

# Preface

Responsible management of radioactive wastes is an important issue for each and every country that makes use of nuclear power and radiation and radioactive isotopes for industry and medicine. Since the end of the twentieth century, the issue of intergenerational ethics in the development and use of nuclear power and materials has been recognized as essential to avoid passing a negative legacy to future generations as a result of the present generation's enjoying the benefits of a convenient life without thinking responsibly about the burden that such a life may place on those who come after.

The twenty-first century is expected to see an increase in the deployment of light water reactors, particularly in Asia, and an essential part of any forward-looking agenda will certainly be the issue of radioactive wastes. While developing countries look at nuclear power to address their growing demand for energy against dwindling resources, it is important to understand that the future development of nuclear power will depend greatly on our success in establishing the required technology for effective management of radioactive wastes. The use of nuclear energy in the twenty-first century is premised on the realization of reasonable radioactive waste management that can ensure public safety, security, and reliability.

While most people are aware that nuclear power facilities generate wastes, research and medicine are other sources where the use of radiation and radioactive isotopes has become routine. Added to this is the waste generated when facilities that employ radioactive materials are dismantled after closure. It is the responsibility of our generation to establish safe and effective systems for the handling of such radioactive wastes for today and for future generations.

This book is designed to provide everyone with an interest in radioactive waste issues, including students and individuals involved in engineering and public administration, with the scientific foundations that support radioactive waste management at a graduate level. This book is also intended to help readers better understand the role of mass transfer and chemical equilibrium theories in the clearance and radioactive waste handling processes.

In brief, the items included in *Radioactive Waste Engineering and Management* are explained in the following. While all processes in the handling of radioactive wastes, from generation to disposal, are often comprehensively described as radioactive waste management, the definition of management is often interpreted as the physical and chemical processing of generated wastes to delivery to a disposal facility and closure of that facility. This thinking is most likely the result of people's tendency to limit the range covered by their direct control. However, radioactive waste management should not be limited in this way. Instead, it should include physically and conceptually wider areas that cover safety regulation concepts and social involvement.

Dismantling of nuclear reactors and nuclear-fuel-cycle facilities has become an emerging interest in the nuclear industry. The generation of radioactive wastes by this action at the end of a facility's lifetime is not the only area of concern. The decommissioning method and the regulatory system for clearance and exemption of very low-level radioactive wastes have a profound impact on the amount and processing of secondary wastes. The management of the wastes exhibits complex coupling among technologies, regulations, and society's acceptance of those clearance and decommissioning systems. This book addresses bases to understand the dismantling and decommissioning of nuclear facilities.

In addition, it is essential to establish the safety of radioactive waste disposal, including deep geological disposal, over a period of time that extends beyond a few generations. How can we prove the safety of radioactive waste disposal with the science and technology that we now possess? What criteria should be provided for the regulations? Also in this issue, we observe complex coupling among technology, regulations, and society in an unprecedented long-time scale. Seeking engineering needed to realize it may bring us to a new engineering horizon completely different from what we now know. This book includes comprehensive coverage of relevant laws and regulations, as well as all technological processes ranging from facility decommissioning and conditioning wastes to long-term safety assessment for final geological disposal. As one of the waste-conditioning technologies, for which active research and development have been performed, roles and effects of partitioning and transmutation are also discussed.

The concept of radioactive waste disposal has developed through extensive and wide-ranging international discussions. Because future use of nuclear energy must be based on safe and rational radioactive waste management, it is necessary to prioritize the establishment of what it should be, and those involved in this field will be required to possess a thorough understanding of the overall picture. We as the authors of this book, therefore, did our best to systematically summarize such knowledge from the perspective of engineering. It is our hope that the readers of this book will play a responsible role in radioactive waste management.

While the issues of radioactive waste management associated with nuclear weapons production are important for nuclear-weapon states, such issues are not completely unrelated to non-nuclear-weapon states under a nuclear deterrent, including Japan. We have decided not to cover those weapon-related issues in this book.

The Fukushima Daiichi accident in March 2011 crippled four nuclear reactors and generated an enormous amount of unprecedented radioactive wastes both on-site and off-site of the Fukushima Daiichi plant. Many issues and difficulties are observed to have similar coupling that we have discussed in this book, i.e., technology, regulation, and society. It is clear that we need to create innovations to resolve this long-lasting challenge of decommissioning and radioactive waste management by developing not only radioactive waste engineering but also a public decision-making process that can actually result in socially agreeable solutions and management. This edition, which is a translation of the original Japanese version published before the accident, does not explicitly address Fukushima issues and includes minimal update where appropriate, but the authors believe that the contents of this book provide the foundation essential for such future development. The authors hope that they will have an opportunity to include achievements since the Fukushima Daiichi accident in a future edition of this book.

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