Many synchronous machines that were designed and manufactured in the last decade of the nineteenth century are still in everyday operation. These are mainly hydrogenerators belonging to long-established utilities. The theory of the synchronous machine was already well advanced when these machines were manufactured. Since then, a profuse amount of theoretical literature has been added, especially with the advent of the computer to facilitate the implementation of numerical analysis techniques. Over the years, the continuous push for higher and higher ratings and operating voltages resulted in the development of more complex mechanical structures, cooling arrangements, and insulation materials. As the complexity of the machine increased, design margins became less forgiving. In addition, the growing dependence of society on electric power and the prohibitive cost of failures put the issue of reliability foremost. Reliability has been the driving force for the continuous improvement of techniques and instrumentation designed to monitor the condition of the machine and for the creation of a wealth of industry standards.

Hand in hand with the development of hardware and written literature, a wealth of expertise has been accumulated on the practical aspects of the operation of these machines. This expertise becomes evident during troubleshooting and inspection activities. In spite of all the instruments and written literature, there is no effective substitute for the expert on the spot to troubleshoot or evaluate the condition of the machine during a visual inspection. The recognition of this expertise is demonstrated by the recent implementation of so-called "expert systems" to diagnose problems in large synchronous machines.
In spite of the universal reliance on visual inspection of large synchronous machines as part of their operation and maintenance, there is no written comprehensive compendium to be found on the subject. Succinct guidelines can be found in numerous standards, technical papers, manufacturers’ bulletins, and other publications. This book fills this gap by providing a comprehensive reference on the visual inspection of large synchronous machines. It is based on the large body of accumulated experience that can be found in a myriad of publications, the personal experience of the author, and foremost, on the contribution of many associates.

Having the in-house capability to perform reliable inspection of its generators and rotary condensers allows electric utilities and independent power producers to make informed choices regarding repairs/refurbishment of these large machines. This independent capacity for evaluating the condition of the machines can result in substantial savings.

This book was written with the machine’s operator and inspector in mind. Although not designed to provide a step-by-step guide for the troubleshooting of large synchronous machines, it serves as a valuable source of information that can prove to be useful during troubleshooting operations. The topics covered are also cross-referenced to other sources. Many such references are included to facilitate the search. Equations describing the operation of the machine were intentionally left out from most of the discussions. There is a vast amount of theoretical literature available for this purpose. The only theory included in this work consists of descriptions of phenomena affecting the reliability of the machine components. In addition, an appendix is included to review the basic concepts of synchronous machine operation. This appendix provides a measure of understanding of how to utilize machine performance characteristics and their sources, and shows how to perform simple circuit calculations.

After a description of site preparation and inspection tools, the book presents a number of forms adequate for entering findings during the inspection of a large synchronous machine. They are written in such a way that most of the items found in major types of machines can be accommodated. Items found only in salient-pole machines are marked SP, and items found only in round-rotor machines are marked RR. Subsequently, each of the items is described in Chapters 4 through 7 regarding visual appearance and the essence of the processes involved. Figures are introduced when available. The items covered appear under the main members of the machine; that is, stator, rotor, and excitation. A list of the most common electric and mechanical tests performed in the field is presented in Chapter 8. Each test is referenced to the corresponding ANSI/IEEE standards and other publications.

This book can be useful to the machine-designing engineer and systems operations engineer. It provides a wealth of information obtained in the field about the behavior of these machines, including typical problems and conditions of operation. By serving as a source for descriptions of different types of synchronous
machines and machine components, it can also be useful to the student of electrical rotating machinery.

The author's intention is to keep updating the contents of this book from his own and others' experience. Therefore, he would appreciate it if readers would please submit their comments or additions to the publisher for incorporation in future editions.