The T generation

Tmax: a new family of molded-case circuit-breakers

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Strong competition and the need to maintain or increase market share is forcing makers of low-voltage distribution equipment to constantly improve their products, many of which have today reached a certain level of maturity. A mix of advanced technology, market feedback and ecological awareness is therefore needed to ensure innovative product design and provide genuine customer benefits. Tmax molded-case circuit-breakers have been conceived with this and the varied requirements of modern-day usage in mind.

Two groups of manufacturers have evolved within the LV distribution equipment business: a small group of established global players and a much larger group of medium-to-small companies that serve the local markets.

The former group offers high-tech, highly standardized products for the main applications – with performance, service and installation characteristics to match – whereas the latter offers a more limited range of solutions with less technological functionality, but designed to meet the specific requirements of their home markets.

ABB SACE has been traditionally strong in the domestic markets with its molded-case circuit-breakers, which have remained a market leader in spite of intense competition. Different conditions exist, however, in the export markets. Here, global companies jockey aggressively for market share, while fending off very strong and well-positioned local manufacturers who are competing on their own turf.

It was against this varied and complex background that the company developed its business strategy of increasing market share worldwide, developing new areas, and improving customer support, instruction and training.

The ambitious objective that underlies this strategy was to meet the diverse customer requirements whilst ensuring high performance and reliability with a new series of highly standardized, molded-case circuit-breakers that also meet the profitability goals of a modern, market-oriented company.

It was clear from the outset that it would first be necessary to analyze, in depth, the current market situation in order to fully understand the needs of the customers. The global marketplace was chosen for this research, which involved ABB sales organizations as well as the direct users (panel builders, wholesalers, OEMs, etc); in all, more than 250 customers were visited.

The data collected enabled ABB to focus on the precise needs of the customer and on those aspects and characteristics that the actual customers consider to be most important.

This important feedback, added to ABB's broad experience in designing and constructing low-voltage circuit-breakers, enabled the product characteristics to be defined. Once this had been done, a technical feasibility study was carried out using advanced simulation tools. This was followed by an economic feasibility study, after which the Technical Product Specification was issued. The Technical Product Specification defined the functionality and performance requirements as well as aspects of production, quality management and control – all in full compliance with the procedures of the ISO 9001 company quality system.

The outcome of this work, which also profited from synergy effects in the areas of data acquisition, analysis and synthesis, was Tmax – ABB's new series of molded-case circuit-breakers 1.

Engineering and production

A 'parallel engineering' approach was adopted during development of the new circuit-breakers in order to standardize as many of the components as possible. Development of all the products, which involved suppliers as well as ABB departments, could therefore go ahead almost simultaneously.

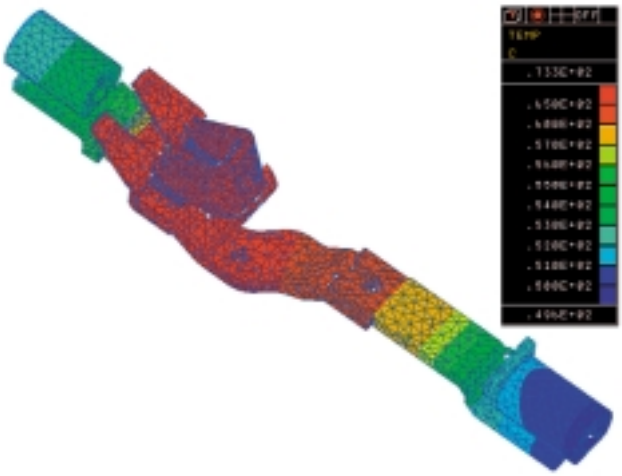
The suppliers were involved in the development of the various parts of the circuit-breaker right from the start. This was done to simplify the product engineering as much as possible and to allow maximum advantage to be taken of the advanced technological solutions offered by the most innovative companies and specialists in the sector.

The 'parallel engineering' approach and timely involvement of suppliers contributed to a considerable reduction in the product's 'time to market'. This has several benefits:

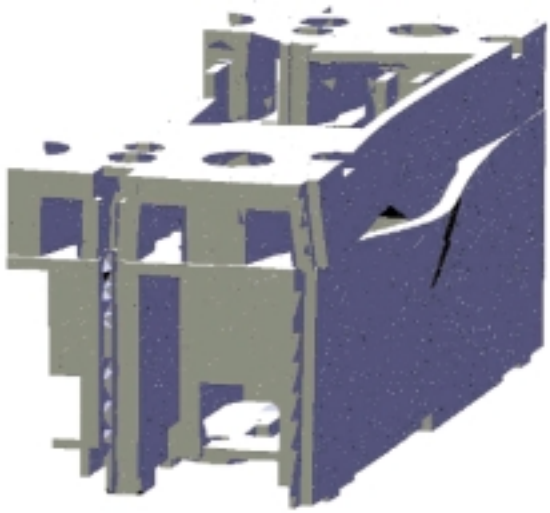
- Customer requirements are met faster.
- Better exploitation of new technologies.

1 The T generation. ABB SACE's new Tmax family of molded-case circuit-breakers

2 Current path optimization. The copper distribution is optimized on the basis of temperature value predictions.



3 Case cover resistance – deformation of the model



- Reduced impact on production; fewer modifications after launch.
- Increase in cash flow.
- Improvement in market share.
- ABB's image is enhanced.

Fourteen project groups were created at ABB and placed under the same number of project leaders, who were directly involved in constructing a specific circuit-breaker or accessory. This provided extra motivation and strengthened the commitment of the participants to their projects, which had a positive effect on the specifications, time scheduling and costs.

A steering committee was set up. This consisted of five people from the various departments, whose job it was to coordinate all activities for the purpose of achieving the objectives, solving problems that might be brought up by the project leaders, and settling any conflicts regarding resources.

An important ingredient in all of this work was the sharing of information: a database was created in which all information about the product and its state of progress was stored.

Having this information available in real time and making it accessible to everyone directly involved in the project helped to avoid major misunderstandings and allowed a fast response in all, especially critical, cases.

New design technologies and simulation techniques

Recent years have seen a progressive reduction in the life cycle of products in the electromechanical sector, mainly as a result of intense international competition.

This market situation, along with the need for a rapid return on investments, has led to a strong drive to reduce time to market. At the same time, new design tools, such as CAD/CAM, are being widely used throughout the industry. This situation has laid the foundation for easy integration of sophisticated simulation tools.

To reduce costs and shorten the design/development time, tools were procured with which the soundness of the project could be assessed. These made use of simulations which allow a 'virtual' analysis of the expected performance of the different solutions proposed by the designers.

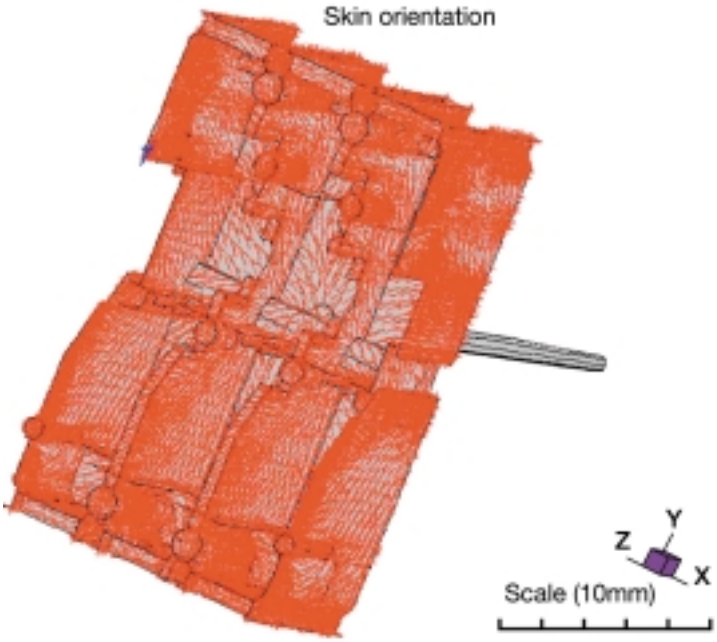
Using these analyses and simulations the designer can 'verify' the behavior of certain solutions, thereby not only boosting his confidence in the project during its definition but also overcoming the time/cost problems involved in making prototypes.

Simulation tools were used for the following:

- Analysis of thermal and mechanical behavior; this was done using the finite element method 2, 3.
- Analysis of the behavior of the opening, closing and release kinematics (multi-body dynamics 4).

4 Operating mechanism. A multi-body dynamics analysis is carried out to verify the total opening time.

5 Molding process – fiber orientation



■ Analysis and optimization of the component plastic molding process – both thermoplastic and thermosetting (mold filling analysis 5).

Environmental impact

Greater awareness of the problems related to the environment and the use of available resources – energy as well as raw materials – underlines the need for an in-depth and complete analysis of the production system. The necessity of such a process is further confirmed by the increased efforts at IEC standardization and the drafting of European directives on this subject.

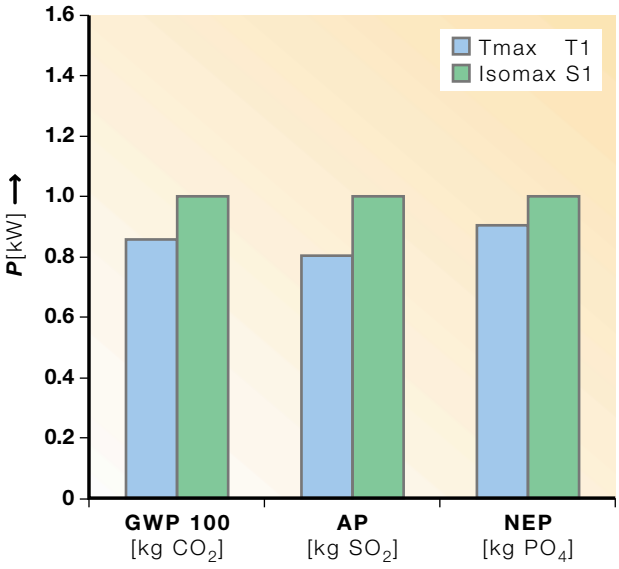
During development of the new generation of molded-case circuit-breakers, special attention was therefore devoted to detailed consideration of all the aspects which might have a negative impact on the environment. Here, all the rules relating to 'Design for Environment' were applied.

In parallel with this, a Life Cycle Assessment (LCA) was carried out by comparing the former series with the new one (ie, Isomax S1 versus Tmax T1). The aim was to demonstrate that the correct materials had been selected during the design phase.

The LCA methodology reliably evaluates the environmental impact associated with the processes and activities throughout a product's life cycle (from cradle to grave), ie from extraction of the raw materials through manufacturing, shipping, distribution and use to disposal [1].

6 Relative contributions to environmental impact categories made by Isomax S1 and Tmax T1 molded-case circuit-breakers

GWP *Global warming potential*
AP *Acidification potential*
NEP *Nutrient enrichment potential*



Design for Environment

The rules applying to 'Design for Environment' put special emphasis on the following:

- Optimized environmental performance of the product
- Increased use of recyclable materials
- Design for easier product maintenance
- Instruction manuals to include information that simplifies end-of-life problems (disposal, recycling, etc)

LCA comparative analysis

The LCA analysis yielded values for all the air and water emissions harmful and toxic to humans, animals and the environment. Using them as a basis, it compared the two different generations of circuit-breakers.

The fundamental environmental parameters that were assessed were 6:

- *Global warming potential* (GWP): CO_2 emissions were evaluated since CO_2 is the dominating 'greenhouse gas'.
- *Acidification potential* (AP): SO_2 emissions were evaluated, SO_2 being a cause of the decreasing pH (acidification) in plants and trees.
- *Nutrient enrichment potential* (NEP): PO_4 emissions were looked at as they are a cause of nutrient enrichment in lakes and in the sea.

While the above substances are the main factors with an environmental impact, many other emissions were also taken into account in the assessment.

Environmentally friendly circuit-breakers

Users of ABB molded-case circuit-breakers benefit from the 'Design for Environment' rules in two areas: handling and maintenance of the products is made easier, while final disposal is simplified by easy dismantling and identification of the different materials as well as clear instructions on end-of-life handling.

As an ecological bonus, the LCA analysis has enabled the emissions of CO_2, SO_2, PO_4, and other toxic substances, to be significantly reduced.

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Reference

[1] ISO 14040: Environmental management – Life cycle assessment, principles and framework.