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PREFACE

Classic—a book which people praise and don't read.

—Mark Twain

Things that are complex are not useful. Things that are useful are simple.

—Michail Kalashnikov, inventor of the simple and reliable Automatic Kalashnikov-1947 (AK-47) assault rifle, which has only eight moving parts.

This book was not meant to be a classic; it was meant to be useful. I have, therefore, written it using straightforward language largely devoid of scientific jargon. In so doing, it is my wish that the book will be accessible to the widest possible audience of readers, regardless of whether they have any technical background. If I have done my job well, readers of this book will learn a tremendous amount about radiation and will find this information useful in many practical ways.

People like to get their learning in the form of stories.[1] As actress Audrey Hepburn once said, "Everything I've learned, I've learned from the movies." Although this is a book, and not a movie, the point is well taken. If you tell an engaging and compelling story, be it through movie or book, people will learn something from it. So that's what I attempt to do here. This book is the story of people's

encounters with radiation, and of how mankind has been transformed by the experience. The story is, therefore, told with an emphasis on the human aspects, and it is told from a health-centric perspective. The goal is to integrate the technological aspects of radiation with the human experience and thereby remove some of the mystery and misunderstanding that surround radiation. Nevertheless, this is not a book about lessening your fear of radiation. Fear is a very subjective emotion, driven by many factors. The only thing that can be achieved here is to present the facts about radiation as objectively and evenhandedly as possible, leaving you to decide which aspects to fear.

Another purpose of this book is to dispel the myth that the subject of radiation risks is so complicated that it is beyond the capability of ordinary people to grasp, leaving reliance on radiation "experts" as their only recourse. This is simply not true. Intelligent people, even those lacking any technical background, should be able to understand the fundamental principles that drive radiation risk and then make their own decisions about how large a threat radiation poses to them personally and collectively. This book seeks both to convince people that they can be masters of their own radiation fate, and to empower them to make their own well-informed decisions about their personal radiation exposures.

Lastly, this book is an experiment in risk communication. The open question is whether radiation risks can be characterized accurately and effectively without reliance on a lot of mathematics, tables, and graphs. These highly quantitative approaches have proved to be largely ineffective in communicating the essence of risk to the public.[2] This book is devoid of graphs and tables and keeps the mathematics to a minimum. Instead, it tries to instill a sense of the magnitude of the threat through a historical scientific narrative about the people who encountered radiation of various types and dose levels, and the health consequences of those exposures. In this way, we can get an accurate sense of the level of the radiation hazard even if we don't have a detailed understanding of the underlying technology.

Can all this be achieved? I don't see why not. It's been done before—in the case of electricity. Electricity was a technological in-

novation introduced to society shortly before radiation. Initially, it was greatly feared as a deadly and invisible threat to health. With time, however, people began to understand that a flashlight battery didn't pose the same danger as a downed power line. Even people who couldn't explain the difference between an amp and a volt began to understand that, although there were risks of death, those risks could be managed so that the benefits of electricity could be maximized and the risks minimized. Now no one speaks of being pro- or anti-electricity. They understand that electricity is here to stay. There is no going back. All we can do is manage electricity to minimize its dangers relative to its benefits.

But we haven't yet reached a similar place with radiation. People today often react to radiation in the same way that people reacted to electricity over a hundred years ago. Our understanding of radiation needs to advance to the point that we develop the same good sense about radiation risks that we have for electricity. Radiation, like electricity, is a technology that is here to stay. So the more that people learn about radiation, the better off we'll all be. This book seeks to increase public understanding of radiation, in much the same way that people gradually came to understand electricity.

You will get the most from this book if you appreciate how it is organized. After a brief opening chapter that sets the stage for the topic (chapter 1), the book is divided into three parts.

Part One (chapters 2–4) tells the story of how radiation was discovered, and how society immediately put that discovery to practical use. You'll learn how a chance observation of a glowing fluorescent screen in a laboratory in Edinburgh, Scotland, saved a man's leg from amputation in Montreal, Canada, just a few weeks later. You'll learn about Thomas Edison's initial enthusiasm for x-ray tubes, why he soon became afraid of them, and the heavy price his assistant paid for acting carelessly. You'll also learn how a cloudy day in Paris resulted in the discovery of radioactivity. Along the way, you will be introduced to a few physics concepts that are important to understanding how radiation affects health. Ideas about radiation and its relevant physics are introduced progressively and systematically, while the health aspects of radiation

make cameo appearances in the form of anecdotes about problems suffered by the early scientific pioneers of radiation research. A comparison is made to electricity, as an example of an earlier technology that was originally regarded by the public with even greater suspicion.

Part Two (chapters 5–11) introduces the effects of radiation on human health. It begins with the story of miners in Germany who unknowingly suffered from a radiation-related illness before radiation had even been discovered. You'll find out what their illness had to do with the mysterious deaths of women who painted watch dials in the United States. And you'll learn how it was discovered that radiation can cure cancer. You'll also learn about radiation sickness and why most medical doctors have never seen a case of it. And you'll find out why you shouldn't be drinking milk after a nuclear power plant accident. Evolving notions about how human cells and tissues react to radiation are introduced, with a focus on how radiation's health effects are measured, culminating in what we now know about their underlying causes. The radiation biology related to health issues, rather than the radiation physics, is dealt with systematically, and the concept of equating "safety" with "low risk" is introduced anecdotally. This is done as a prelude to Part Three, where the role of risk/benefit analysis in making decisions regarding radiation use is explored.

Part Three (chapters 12–17) is a collection of chapters narrowly focused on radiation topics of popular interest. To mention just a few, you'll learn how dangerous the radon in your basement is, how hazardous it is to eat food contaminated with radioactivity, and how risky it is to live next to a nuclear power plant. Although you may be tempted to cherry-pick these chapters, and read only those of particular interest, you should resist that temptation. Embedded within each chapter is an illustration of a specific risk assessment concept, and the chapters are ordered so that they progressively reveal the value of considering both risks and benefits when making health decisions, as well as the importance of weighing alternative risks. Also included is systematic discussion of how uncertainty affects the validity of our radiation decisions. It is possible to read the chapters in this part out of numerical order with-

out any loss of narrative continuity, but the developing story of risk assessment and its relationship to safety will be garbled, so a nonsequential approach is not recommended.

The epilogue contains some final thoughts regarding all that we've learned about radiation and how best to apply that information to everyday life. It also includes one final story about radiation that has a very important take-home message.

With this overview, you are now ready to begin your exploration of the world of radiation. You will likely find it both interesting and enjoyable, but also a little scary. Nevertheless, in the end, you'll be much better equipped to deal with any radiation issues that you encounter during your travels through life in a modern technological society, where radiation presents itself at every turn. Good luck on your journey.

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