

Preface I

The authors have spent over 30 years analyzing reactor physics problems. They have been working on code development, validation and verification of reactor codes. In addition, they have worked on the development of core monitoring system, various versions of the VERONA core monitoring at NPP Paks and on the validation and verification of newly developed calculational models.

This work is a survey of various techniques that the authors have found useful in practical work. Maybe the reader finds it obsolete to seek the coherence and interdependence of practical problems and ensure theoretical background in a world which prefers ready-made computer programs, preferably based on some easy-to-comprehend numerical methods to understand and analyze the problems. Computer capacity and memory are continually growing. The solved problems pile up in code libraries; this is especially true for mathematical problems. Unfortunately problem solution is more complex than running a Monte Carlo code for a couple dozen cases.

The problems considered in this book are practical problems, in which it should be taken into account that the measured values include error, the model in the computer code involves approximations, and, it may happen that the physical-mathematical background of a phenomenon has been understood only partly. Yet the plant operator has to decide every day: should I reduce the power or not?

The authors do not believe that operators should base their decisions on the present-day theory of turbulent flow, random processes and numerical solution methods. But they do believe in the necessity of a solid scientific background in design, operation and maintenance of large industrial devices.

The first, introductory part of the book presents the safety principles applied in nuclear power plants.

The second part is devoted to core monitoring. In a noisy surrounding, in a limited space, monitoring provides information to decide if the reactor state is within the design limits. From the in-core instrumentation, two measurement types are discussed in detail. Axial power shape is determined by self-powered detectors, radial power distribution by thermocouples. We discuss the measurements in modest detail, and the goal is to provide the reader with sufficient information to

comprehend major aspects of the measurement, the signal processing and the evaluation of the measured values.

Models play a central role in the evaluation of the measurements. Designer, operator, staff member and regulation staff members should comprehend the possibilities and limits of the involved models. Various models are discussed in Chaps. 3–5. Chapter 4 deals with models in reactor calculations.

Third part deals with the connection between the measured values and the processes taking place in the reactor core.

Budapest-Petten
February 2017

Mihály Makai
János Végh

Preface II

The subject of the present work is the processing of in-core measurements. It is assumed that there is a reactor instrumentation providing input to be evaluated. The mentioned signals are provided either by self-powered neutron detectors or by thermocouples or by other temperature measurements. We deal with signal processing (background correction, cold point processing, calibration) only in a limited extent, which is needed to understand the signal evaluation process. We follow signal processing until the evaluation of reactor safety. Safety limits are only touched; our discussion is confined to the evaluation of the core state.

It is assumed that the reader is familiar with the concept of a nuclear power plant, its main units, and its operation concepts. Although we mention some reactor types, the list is far from being exhaustive. The text deals with the two most generally used PWR and BWR reactor types.

The authors' experience is limited to pressurized water energy producing reactors (PWR) and research reactors. In core geometry, instrumentation and operation this is a limitation. Experimental facilities, training reactors, boiling water reactors may essentially differ from PWRs.

Models have been emphasized to make the reader comprehend the limited range of applications of the applied methods. The book reviews computational methods but it is not the authors' intention to provide the reader with a survey of reactor theory or reactor computation methods. There are excellent books written in several languages conveying theory of reactors and computational methods.

The book shortly mentions the first analytical nodal solution of the diffusion equation in the early eighties, a method applicable to square, triangular or hexagonal fuel assemblies. Another interesting topic is the application of symmetry considerations in reactor calculations, also from the early eighties. The next item on the list is a better description of non-uniform lattices, see Ref. [47] in Chap. 4, or the matrix formalism in the solution of time-dependent problems in Chap. 3.

Parts of the book require various knowledge levels from the reader. Statistics, probability theory, numerical methods and partial differential equations are widely used in reactor theory but an operator does not need that sound background.

The authors did their best to provide the most required background knowledge in the appendices.

The authors intend to supply readers with useful knowledge. Most of the methods have been used in the practice. The suggested measurement or evaluation methods have been applied in practice. The presented calculational methods have also been applied.

Budapest-Petten
February 2017

Mihály Makai
János Végh

Reactor Core Monitoring

Background, Theory and Practical Applications

Makai, M.; Végh, J.

2017, XXIX, 423 p. 96 illus., 76 illus. in color., Hardcover

ISBN: 978-3-319-54575-2