Faculty of Science
Chemistry Department

Assessing the Environmental Radiological Impacts of Gaseous and Liquid Releases for Nuclear Power Plants

A Thesis Submitted for the Award of Ph.D. Degree in Chemistry

By

Nema Mohamed Kandil Mohamed
M. Sc. Degree in Chemistry (Physical Chemistry) from Faculty of Science, Cairo University (2013)

Chemistry Department
Faculty of Science
Ain-Shams University
Cairo, Egypt

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Approval Sheet for Submission

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Nema kandil

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

قالوا سبحانك لا علم لنا إلا ما علمتنا انك انت العليم الحكيم

سورة البقرة-الآية 32

صدق الله العظيم

ABSTRACT

Assessing the Environmental Radiological Impacts of Gaseous and Liquid Releases for Nuclear Power Plants

By: Nema Mohamed Kandil Mohamed

The aim of this thesis is the prediction and assessment of the impact of the normal operation of hypothetical NPP in El Neguila site, Egypt. Also the evaluation of the emergency plan action is very important to mitigate the accident consequences. The site evaluation report and environmental impact report of any proposed nuclear power plant should include the previous studies.

The first part of this thesis includes analysis of the hourly metrological parameters of the study area for one complete year 2014.Where all parameters such as wind speed; wind direction, temperature, rainfall and relative humidity were evaluated. Also the stability classes were determined and classified.

The second part evaluates the human health regional and local impact or routine atmospheric release from proposed nuclear power plant using PC-CREAM code. The input parameters for PC-CREAM code such as metrological data, source term, exposure pathways and the receptors position were evaluated. The doses of routine discharges were calculated to the critical group. The critical groups are adult, child and infant.

The third part is concerned with the prediction of annual doses to the population living within 50 miles of the site as a result of liquid radioactive waste effluent discharges from the nuclear power plant (NPP) which has been calculated using the PC-CREAM model from all pathways assuming conservative inputs. Data collection also included the amount of annual liquid release, population concentration, population habits and food consumption rates.

Finally, the impact of hypothetical accident was assessed using RASCAL 4.2 code. This part includes description of emergency plan phases, protective actions and emergency plan zones.

Key words: analysis of metrological parameters, human health regional and local environmental impact assessment, PC-CREAM model, RASCAL code, radiological accidents consequence analysis of nuclear accident.

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Assessment of Dispersion Characteristics and Radiation Doses Consequences of a postulated Accident at a Proposed Nuclear Power Plant

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Abstract:

For site evaluation and environmental impact assessment for any nuclear power plant models are needed to predict consequences of a hypothetical accident and evaluate the suitable protection or mitigation actions for emergency plan.

This paper aims to predict the mitigation actions of emergency plan for a proposed site for NPP (El-Negila in the North Western coast in Marsa Matruh Governorate -Egypt) by calculating the radiation doses resulting from a hypothetical accident. The hypothetical accident postulated in this work is a large loss of coolant accident (LOCA) followed by core melting with early containment failure leakage and bypass.

After any accident, the impact of radioactive releases on the environment depends on several factors such as weather conditions, time of accident , the nature and activity of radiation release (source term) and topography. Total Effective Dose Equivalent (TEDE) caused

by accidental release was evaluated using Radiological Assessment System for Consequence Analysis code (RASCAL 4.2). RASCAL is the software developed and used by the U. S. Nuclear Regulatory Commission (NRC), in order to estimate the projected doses in case of radiological emergencies. The TEDE was assessed for all seasons of the year 2014 at a proposed site to study the effect of accident time on consequences of accident. These calculations take into account all exposure pathways such as cloudshine, inhalation and groundshine. Finally, the protection actions are evaluated in every case according to the dose threshold for sheltering, evacuation and administering potassium iodide (KI) as a supplementary action.

Key words: nuclear accident, environmental impact assessment, RASCAL code, radiological accidents consequence analysis.

List of Abbreviations

SAR	Safety Analysis Report
TEDE	Total Effective Dose Equivalent
PWR	Pressurised water reactor
GPM	Gaussian Plume Model
HPA	health protection agency
EC	European Commission
ICRP	International Commission of Radiological Protection
PC-CREAM	Consequences of Releases to the Environment Assessment Methodology
RASCAL	Radiological Assessment System for Consequence Analysis
LOCA	Loss of Coolant Accident
NRC	Nuclear Regulatory Commission
NPP	Nuclear Power Plant
PAG	Protective Action Guide
PRA	Probabilistic Risk Assessment

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