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ScienceDirect

Energy Procedia 131 (2017) 279–284

Energy Procedia

www.elsevier.com/locate/procedia

5th International Symposium on Innovative Nuclear Energy Systems, INES-5, 31 October – 2 November, 2016, Ookayama Campus, Tokyo Institute of Technology, JAPAN

User Interface of Atmospheric Dispersion Simulations for Nuclear Emergency Countermeasures

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Abstract

In the event of a nuclear emergency, evacuation experts will have very limited time to make life saving decisions. Therefore, it is very important to provide these experts with knowledge of plume characteristics which are generated by an intuitive user interface; backed by simulations of radionuclide dispersions to better assist experts in evacuation planning. This study aims to verify the effectiveness of the user interface that can provide a one year meteorological and dispersion data based on WSPEEDI-II library. Such a user interface might be beneficial to risk and crisis management planning in case of a radioactive dispersion.

Keywords: WSPEEDI-II; nuclear emergency; evacuation planning; radioactive dispersion; plume analysis; accident; risk management; crisis management; user interface

1. Introduction

After the accident at the Fukushima Daiichi Nuclear Power Plant (hereinafter referred to as FNPP1) there have been a lot of studies focusing on emergency preparedness regarding radionuclide dispersion resulting from a nuclear

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10.1016/j.egypro.2017.09.429

power plant. Prefectural governments in Japan that host nuclear power plants are working on numerous ways to improve their crisis management plans and to also improve nuclear emergency countermeasures [1]. After the incident of FNPP1 it is obvious that steps need to be taken to assist evacuation experts. Experts need to make quick decisions regarding the safety of the people residing near nuclear power plants. One way of tackling this issue is by using an intuitive user interface. The interface can provide these experts with knowledge of the plume characteristics from simulations of radionuclide dispersions. The interface can also display crucial information regarding radionuclide dispersion, which then compares levels of radioactivity in the atmosphere with current policy on evacuation due to radioactive release. For example, in case of a disaster unfolding, and in the event of a plume passing, then evacuation experts would be able to assess the situation by using information retrieved from the interface to view certain characteristics of the plume. Plume characteristics are crucial because they can determine air dose rate from deposition, and total air dose rate, hence triggering an evacuation order if deemed necessary.

An equally important method to be taken from this study is the minimization of uncertainty when pre-planning for any potential radionuclide dispersion accident. This user interface can help experts, in the field of mass evacuation, view predictions regarding a certain scenario, and its outcomes. This will then planned for ahead of time to help in reducing uncertainty. Pre-planning maybe done by using this user interface to view many different scenarios which could have different simulations that show different times, radionuclides, terrain and plume analysis. The main aim of this study is to verify the effectiveness of our user interface by conducting a calculation performance test based on the scenario of Fukushima Daiichi Disaster and to demonstrate ease of data access. Such data would include for example: time of radioactive release, air dose rate from deposition, total air dose rate, distance of the maximum value of the total air dose rate from the release point (FNPP1) and the direction in degrees. Being provided with this information can help in determining where and how to evacuate residents in the affected zones.

2. Methodology

The method that supports the evacuation experts (the users) is based on an atmospheric dispersion simulation system, known as Worldwide version of System for Prediction of Environmental Emergency Dose Information II (WSPEEDI-II) [2] developed by Japan Atomic Energy Agency (JAEA). A library has been created by a research group in JAEA which contains data for any one year period based on simulations compiled by WSPEEDI-II. The library consists of spatiotemporal data of radioactive dispersion in the air, and deposition on the ground.

Initially, a meteorological dataset has been developed using a meteorological model. The plume dispersion scenarios differ in weather or season, radionuclides, and release rates. Secondly, the dispersion is modelled using a modified Lagrangian particle dispersion (new-GEARN) of WSPEEDI-II which conducts one hour unit release periods. In these calculations, the radioactive decay for each individual radionuclide is not applied. Instead, radioactive decay is applied to the output, therefore calculation results for any type of radionuclide can be obtained for the referenced radionuclide. And these release periods will be done for every one hour segment of release within a target of any one year period. Because this calculation is done for every field of meteorological combination it therefore outputs a matrix for all calculations with regards to nuclide, deposition, release height and time. Finally, the method to reproduce spatiotemporal distributions of radionuclides for any condition of a source term is by linear combination of a matrix [3]. Essentially, this step is the most important in the case of the expert because new scenarios will emerge hence helping identify important plume characteristics. Such characteristics might include direction of the plume, size, types of radionuclide and different scenarios in different seasons.

The user interface will use the data from the library to provide short summaries of various scenarios, and finally the user will then decide which of the data provided will be of interest to them. The platform of the user interface can run on any computer running a Linux operating system with the programming language of Fortran 90; hence making the interface friendly and simple to setup and use.