

Foreword

The technical literature concerning power transmission equipment lists a great number of technical papers, as well as several books, concerning power transformers in general and, though to a lesser extent, their dynamic performance, that is their mechanical behavior in front of forces of high magnitude caused by short-circuit events which occur in the networks. Hence, there would be no reason to add another book for treating quite a same subject.

Quite recently, a further publication titled *The short-circuit performance of power transformers* was issued by CIGRE,¹ aimed at better clarifying the behavior of transformers on the occasion of external fault events. Nevertheless, the perception is that the short-circuit strength aspects of power transformers are still scarcely known by the experts who are interested in purchasing or operating power transformers, and possibly also by those experts who are in charge of evaluating technical proposals in connection with tenders or of performing design reviews on this type of equipment.

Differently from other performance requirements and aspects of power transformers, such as insulation characteristics, power losses, thermal performance, sound emission, etc., which all can easily be checked and verified by means of measurements and tests performed at the manufacturer's premises, the short-circuit strength is usually acknowledged on a purely documentary basis. Indeed, due to either technical or economic reasons, or both, the case that the withstand capability of a medium or a large power transformer is verified by means of a real short-circuit withstand test is extremely rare.

In this publication information is given as regards the physical structure and the basic functional characteristics of power transformers, with special reference to the design aspects and manufacturing practices which play a fundamental role in assuring an adequate short-circuit performance. Topics such as operation principles and physical structures of power transformers, materials used in construction, short-circuit events, calculation of fault currents, electrodynamic forces and consequent mechanical stresses, critical and allowable stress figures, manufacture practices, testing techniques, etc. are part of the content of this book. The ways, and the frequency, by which power transformers fail in service or in the short-circuit withstand test due to an inadequate withstand capability are described in detail. Information is also given as regards both the design criteria and the manufacturing practices adopted by ABB for this type of equipment. In this sense, the book can be considered as an important complement to IEC Standard 60076-5, *Power Transformers - Part 5: Ability to Withstand Short Circuit*, Edition 2006-02, with particular reference to its Annex A: *Theoretical evaluation of the ability to withstand the dynamic effects of short circuit*.²

It is noted that a few parts of this book stem from the previous publication titled *Short-circuit Duty of Power Transformers*, 3rd Edition, 2007.³ This has inevitably involved a little repetition and overlapping, but they have been kept to a minimum, having been included in this book for the sake of clarity and completeness.

In times when both specific competence and decisive power of technical people get reduced as against economic issues and when market constraints put pressure on the squeezing of costs by reducing the amounts of materials, ABB is pleased to share this information with all persons who, at different levels and for different reasons, are interested in power transformers. Hopefully, they will benefit of the content of this publication and perhaps find enough good reasons for relying on the quality of the ABB transformer products.

ABB would like to thank Giorgio Bertagnolli for his valuable contribution, deep knowledge and big support to make such a comprehensive book.

¹ It deals with CIGRE Publication No. 209, August 2002, prepared by CIGRE Working Group 12.19. The content of this publication will be examined and commented in following Chapters. CIGRE is an acronym which stands for *Conseil International des Grandes Réseaux Électriques*, an International Organization established in Paris in 1921.

² Originally, the author, who had been appointed as a Convener of the group of experts in charge of laying down a draft of third edition of IEC Standard 60076-5, had proposed a much more detailed version of the Annex A to the Standard compared with the one included in the Edition 2006-02. Actually, the experts considered the material as being too specific for any inclusion in an IEC Standard. The material prepared at that time is part of the content of this book.

³ The book has been issued by ABB Management Services Ltd. Transformers; <http://www.abb.com/transformers>.