[redacted]
Manager, Regional Rail Vehicle Engineering
SEPTA

September 16, 2025

Failure Analysis Report Main Smoothing reactors 9/3/2025

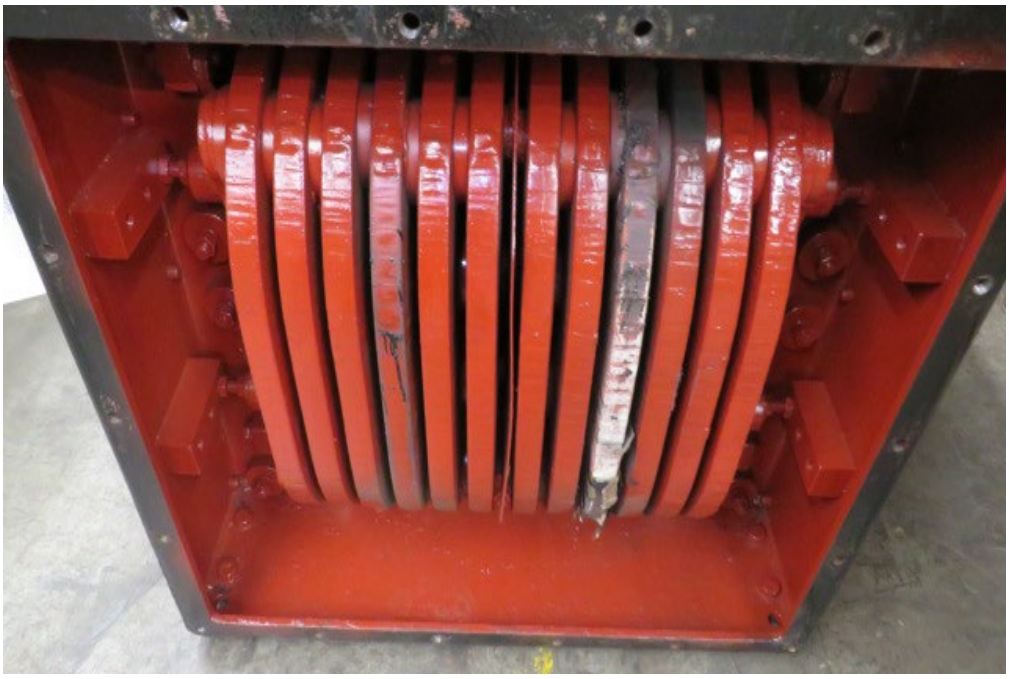
We visited the SEPTA Overbrook facility on Wednesday September 3rd to inspect two GE manufactured Main Smoothing reactors (EX54) that had been exposed to fire damage.

The reactor in the February 2025 incident is:

#132 serial no. K546422

History : complete rewind with new coils in Feb 2012, then a Basic Overhaul, (clean and revarnish) by the SEPTA repair shop in 2017.

The SEPTA mechanics took some electrical readings for resistance and impedance, and megger tested the insulation resistance. Results are with SEPTA.
The reactor was then disassembled by SEPTA mechanics under the direction of our technician, and the coils were separated from the core.
We looked at the visual condition of the reactor. There was evidence of excessive burning of the outside leads and a small section of the coils where the opening to the cooling duct would have been. The burning was localized in this particular area. The remainder of the reactor coils, although darkened by smoke damage, did not show any signs of insulation failure, or burning, and in fact the insulation looked to be in good condition.
From our 15-year repair history of these units, we have found the main reason for failure of these reactors is when the interturn insulation between the copper conductors starts to break down. This creates short circuits and subsequent overheating in the coil itself. If the reactor remains in operation at this point, the coil will eventually burn itself out and the adjacent coils will also begin to fail. Ideally, the reactor is taken out of service at this point and shipped to us. Then we see a reactor with one of the 12 coils obviously burnt, with darkened and burnt insulation while the other 11 coils are visually undamaged. (see a sample picture below for an example)



From the visual evidence we believe that the reactor was not the cause of the fire, but was damaged by fire coming from another source, travelling down the cooling duct and burning the section of coils that were directly in the path of the duct.
We have since received the coils from this reactor and we will conduct further tests to see if there is any evidence that the reactor had begun to fail before the fire.

We do not suspect that this reactor was the source of the fire.

The reactor in the July incident is:

<u>#114 serial no. K545945</u>

History: complete rewind with new coils in May 2012, then a Basic Overhaul, (clean and revarnish) by our WALCO repair shop in March 2021.

The SEPTA mechanics took electrical readings and megger tested the insulation, but it was clear from the visual evidence that the reactor had been completely burnt throughout.
All parts of the external insulation tape were burnt, as was the majority of the insulation separating the two coil banks, and the main core insulation.
There were no obvious localized spots of burning, and it looked like the whole reactor had been on fire.
The reactor was disassembled by SEPTA mechanics, and the coils were removed from the core.
We then separated the 12 coils from each other, and starting with the innermost coils from each bank (labeled #6 and #7) we removed the outside insulation from the coils.

The outside glass tape was completely burnt, and the inside layers of mica tape were also burnt. We exposed the copper coils to examine the interturn insulation and it was quite obvious that the interturn insulation had also completely burned. There were sections of the coil that were burnt more than others which would suggest that this was the location within the coil where the failure began, and subsequently spread throughout the coil.
This was the same for both #6 and #7 coils, which were the two middle coils of the bank of 12, and would normally be the hottest when in service.
We then examined coil #1, which is the outermost coil, and would normally be slightly cooler in operation because of its location. The glass insulation tape was stripped away from this coil to expose the layers of mica tape beneath .
Although the glass insulation tape on the outside had been badly burnt, the mica tape beneath it had not suffered the same amount of damage as the mica tape from the innermost coils (#6 and #7). The coils interturn insulation had been overheated and burnt , but not to the same extent as the innermost coils. This would suggest that this particular coil had been burnt from the outside in, and was damaged from the fire created from the failure in the innermost coils, which had burnt from the inside out.

In cases like this where the fire damage is so extensive it is difficult to exactly pinpoint the cause of failure, but based on our experience of working on these units we would guess that the failure began when one of the coils had a failure in the interturn insulation (probably #6 or #7). This would then have continued to burn the coil. Meanwhile, with the heat generated by the failing coil, and possibly excess current due to the short circuits in the coil, the adjacent coil(s) would begin to overheat and fail also. Eventually there would be enough heat to ignite a flame. The insulation is impregnated with varnish and this would have added fuel to the fire.

The general consensus of opinion of all the parties present, based on the location and lesser amount of damage to the connected units (Double end blower etc) was that this reactor was the original source of the fire. We see no reason to think otherwise.

[redacted] General Manager
[redacted] Production Shop Manager
Walco Electric
303 Allens Avenue
Providence RI 02905