

Handbook of Electrical Engineering

Handbook of Electrical Engineering

**For Practitioners in the Oil, Gas and
Petrochemical Industry**

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This book is dedicated to my dear wife Ilse who with great patience encouraged me to persevere with the completion of this work.

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Foreword

The oil, gas and petrochemical industries depend for safe and efficient operation on their electrical supply and equipment. There have been huge advances in electrical engineering in the last 50 years and thus a need for a comprehensive book on a very sophisticated and complex subject.

When an experienced engineer is considering retirement it is very sad if all his carefully acquired knowledge disappears. I am therefore delighted that Dr Alan Sheldrake has taken the trouble to record his knowledge in this book. He covers both the design of the electrical supply and the specification of the equipment needed in modern oil, gas and petrochemical plants. The book covers generation, supply, protection, utilisation and safety for a site which is brimming with potential hazards and reliability requirements. As a consulting engineer I experienced many of the design problems that are explained here, I only wish this book had been available then for reference with its detailed explanations and specifications.

This is a book that every electrical engineer working in the petrochemical industry should have on his desk. In my time I have read many books on this subject but never one as comprehensive as this. It should be read by every young engineer and dipped into by the more experienced engineer who wants to check their designs. Students will find the theory section useful in their studies.

This book is well laid out for easy reference, contains many worked examples and has a good index for those who do not have not the time to read it from cover to cover.

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Preface

This book can be used as a general handbook for applying electrical engineering to the oil, gas and petrochemical industries. The contents have been developed from a series of lectures on electrical power systems, given to oil company staff and university students, in various countries. The author has condensed many years of his knowledge and practical experience into the book.

The book includes summaries of the necessary theories behind the design of systems together with practical guidance on selecting most types of electrical equipment and systems that are normally encountered with offshore production platforms, drilling rigs, onshore gas plants, pipelines, liquefied natural gas plants, pipeline pumping stations, refineries and chemical plants.

The intention has been to achieve a balance between sufficient mathematical analysis and as much practical material as possible. An emphasis has been put on the 'users' point of view because the user needs to know, or be able to find out quickly, the information that is of immediate application in the design of a plant. The subjects described are those most frequently encountered by electrical engineers in the oil industry. References are frequently made to other texts, published papers and international standards for guidance and as sources of further reading material.

Power systems used in these industries have characteristics significantly different from those found in large-scale power generation and long-distance transmission systems operated by public utility industries. One important difference is the common use of self-contained generating facilities, with little or no reliance upon connections to the public utility. This necessitates special consideration being given to installing spare and reserve equipment and to their interconnection configurations. These systems often have very large induction motors that require being started direct-on-line. Their large size would not be permitted if they were to be supplied from a public utility network. Therefore the system design must ensure that they can be started without unduly disturbing other consumers.

Rule-of-thumb examples are given so that engineers can make quick and practical estimates, before embarking upon the more detailed methods and the use of computer programs. Detailed worked examples are also given to demonstrate the subject with practical parameters and data. Some of these examples may at first seem rather lengthy, but the reasoning behind such detail is explained. In most cases they have been based on actual situations. These worked examples can easily be programmed into a personal computer, and the step-by-step results could be used to check the coding of the programs. Once programmed it is an easy exercise to change the input data to suit the particular problem at hand, and thereby obtain a useful result in a very short period of time.

The chapters have been set out in a sequence that generally represents the approach to engineering and designing a project. The first step is to estimate a total power consumption or load for a plant. Then it is necessary to decide how this load is to be supplied. For example the supply could be from a utility intake, by captive generators or by a combination of both supplies.

Thereafter the problem is to develop a suitable distribution system that will contain a wide variety of equipment and machinery. These equipments and machinery are subsequently covered in the later chapters.

The appendices contain comprehensive listings of abbreviations in common use, international standards that are most relevant, conversion factors for units of measure, detailed worked examples of calculations, the IEEE numbering system for protective and control devices with a commentary pertaining to its use in the oil industry.

All the diagrams and graphs were drawn from a graphics package that was driven by Fortran 77 programs, which were specifically written by the author for this book.

This edition of the book is the first, and the author will be most encouraged to receive any comments, suggestions or additions that could be added to future editions.

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Over the last 10 years my former colleagues have given much encouragement, especially in recent times those at Qatar General Petroleum Corporation and Maersk Olie og Gas A/S in Denmark; and my many associates and friends in the manufacturing companies that I have had the pleasure of interfacing with over many years.

The concept of writing this book came from the experience of providing lectures in the mid 1980's, whilst being employed by Mr Spencer Landes in his company in London. Mr Landes has also encouraged me to complete the task.

I also acknowledge the greatest opportunity given to me in my life by the late Professor Eric Laithwaite and the late Dr Bernard Adkins when I applied to Imperial College to join their MSc course in 1968. The circumstances were unusual; they made an exception to the established practices, and gave their time and patience to interview me. Their confidence was imparted to me, and I have not looked backwards since then.

About the Author

The author began his career in the electrical power generating industry in 1960 as an apprentice with UK Central Electricity Generating Board (CEGB), in a coal-burning steam power station. He gained six years' experience in all aspects of the maintenance and operation of the station. He remained with the CEGB until 1975, during which time he worked in the commission, research and development, and planning departments of the CEGB.

Since 1975 he has worked in the oil, gas and petrochemical industries on projects located in many different parts of the world. He has been employed by a series of well-known engineering companies. Most of this work has been in the detailed design and conceptual design of power generating plants for offshore platforms, gas plants, LNG plants, fertiliser plants and refineries. He has held positions as Lead Electrical Engineer and Senior Electrical Engineer, Project Manager of multi-discipline projects, Consultant and Company Director. During these projects he has given lectures on various subjects of power generation and distribution, instrumentation and control and safety to groups of the younger engineers at several oil companies. He has been involved in a conference on hazardous area equipment and postgraduate university seminars.

He gained an MSc degree in power systems in 1968 at Imperial College, London, and a PhD in 1976 on a part-time basis also from Imperial College. He is a Fellow of the Institution of Electrical Engineers in UK, a Senior Member of the Institute of Electronic and Electrical Engineers in the USA, and a Fellow of the Institute of Directors in the UK.