

## Application Note

# Transformer Rewind Shops, as a potential market for Neoptix Temperature Fiber Optic Sensor Products

Date: November 2011

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Many utilities are using rewind shops to rebuild old transformers, as a way to save (some) money over building new transformers with equivalent specifications. These transformers have often been in used for more than 30 or 40 years, and have either reached their end-of-life or have had some incidents that have forced their retirements. While inspecting the inside components of these old transformers, it is interesting to note the following:

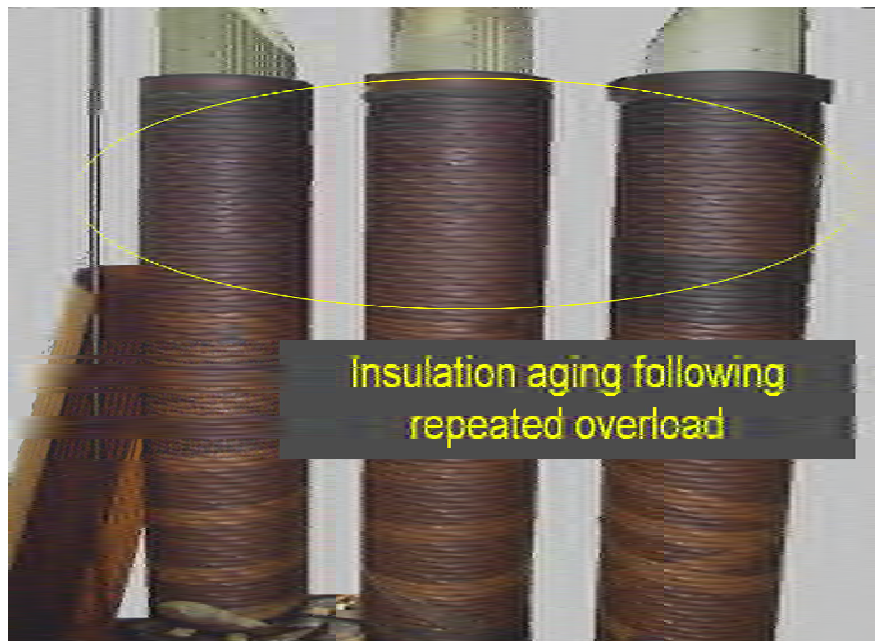
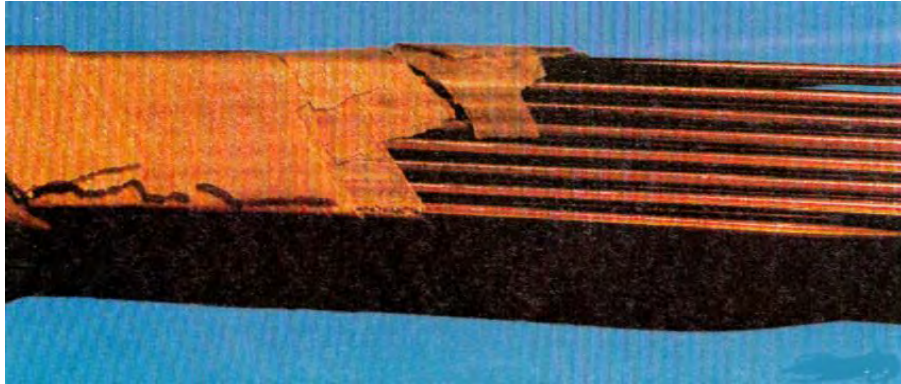
- Insulation paper that is darkened and that easily disintegrates or crumbles; this is normally observed near the top of windings, particularly the LV windings; this is a clear indication that these areas have suffered from excessive temperatures, and are good locations for eventual fiber optic probe installations. These pictures illustrate the heat damage to the active part of a transformer (65MVA), after 35 years of use (left picture represents the old active part, after de-tanking, and the right picture is a close-up of damaged paper on top of LV winding).



- With time and temperature, all cellulose materials undergo a “depolymerisation” process; i.e.. cellulose chain breaks down into smaller chains and the paper loses its mechanical strength and becomes brittle and, as a consequence, its dielectric properties are negatively affected. The aging process is irreversible and define the end of life of a transformer.

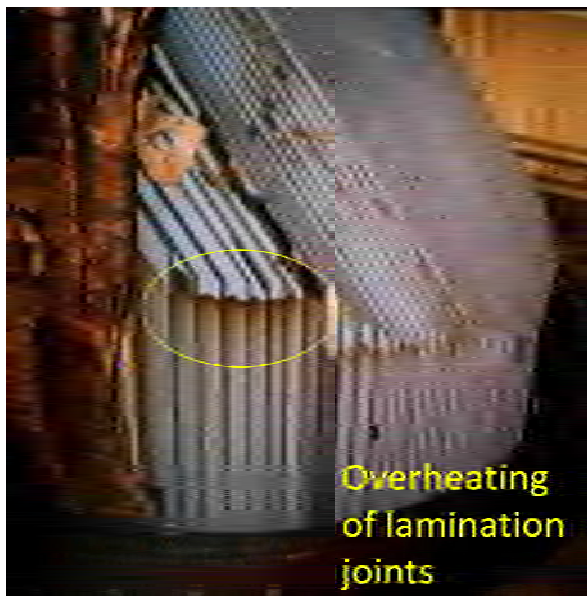
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More pictures of damaged insulation paper in windings:

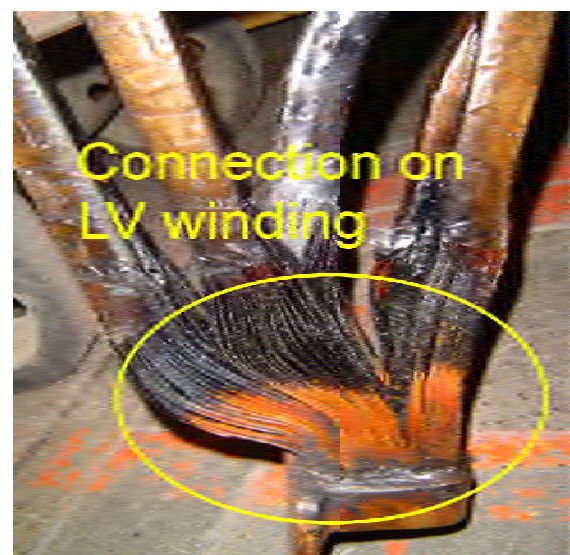


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- Detection of winding temperature is critical because it has a direct effect on insulation aging and ultimately defines the transformer end of life.
- Core overheating. This can happen for several reasons, such as:
  - Excessive spurious currents in the core yoke, caused by the regulating winding on some tap positions.
  - Excessive stray flux from winding during overload conditions.
  - Steel rusting with the years, causing spurious currents to circulate between laminations. Excessive moisture in oil can be a long term problem, causing laminations to rust, and then current conduction occurs, and could cause excessive temperature rise.



- Darken spots, connection overheating, burned paint, etc. This indicates that these areas have had excessive temperature exposures, and could indicate trouble spots; this damage is usually caused by spurious Eddy current losses, and can be seen particularly on steel structural elements.



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The visual locations of trouble spots should be very good indications on where future fiber optic probes should be located. This is why rewound transformers should be targets of choice for the Neoptix fiber technology.

In USA, Southwest Electric<sup>1</sup> in Alabama is a good example of a rewind shop; Grand Eagle<sup>2</sup> in Ohio is another good example. Worldwide, the major transformer manufacturers, CG, Siemens<sup>3</sup>, Alstom<sup>4</sup> and ABB<sup>5</sup> (also General Electric<sup>6</sup>), all have rewinding (also called remanufacturing) shops around the world.

## Summary

For transformer end-users, important fiber optic temperature benefits are:

- Fiber sensors located at trouble spots will provide long-term valuable information about the transformer aging history (insulation end of life).
- During the heatrun<sup>7</sup> test: As they may not have done the original design of this old transformer, fiber optic can be an excellent confirmation of the “real” MVA rating of this transformer; this information should be very useful for the transformer manufacturer as well.
- Fiber sensors give better real-time data on actual hot spot temperatures; it is thus not surprising that more and more transformer cooling control is made using fiber readings, instead of the traditional WTI device.

For transformer manufacturers, important fiber optic temperature sensor benefits are:

- The main benefit for a manufacturer is to use the heatrun test data to “fine-tune” their R&D and Engineering knowledge.
- Fiber sensors can be an excellent monitoring tool in case of subsequent warranty claims by the utility.

## A case study

In 2008, Hydro-Québec refurbished a 35-year old 66 MVA transformer, and installed 18 fiber probes in it. This old transformer, installed in Québec City, blew up during a very cold January night. Dr. Patrick Picher, of IREQ, wrote a technical paper on this transformer, which was presented at the Cigré Conference in Paris in August 2010<sup>8</sup>.

This transformer is still being monitored continuously by Hydro-Québec, using 2 Neoptix T/Guard's and a Qualitrol 509 ITM monitor.

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<sup>1</sup>These web links were up-to-date in August 2011.

See <http://www.swelectric.com/power-transformer-services>

<sup>2</sup> See [http://www.mediaii.com/pdfs/ge\\_transformer.pdf](http://www.mediaii.com/pdfs/ge_transformer.pdf)

<sup>3</sup> See <http://www.energy.siemens.com/mx/en/services/power-transmission-distribution/transformer-lifecycle-management/repair-retrofit.htm>

<sup>4</sup> <http://www.alstom.com/grid/powertransformerservices/>

<sup>5</sup> [http://www05.abb.com/global/scot/scot252.nsf/veritydisplay/fea84e88e6fe2064852571c50068c008/\\$file/1zul004509-005\\_fieldservicelinecard3.pdf](http://www05.abb.com/global/scot/scot252.nsf/veritydisplay/fea84e88e6fe2064852571c50068c008/$file/1zul004509-005_fieldservicelinecard3.pdf)

<sup>6</sup> [http://www.ge-energy.com/products\\_and\\_services/products/transformers\\_and\\_capacitors/transformers.jsp](http://www.ge-energy.com/products_and_services/products/transformers_and_capacitors/transformers.jsp)

<sup>7</sup> Also called “Temperature Rise Test”.

<sup>8</sup> P. Picher, F. Torriano, M. Chaaban, S. Gravel, C. Rajotte and B. Girard, Hydro-Québec, Canada. “Optimization of transformer overload using advanced thermal modeling”, Cigré 2010, Paper # A2-305. Do not hesitate to contact me for a copy of this paper.