

# Preface

## Why I Decided to Write This Book

“Red-hot core fuel rods are melting down and turning into round balls of molten substance, dropping on the bottom of the pressure vessel. The heat caused the molten core and water in its vicinity to react to generate hydrogen, which in turn caused a hydrogen explosion to damage the reactor building. The red-hot molten core further penetrated through the bottom of the pressure vessel to drop on the floor of the containment vessel and melted the concrete floor of the containment vessel as well. Luckily, because the decay heat from the core subsided, the molten substance penetrating through the containment vessel seems to have been just barely prevented.”

Such was the typical expression used by NHK (Nippon Hoso Kyokai, the public TV network in Japan) in their reports of what happened in the accident in Tokyo Power Electric Company's (TEPCO's) Fukushima Daiichi Nuclear Power Station. I suppose that the image most readers of this book have of the Fukushima accident is basically the same as this. It is not just the readers. The understanding that the majority of the people related to the nuclear accident have in their minds is probably not that different from the above. However, such an understanding is far from the truth.

As proof of this, after 3 years have passed since the accident, we have not seen any explanation presented by the government, nuclear power industry, or TEPCO as yet on how the core melt and the hydrogen explosion occurred, which is the crux of the accident. It is true that the phenomenon that occurred in the accident in question is very complex, but the reason that they failed to explain it logically is because there is an error in the image described above.

This book tries to correct the error and to analyze the specific phenomena that occurred in Fukushima Daiichi's Units 1 through 4. The data used here are strictly limited to indisputable accident phenomena and the actual measurement data that can be found in *The Fukushima Daiichi Nuclear Power Station Disaster* reported in June 2012 by TEPCO (original Japanese version; an English version was issued

in March 2014). The rest consists of my studies of the factual data. My studies are based on the analyses of the accident phenomena of the Three Mile Island (TMI) Nuclear Reactor in the United States and the Chernobyl Nuclear Power Plant in the Ukraine (then U.S.S.R.) as well as the results of the safety experiments conducted jointly between the U.S., Germany, Japan, and France. In other words, this book is the result of deductions based on, and studies of, the actual facts.

The decision to write this book was triggered when I was asked to attend a meeting held in November 2012 with the U.S. Science Academy's team investigating the accident. The meeting's primary purpose was to investigate the facts of the accident, but the questions raised in the meeting were almost all about confirming the facts and the comparisons between them and the results of the analyses using well-known computational codes. It seemed to me that this was an exercise to check the computational codes, which is somewhat different from a discussion seeking to clarify what really happened in the accident.

Since the well-known computational codes were created based on the past experiences, it was obvious that they might not fit perfectly with what really happened in the unexperienced accidents. In particular, the Fukushima accident was extremely complex and contained various phenomena that had not been incorporated in the computational codes. Using such codes, if we tried to fine-tune the input too radically in order to make the calculation match the measurement data, the overall coherence of the accident would be lost. I guess what they meant to do in the meeting was to identify such discrepancies so that they could modify the computational codes for the future. Consequently, no clear-cut explanation has been provided for what really happened in the Fukushima accident.

The inability to provide a clear explanation is due to the use of a feeble investigative method that relies on computer calculations without having conducted a physiochemical clarification of the accident phenomena. I thought that this was a common problem of both the Japanese and American teams. I had not gotten involved in investigating the accident, thinking that there was no need for an old fellow like me to do so, but the meeting between the Japanese and American teams above changed my thinking. If the younger people we had nurtured did not have the ability to do so, I must take the helm, I thought. Studying again was not easy for an old man.

Although from the time of the accident I had a rough sense of how it progressed and how the various phenomena could be explained, checking each phenomenon required a lot of work. After about 6 months of staring at the reports and data trying to understand the various phenomena, I finally thought I generally understood the accident, so I started to write. However, during the course of writing, I often came up with questions concerning my interpretation of a fact, and the answers affected the overall understanding of the incident sometimes, so that I had to go through days of agony of further investigation and rewriting to eliminate contradictions. I now believe that I wrote everything I needed to write about, without any major mistakes.

This book consists of Part I, which is a study of the mechanisms of the core melts and hydrogen explosions that occurred in the Fukushima Daiichi nuclear power station accident, and Part II, which compiles my thoughts on the issues of the general

safety of atomic power and the reconstruction of Fukushima, including the causes and effects of the accident. The main purpose of this book is condensed into Part I, so I hope that readers spend time to read it carefully.

The bases of my studies presented in Part I are the facts by the aforementioned TMI and Chernobyl accidents, as well as the results of a series of experiments called the fuel rod behavior test. It was a part of the joint safety research studies concerning light water reactors conducted for about 10 years since 1975 mainly by the U.S., Germany, and Japan. Their essential aspects are described in Chap. 1. Because my studies of the Fukushima accident are essentially based on these basic findings, readers are encouraged to read Chap. 1 carefully to grasp the ideas. Following my thoughts should not be that tough.

Chapter 2 deals with the performances (core melts and hydrogen explosions) of the nuclear reactors of Fukushima Daiichi's Units 1 through 3; it is the centerpiece of the book. It is meaningless for people to try to have an overall perspective of the accident without first examining the data and accident phenomena of Fukushima carefully one by one. Therefore, you may find some parts of the book annoying, as similar narrations will come up again and again. You may skip those repetitions if you wish. What is important is for you to grasp the outline of the accident; there is no need for you to be tied up in the details. A summary is provided at the end of each segment of Chaps. 1 and 2 in particular so that you can grasp the outline of each accident to prepare you for the next segment. The Fukushima accident is that complicated and difficult to understand.

However, those of you who are trying to be the young lions of the next generation in the field of nuclear power should read Chaps. 1 and 2 carefully while sweeping away your sleepiness. If you do so, you should be able to see automatically how wrong the core meltdown story I presented at the start of this preface is. And that knowledge will contribute to the improvement in the safety of nuclear power in the future.

Chapter 3 is my study of the explosion that occurred in Unit 4 of Fukushima Daiichi.

Part II describes my thoughts on various issues about the Fukushima accident from the technical point of view. It contains some outspoken comments which I believe will be useful for the future of the nuclear safety and the reconstruction of Fukushima. I hope that this book is useful for such purposes.

Now let's move on to Chap. 1 of Part I, the basis of understanding the accident phenomena.

Tokyo, Japan

Michio Ishikawa

A Study of the Fukushima Daiichi Nuclear Accident  
Process

What caused the core melt and hydrogen explosion?

Ishikawa, M.

2015, XVI, 231 p. 39 illus., 36 illus. in color., Softcover

ISBN: 978-4-431-55542-1