

Radiation Protection at Light Water Reactors

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Preface

Numerous excellent Health Physics textbooks have been published over the years with many of these texts now into their third or fourth editions. These texts cover a wide range of health physics discipline areas. General introductory health physics texts cover such subject matter as the interaction of radiation with matter, definition of radiation dose quantities and units, measurement of radiation dose, principles of detection, controls associated with the handling of radioactive materials and basic radiation safety principles. Many of these texts cover specialty health physics discipline areas including medical or environmental health physics or the detection and measurement of radiation for example. Radiation protection aspects associated with the operation of the worlds' current fleet of light water reactors has been marginally presented in existing health physics texts. Many texts that cover various health physics discipline areas often do not contain any discussion relating to light water reactor health physics. This text is meant to fill that void and is targeted to those health physicists currently employed in the light water reactor industry and to serve as the basis for a course of study for students entering the light water reactor radiation protection field. The text does not attempt to cover basic health physics topics in detail such as the principles of interactions of radiation with matter, the design of nuclear instrumentation, theory associated with the design of personnel dosimetry devices, calibration of survey equipment or detailed discussions associated with radiation quantities and units. All these subject areas are covered in much greater detail by others who are recognized as subject matter experts in their field. No useful purpose would be served by the author in attempting to cover these areas for which the author is only a novice. Texts related to the topics covered in this text that present supporting subject matter in greater detail are listed at the end of each chapter. Many of these texts provide extensive coverage of a given topic and often serve as the basis for an in-depth course.

This text was written for those individuals who wish to gain an understanding of radiation protection aspects associated with the operation and maintenance of commercial light water reactors in operation today. The author has attempted to focus each chapter on those topic areas directly related to radiation protection

program activities required to support the operation and maintenance of light water reactors. Chapters 2 and 3 provide an overview of pressurized and boiling water reactor systems of radiological concern along with an overview of the purpose and function of those systems. A discussion of the parameters that effect radiological conditions of the various systems is also presented along with the radiological environment associated with these systems. Chapter 4 discusses the radiological source terms at LWR facilities and those parameters that influence the magnitude of source terms. Chapter 5 defines the various radiological zone classifications and the requirements associated with the posting of radiological areas. Chapter 6 presents the elements of those activities associated with a LWR radiation protection program at the functional level. Radiological surveillance activities, radiological signposting, RCA access control measures, job coverage aspects, use and purpose of radiation work permits, departmental interfaces and work control activities are presented. Chapter 7 presents those elements associated with the planning, scheduling and implementation of radiological work activities and techniques and methods employed to minimize personnel exposures. Chapter 8 describes contamination and radiation source control measures and techniques to minimize the presence and spread of radioactive contamination. Various measures to minimize and control the production of contamination source terms and the affects of water chemistry on source terms are presented. The various types of protective clothing and their use, equipment and supplies commonly used to control the spread of radioactive material, and elements of a respiratory protection program are presented in Chap. 9. Chapter 10 describes the elements of a LWR personnel dosimetry program. The utilization of various dosimetry devices for whole-body and extremity monitoring are discussed along with those elements that comprise a LWR bioassay program. An overview of the instrumentation requirements to support a LWR radiation protection program is presented in Chap. 11. Instrumentation commonly used along with the purpose and function of various types of fixed and portable survey equipment is described.

Problems and exercises have been provided that encompass those issues most likely to pose radiological incidents at a LWR. Many of the problems present a unique situation whereby a health physicist is challenged to evaluate a given issue in sufficient detail to ensure that an appropriate radiological assessment of the situation has been performed. The problems are also designed to encourage students to identify root causes and what actions would they take to minimize future radiological incidents or to prevent recurrence. Radiological incidents at LWRs seldom occur as a result of a technical issue requiring detailed calculations to determine doses received by those involved in the incident. Primary dosimeters along with whole-body counts and bioassay data are typically sufficient to support an adequate dose assessment. Oftentimes it is the non-technical and human performance aspects that contribute to a radiological incident that require attention and an adequate evaluation in order to improve radiological safety performance of a LWR radiation protection program. Consequently the problems and exercises are meant to enforce these aspects of radiological incident investigations. For many problems there is no “one right answer” rather the focus is to have students look at

the “bigger picture” and utilize the skills and practical knowledge that a LWR health physicist should possess to ensure that corrective actions associated with radiological incidents are identified and thoroughly investigated. Any errors found in the text or problem solutions should be forwarded to the author.