Guideline

Thermal Behaviour of Steam Turbines

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Preface to the First Edition

When starting and shutting down steam turbines or changing their power outputs, steam temperature variations are bound to occur that lead to temperature differences in and between the components. These temperature differences result in free expansions of the components relative to each other, deformations of the components themselves, and stresses in the components. If such expansions, deformations and stresses exceed certain limits set by design features or the materials used, both immediate damage — axial or radial rubbing — and long-time damage — inadmissible permanent deformation and crack formation — may occur.

Finding solutions to this complex of problems is gaining importance in the field of steam turbine construction and operation. While component dimensions and thus the effects of major temperature differences inevitably become more pronounced as unit outputs increase, it is desirable to avoid availability losses due to thermal overloads. In addition, more stringent system requirements are now placed on the loadability and controllability of large turbo-generator sets. Last but not least, the expected increase in unit output and the fact that conventional, medium-size and large power stations are being pushed toward the peak and medium-load range by other, more economic stations — e.g. nuclear — providing the base load, lend greater importance to the problems mentioned here.

Being aware of the relevance of the problems, scientists and engineers have made numerous theoretical studies, laboratory and field experiments in the past years which led to a better understanding of the processes involved and the possible damages that may occur. The results have revealed that major parts of the brochure "The Warm-Up Process in Steam Turbines", issued by VDEW in 1961, are now obsolete. Thus the VGB Working Group "Turbine Development" has set itself the goal to describe the current state of the art. In order to keep the work within reasonable limits, a restriction of the generally applicable information has proved to be necessary. However, the bibliography enables the problems indicated to be dealt with in more detail.

The Working Group for "Turbine Development" hopes that this updated publication will be of interest not only to turbine manufacturers but also — and above all — to power station design engineers and operators, and will serve the better understanding of the possibilities and limitations of the thermal behaviour of turbines. It should always be remembered that placing excessive requirements on the start-up and loading behaviour of turbines will reduce
the serve life of certain components. Mention is also made of the gentle mode of operation nowadays possible when suitable monitoring equipment or automatic systems are used. The brochure is not meant to replace operating instructions or start-up curves supplied by the turbine manufacturers, although the derivation of such curves is explained and “typical” start-up and load times are specified.

The brochure was drawn up in the VGB Working Group "Turbine Development" by a team headed by Mr. Haas, Kraftwerk Union AG, extensive contributions being made by Dr. Busse and Mr. Kramer, Brown Boveri & Cie., Mr. Andreae, Mr. Langbein, Dr. Loreck and Mr. Tümners, Kraftwerk Union AG, Mr. Cernoch, Dr. Martin, Mr. Mayer and Mr. Strätz, Maschinenfabrik Augsburg-Nürnberg AG.

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Preface to the Second Edition

The second revision of this guideline was made by a team including Andreae, Dr. Busse, Höxtermann, Dr. Peter, Strätz and Wolf.

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