Radiation hazards in a nuclear power plant: Ascertaining the hurdles and proposing corrective strategies

Saurabh R. Shrivastava, Prateek S. Shrivastava, Jegadeesh Ramasamy

Department of Community Medicine, Shri Sathya Sai Medical College and Research Institute, Kancheepuram, Tamil Nadu, India

INTRODUCTION

A radiation accident is defined as an event which results in a significant adverse effect on the exposed people, the environment or the facility.\textsuperscript{[1]} In excess of 25 nuclear power plant related accidents and incidents have been observed across the world since 1952, which has endangered the lives of millions of people.\textsuperscript{[2]} The International Atomic Energy Agency has developed an International Nuclear and Radiological Event Scale (INES) to allow rapid communication to the general people and nuclear authorities about the occurrence and consequences of any nuclear accidents.\textsuperscript{[3,4]} The INES rates the nuclear accidents in seven levels (viz. Levels 1-3 are “incidents” and Levels 4-7 “accidents”), based on three factors - impact on the people and the environment; radiological barriers and control; and defense in depth.\textsuperscript{[1,2]}

AFTERMATHS OF RADIATION EXPOSURE

Following the exposure to radiations, a wide gamut of adverse consequences ranging from acute events (such as skin burns, acute radiation syndrome, and local radiation injuries); malignancies (viz. basal cell carcinoma, thyroid malignancy, etc.); birth defects (viz. due to the exposure of pregnant female during antenatal period); psychological distress and psychiatric conditions (like anxiety disorders, depression, post-traumatic stress disorder, and alcohol abuse); and even death (in extreme cases), have been reported.\textsuperscript{[5-11]}

IDENTIFIED SHORTCOMINGS AND CHALLENGES

Since the occurrence of Fukushima Daiichi nuclear disaster in 2011, multiple deficiencies and challenges such as shortage in the number of radiation health experts at the time of nuclear fallout and while monitoring potentially exposed people for radioactive contamination; lack of preparedness (minimal number of simulation exercises); no authority to restrain movement of people exposed to radioactive substances; human resource or logistics constraints (viz. untrained health care providers, poor or interrupted supply of personal protective equipments, etc.); deficiencies in the communication network at times of nuclear fallouts; lack of risk communication, and absence of uniform standards for radiation measurement worldwide, have been identified.\textsuperscript{[12,13]}

LESSONS FROM THE FUKUSHIMA NUCLEAR DISASTER

The experience from the Fukushima nuclear disaster gave valuable lessons to the operators for other nuclear power plants worldwide, namely provision of radiological monitoring equipments to the workers in nuclear power plants (by ensuring their availability at different sites);...
devising a mechanism to enable rapid access to personal protective equipments in different parts of the power plant; formulation of a back-up plan to address the issue of loss of installed monitors at the site boundaries so that timely environment survey can be obtained; training of the nuclear power plant workers to manage nuclear emergencies and not leave the site in panic (by explaining them about the individual roles of each cadre of workers at times of mock-drill); etc.[13,14]

**INDIAN OVERVIEW**

The Department of Atomic Energy (DAE), Government of India supervises the overall operations of nuclear power plants and is engaged in the development of nuclear power technology and use of radiation technologies in various sectors. DAE consists of five research centers, five public sector undertakings, three industrial organizations, and three service organizations. A regulatory body - Atomic Energy Regulatory Board, has been constituted whose primary role is to ensure that under no circumstances safety of humans and environment is compromised because of the use of ionizing radiation. In addition, a Crisis Management Group (consisting of senior officials drawn from various units of DAE and an official from the regulatory authority) has been functioning in DAE, which will sensitize the response agencies/network of centers that can respond to radiation emergency/accident situations to mitigate their consequences. Furthermore, the National Disaster Management Authority has been regarded as the apex body, which formulates the policies, plans and guidelines for radiation emergencies, to ensure timely and effective response to disasters.[15,16]

Other than that, radiation safety officers have also been appointed who plan and implement appropriate measures to control the amount of radiation exposure among the employees and the members of the community. However, to ensure that the recommended limits for radiation exposure have been adhered, Environment Survey Laboratory has been established in each of the nuclear power plants even before the commissioning of the same. As a part of capacity building and strengthening of the existing resources, medical professionals have been trained in all aspect of radiation exposure. Even, the other stakeholders such as local district authorities/district hospitals/government hospitals, radiotherapy centers in the country, and other prominent healthcare facilities, have also been scaled-up to successfully deal with radiation emergency.[15,16]

In the modern era with potential risk of nuclear fall-out anytime because of natural/man-made reasons, the recent developments should be shared with the public health managers, the concerned departments, the members of the public health community, and the other stakeholders.[12] In India, all the nuclear facilities are designed in accordance with the internationally accepted guidelines to ensure not only their safe functioning but even safety to the general population and the environment.[15,16]

**PROPOSED STRATEGIES**

Although, the government health authorities take adequate measures to prevent any radiation exposure to people beyond permissible limits, the general public should be informed about the do’s and don’ts at times of radiation emergencies.[13] In addition, it is the responsibility of the policy makers to ensure rational allocation of funds; implement measures for capacity building and infrastructure support; steps to enroll, train and retain the employees; development of an effective warning system; improvement in modes of communication at times of nuclear emergency; involvement of different stakeholders; encourage research work to provide enough evidence to improve the safety of nuclear power plants; ensuring periodic monitoring and evaluation activities by a competent agency; and employing different modes of communication to not only remove the associated fear and stigma, but even, enhance the acceptance level of local people toward the nuclear power plants.[12,13,17,18]

**CONCLUSION**

To conclude, as a wide range of radiation hazards has been associated with the operation of a nuclear power plant, it is indispensable to systematically assess the different aspects of the plant and then work on to rectify the existing shortcomings and at the same time strengthen it in accordance with the national and international predefined standards so that any future disaster can be prevented.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

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