



Partners in technology

A French utility giant and ABB work together to “transform” the distribution network

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Behind every successful product lies knowledge, innovation and team work. One such example is ABB’s TPC transformer, a three-phase distribution transformer with built-in protection. It was designed in response to EDF (Electricité De France) demands for extra functionality and safety, as well as increased distribution network reliability. This transformer meets stringent environmental regulations in that it is hermetically sealed. It is also an example of how effective cooperation can lead to unexpected gains for both sides.

EDF (Electricité De France) Factbox owns and operates one of the biggest distribution networks in Europe. In France alone, 700,000 oil filled distribution transformers, rated at between 50 and 1000 kVA, are installed. While the transformer is considered one of the most reliable components in a network, this reliability is threatened if adequate protection is missing. In particular the relatively small (usually 50 to 160 kVA) pole mounted transformers tend not to be protected by fuses and a load break switch, and this can have significant consequences for the rest of the local network especially during severe storms, and the one that hit France in December 1999¹⁾ serves as an excellent example to illustrate this. This storm exposed the vulnerability of sections of the network and so the EDF decided to bury part of the MV distribution network. Some of the now buried lines use small non walk-in compact secondary substations (CSS) which are equipped with small transformers (100 to 250 kVA). A switchgear is used to protect these transformers. Doing this also significantly impacts the total investment required.

In any case, long before the storm struck EDF had realized the need to secure the distribution network, and a program was launched in the 1990s to do just that. Beginning in 1996, EDF introduced their own technical specifications for a “self protected” range of transformer rated from 50 to 250 kVA. Known as the TPC transformer, it should be filled with oil and include a load break switch, fuses, and thermal and oil level protection in the tank. Some of the first companies to successfully meet these specifications included Areva (former Alstom), Schneider, Transfix and Pauwels. However back in 1993 ABB was one of the first companies to be involved in the development of self protected transformer technology.

EDF purchases 17,000 transformers per year of which 75 percent are of type TPC. In fact the group believes that “in the near future all new oil filled distribution transformers will be of type TPC to ensure better reliability of the distribution network”. Unfortunately a significant part of these oil filled distribution transformers are PCB polluted, and in accordance with European and French regulations the group has launched an exchange campaign to clean up the network before 2010. In addition to this all CSS equipped with 400 and 630 kVA transformers will receive a TPC type transformer. These CSS, specific to the EDF market, will then be known as PUIE.

As an established and recognized supplier of world class transformers, ABB wanted to have its own TPC concept certified by EDF. Not only has this happened but the company is now a concrete part of the frame contract with EDF. This means ABB TPC transformers have access to one of the biggest European utility markets and are

also in a strong marketing position in EDF influenced markets. The transformer concept is discussed in greater detail in the following paragraphs.

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TPC transformer concept description
ABB's TPC transformer, **1** and **2**, adheres to the current transformer (CT) principles and standards but greatly extends the functionality provided by distribution transformers. This three-phase transformer is completely filled with mineral oil and are hermetically sealed²⁾. With additional built-in protection, environmental and customer impact is minimized in the event of unforeseen disasters. The product fulfills the technical requirements as described by the EDF specification³⁾. On top of this, ABB's TPC transformer also complies with the new IEC 60076-13 standard⁴⁾ for “Self protected liquid-filled transformers”.

The built-in TPC transformer protection functionality is generally activated by high voltage wiring faults causing a “three-phase disconnection”. The overall purpose of the internal protection is to then:

- Clear all internal faults without any external manifestation
- Protect the upstream network
- Clear the downstream faults without any external manifestation
- Clear the low voltage bushings and busbar faults that in turn cause fuse and overpressure protection tripping
- Protect maintenance crews against possible transformer faults

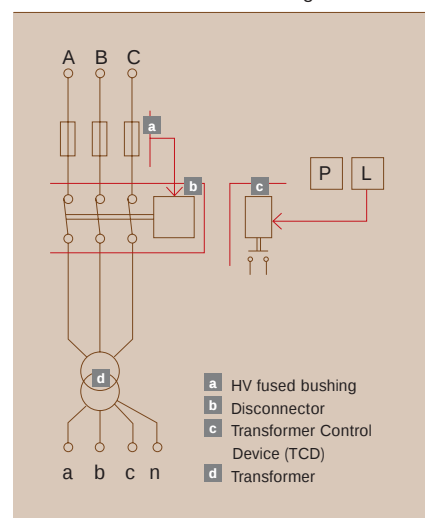
TPC transformer protection does not function when the fault is located on the supply network and when in

Factbox | EDF (Electricité De France)

The EDF group is an integrated energy operator present in all sectors of the electricity industry and is a major player in the French electricity market. It also has solid positions in the United Kingdom, Germany and Italy. The group has the largest generation capacity in Europe. It has approximately 37 million* customers worldwide and a workforce of about 156,000 employees*. See www.edf.com for further information.

*2006 figures

1 TPC electrical connection diagram



2 TPC substation unit equipped with plug-in resin bushings



Footnotes

¹⁾ On the 26th, 27th and 28th December 1999, France and Germany were hit by severe storms and rain. The storms caused extensive damage to property and trees as well as the French and German national power grids. For more information, please refer to http://www.absconsulting.com/resources/Catastrophe_Reports/Lothar-Martin%20Report.pdf (April 2007).

²⁾ Flexible corrugated tank walls enable sufficient cooling of the transformer and compensate for the changes in the oil volume during operation.

³⁾ The CDN, (Standards Centre) which is part of EDF R&D, publishes a catalogue of technical specifications. These specifications list a series of technical requirements that must be met by a product, a process or a service.

⁴⁾ IEC 60076-13 applies to high-voltage/low-voltage self-protected liquid-filled and naturally cooled transformers rated from 50 kVA to 1,000 kVA for indoor or outdoor use. <http://www.iec.ch> (April 2007).

Power collaboration

operation, it doesn't cause a supply network outage.

The advantages of TPC transformers are numerous, with the most obvious being the environmental impact in times of failure. Additionally the quality of the energy delivered is improved by reducing shut-down times. Maintenance is simplified because the rules for the TPC transformer are equivalent to the standard hermetically sealed transformer maintenance rules. The use of pole mounted units ³ eliminates the need for the fuse/switch elements, and in substations, TPC transformers are considered a compact solution.

Even though the transformer was designed according to EDF requirements, the concept can be applied to three-phase oil immersed transformers from 50 to 250 kVA, with the possibility of extending it to 630 kVA in the future. The current equipment limits the voltage of the transformer to 24 kV.

Manufacturing

ABB's TPC transformer technology was initially developed in Finland. However in 2004 the project was transferred to Lodz, Poland mainly because it is the site of an ABB "focused factory" [1] which concentrates on the manufacture and testing of SDT oil transformers. The initial TPC concept has since been modified meaning that the cut off protection system concept has been redesigned and simplified to make the proposed solution more reliable and production friendly. This was

³ TPC pole mounted transformer type equipped with outdoor resin bushings



mainly driven by feedback from EDF (in particular EDF R&D) and their in-depth understanding of specific customer needs. The TPC transformers have been subjected to numerous tests around Europe but the protection functionality has been verified at the experienced and specially equipped EDF laboratory in Les Reanadiers.

This new solution is currently being patented, something that may not have been possible were it not for the fruitful cooperation that existed between ABB and EDF.

The things that differentiate one transformer from another are the security features provided and/or additional functions that satisfy customer requirements and build added value.

TPC as a new marketing tool

The relationship between ABB and EDF is most certainly not over. Rather it looks set to continue for the foreseeable future. EDF is a natural partner and the main customer for TPC transformers and ABB's strategy will focus on continuously improving its business relationship with France's biggest utility. As a fully approved transformer supplier ABB is not only in a position to meet normal EDF demand, it will also help the group meet the requirements of the PCB oil transformer replacement program.

On the other hand, having a fully approved product means the search for potential customers is definitely more diversified. And the TPC solution is not limited to EDF and France. For example, to meet new regulations brought into force following the havoc caused by hurricane Gudrun in 2005, Sweden is currently working towards a specification which follows the IEC 60076-13 standard. In anticipation of this ABB has developed standard transformers with TPC features specifically for the Swedish market⁵. Successful marketing has already yielded an order from Jämtkraft, a utility com-

pany in the north of Sweden. The order was secured in cooperation with the CSS manufacturer Norrmontage. ABB in Lodz commenced production of the TPC transformer for the international market in the first half of 2007. ABB sales teams around the globe are now busy promoting this sophisticated and advanced TPC transformer concept as well as monitoring the markets for potential customers.

The basic principles or physics surrounding transformer operation will always remain the same. What differentiates one transformer from another however are the security features provided and/or the inclusion of functions that satisfy various customer requirements and build added value. ABB shows that it understands these requirements by promoting new and more effective solutions, and by leading the change process wherever it is needed.

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Footnote

⁵ These solutions have been developed and introduced by ABB Sweden under the SafeGrid concept.

Reference

[1] Hegyi, S., The manufacturing beat, *ABB Review* 1/2006, pp. 12–15 (paragraph entitled Batch flow factories, p. 14).