

Preface

In December 1951, electric power was generated for the first time by a nuclear reactor called EBR-1 (Experimental Breeder Reactor-1) located at Idaho, USA. Subsequently in 1954, a small-scale (5 MWe) graphite-moderated, water-cooled reactor Nuclear Power Plant (NPP) began operation at Obninsk in the former USSR (present-day Russia), followed by the first commercial Gas-Cooled Reactor NPP at *Calder Hall*, UK in 1956 and the first commercial Pressurized Water Reactor NPP at Shippingport, PA, USA in 1957.

Since then, many NPPs have been constructed worldwide. According to the IAEA Power Reactor Information System data (updated on December 16, 2009), 436 NPPs are currently in operation with a total net installed capacity of 370,304 MWe. Light water reactors (LWRs) have been most widely used and 88.3% (326,860 MWe) of the world's total nuclear power generation are by 356 LWR NPPs.

The number of NPPs rapidly increased until the Three Mile Island accident in 1979 and the Chernobyl accident in 1986; these events led to a slow down or stoppage in the construction of subsequent plants. However, even during the years of setback that followed, considerable R&D efforts for improving the design of LWRs continued. Thanks to these tireless efforts, evolutionary LWR NPPs have been developed in recent years, and some are already in operation and many are under construction or being planned worldwide.

To build a bridge between fundamental research and practical applications in LWR plants, the University of Tokyo organized the first International Summer School of Nuclear Power Plants at Tokai-mura, Ibaraki Prefecture, Japan, from July 28 to August 5, 2009. The School was hosted by the Executive Committee and was cosponsored by the GoNERI Program of the University of Tokyo and the Japan Atomic Energy Agency, in cooperation with the Atomic Energy Society of Japan. The School presented state-of-the-art technologies, methods, and research studies on NPPs to young researchers and engineers from universities, R&D institutes, and industries working in nuclear science and technology. A total of 57 participants (14 from Japan, 28 from China, 9 from the USA, and 6 from the Republic of Korea), 22

lecturers (invited from internationally renowned manufacturers, research institutes, and universities), and 14 executive committee members and staff joined the School at the Tokai-mura venue. The participants benefited greatly from lectures delivered by the world's top experts who stayed a few days following their lectures to allow intensive exchange of knowledge between lecturers and participants.

In 2004, the IAEA published TECDOC-1391, "Status of Advanced Light Water Reactor Designs," which is an overview of evolutionary LWR design. However, there is no textbook which explains basic research linked to practical LWR applications. To fill this gap, this publication includes 10 selected lectures of the International Summer School and the authors further refined them and elaborated them into a textbook style. Most of the authors are technical experts from manufacturers and their experiences are the key elements of the book. The editors hope the contents will be useful to engineers and researchers at manufacturers, utilities, regulatory bodies, and research institutes as well as to graduate students and professors in the nuclear engineering field.

As for specific evolutionary LWRs, the ABWR, APWR, EPR, and APR1400 have been selected. Relevant studies and research on the safety of these reactors – such as the use of probabilistic safety analysis (PSA) in design and maintenance of the ABWR (Chap.1), development of an advanced accumulator (a new passive ECCS component) of the APWR (Chap.2), studies on severe accident mitigation for the APR1400 (Chap.3), and development of a core catcher for the EPR (Chap.4) – are presented. Current LWR development and severe accident research in China are summarized in Chap.5. Other important advances in LWR technologies – such as full MOX core design, application of CFD in design of LWRs (BWRs), next-generation digital I&C technologies, use of advanced CAD and computer models in design and construction of LWR (ABWR), and advances in seismic design and evaluation of LWR (the new Japanese safety guide on seismic design and seismic PSA) – are given in Chaps.6, 7, 8, 9, and 10, respectively.

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