

Preface

There are currently 99 commercial reactors, operating at 61 nuclear power plant sites in the USA. Nuclear power plants (NPPs) are associated with potential core meltdown accidents, which could ultimately lead to catastrophic events. The three main nuclear disasters with the most significant historic and catastrophic impacts are as follows: Three Mile Island in the USA, which occurred in 1979; Chernobyl, Ukraine, in 1986; and Fukushima Daiichi, Japan, in 2011. The Fukushima Daiichi accident, the most recent disaster of the three, demonstrates that the risks of nuclear core meltdown accidents could be magnified by a natural disaster event such as an earthquake, tsunami, or similar natural events.

The immediate impacts from nuclear power core meltdown accidents is the release of high-level radioactive materials into the air which could be carried away for several hundreds of miles away, depending on the geographical location of an NPP, the size of the population living in areas around the facility, wind speed and directions, and weather conditions on the day the event is taking place. The Chernobyl accident caused hundreds of thousands of people to evacuate, and additionally, millions of people were exposed to radioactive radiation. The larger areas near the nuclear power plants were radiation-contaminated, and some areas were permanently restricted for habitation due to high level of radiative contamination. According to Perrow (1992), accidents related to NPPs are normal because the operating systems are coupled, and failure in one of the systems will have impact on other parts of the system, leading to the failure of an entire nuclear system. Given that accidents are considered to be normal for nuclear power plants, the risks of such accidents are inevitable.

There are three options to manage such inevitable risks: shutting down all NPPs, transforming inevitable risks to evitable ones, and effectively managing future nuclear power emergencies. The first option of shutting down all NPPs is not a currently feasible option, for a number of political and economic reasons. The second option involves the Nuclear Regulatory Commission (NRC), which has initiated reactor oversight framework which emphasise on three performance areas: reactor, radiation, and safeguards. However, the agency faces challenges of human errors and the nature of the inevitable accident (Perrow's Normal Accident Theory)

in its efforts to transform the inevitable risks. The last option presents opportunities to minimize the negative impacts associated with the NPPs.

Managing the nuclear power emergencies is significantly different from managing those of other disasters such as fire or flood emergencies. For example, in the case of a fire emergency, as soon as the 911 call center alerts the fire department, firemen are dispatched to the place the fire is taking place, usually within minutes of the initial call. However, managing nuclear power emergencies requires certain procedures and protocol to go through, prior to an initial announcement of evacuation could take place. To effectively manage nuclear power emergencies, it is necessary to understand the problems in the previous nuclear power accidents, as well as demographic data of the populations prone to high-level radiation doses, living in areas surrounding the NPPs. Critically important in nuclear disaster management plans are the places the radioactive plume will disperse, and the individuals under the plume path at risks of exposure to the high-level radiation dose, and the challenges faced in evacuating individuals living in the areas with high-level radiation doses.

The development of commercial NPPs in the USA, the impacts of the three historic nuclear power core meltdown accidents, and the problems associated with response and evacuation are discussed in Chap. 1. The impacts of the three nuclear core meltdown accidents are analyzed, coupled with addressing the problems with response and evacuation, from a disaster and emergency management point of view. Chapter 2 captures the geographical locations of the 61 nuclear power plants within the USA and the communities exposed to the potential risks of core meltdown accident associated with the NPPs. In an event of a nuclear emergency, it is vital to carry out evacuation activities immediately so that the people living around the NPPs could be protected from the potential high-level doses of radiation. Chapter 3 examines the current radiological emergency plan and carefully investigates the process and potential problems that could lead to undermining the effectiveness of immediate response and evacuation. To evacuate people, it is imperative to know where the radioactive plume will go, given the weather conditions on the day the event takes place. Chapter 4 demonstrates utilization of powerful computer code, namely Radiological Assessment Systems for Consequence Analysis (RASCAL) to estimate the places the radioactive plume could be carried away by the given weather conditions during a nuclear core meltdown accident. The chapter provides two simulation exercises at two NPPs, namely the Palo Verde Nuclear Generating Station in Arizona, and the Indian Point Nuclear Generating Station in New York. The simulation exercises utilizing the RASCAL computer code with step-by-step procedures provides fundamental understanding and special technical skills needed to carry out a part of the effective nuclear power emergency management process. Chapter 5 examines the issues related to the nuclear power emergency plan in place. The discussion focuses on issues in terms of policy, priorities, process, participation, evacuation, and recovery. Chapter 6 proposes the three options for minimizing the risks associated with NPPs, suggesting the elimination of all NPPs in operation in USA, transforming inevitable

risks to evitable risks, and transforming the current radiological plan into an effective emergency management plan.

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