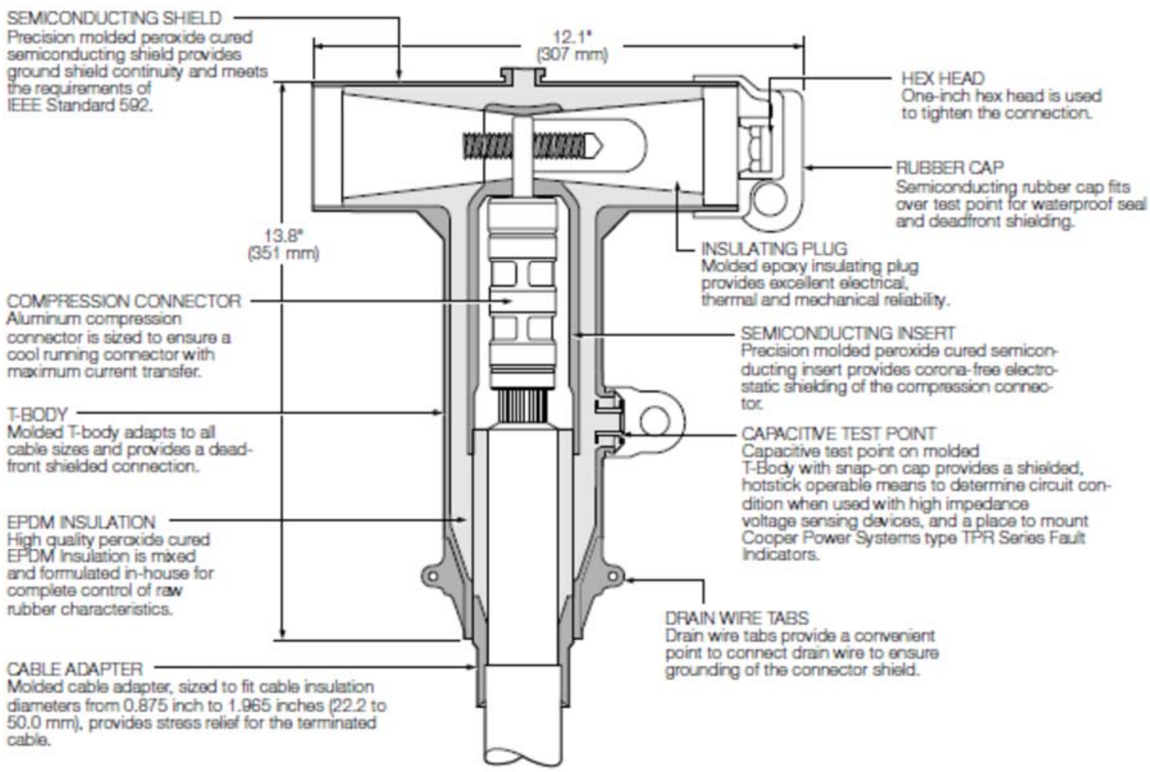


Figure 2.
Bol-T cutaway illustrates design features.

The AMP Technicians immediately notified the customer that the H2A double stacked deadbreaks on this transformer had a ~38°C temperature difference between its neighboring phases of H1A and H3A. This hot spot was not an expected part of the intended investigation, but was something that needed to be addressed immediately. After explaining the severity of the temperature differential by a technician, the customer then decided, due to plant production demands, to wait for the next scheduled outage, which was two weeks away to do any further investigation into what was causing the hot spot. Prior to the scheduled outage the customer was able to determine that loading was equal across all three phases and well within expected loads for that feed.

The customer outage was completed over a holiday weekend with a local electrical contractor investigating the deadbreak connections to determine what might be causing the hot spot. The following Cooper deadbreak double stack adapter was removed from the transformer.

The electricians reported that the connections were finger-tight and appeared to have not been torqued. The loose connection between the two deadbreak termination connection adapters had generate heat due to a high resistance condition. AMP supplied a new termination kit to replace the damaged components and allow the transformer to be placed back into service by the time the outage was scheduled to be complete.

The price to repair the damaged adapter and cable deadbreak termination was in the hundreds of dollars as opposed to a more expensive unplanned outage if the equipment had suffered a catastrophic failure while in service. This left the customer with a better appreciation of the value of conducting a more in depth IR thermographic survey of the facilities equipment. Even though the cable terminations in question were outside the scope of the original survey, the technicians spent the few extra minutes to take a look into the customer's equipment and found an unforeseen potential problem.