UNIVERSITI TEKNOLOGI MARA

PREDICTION OF UNCERTAINTY QUANTIFICATION ON THE HUMAN CONSEQUENCES AT INDUSTRIAL DOMINO EFFECT ACCIDENT SCENARIO

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ABSTRACT

A new and improved model for the evaluation of uncertainties related to the assessment of human consequences of a fire and explosion domino accident scenario is to be developed at the end of this research. While the scope of this research is limited to studying the impact of explosion on human, structural consequence is also an important aspect to be considered. This is because in the case of domino accidents, structural consequences such as structural failure and flying debris can play a significant role in causing damages farther away from the leaking area. Propagation of blast waves, or overpressure, lead to debris trajectories that could pose danger, should it hit any human within the vicinity of the trajectories. Consequently, this contributes to human impact, making it necessary to consider structural consequence in this study. In the case of liquefied petroleum gas tank explosion, the risk impact assessment on the storage facilities were carried out and a cylindrical LPG tank in Feyzin Refinery, France is selected as a point of study in this research. To obtain an accurate result of injuries, fatality and survival, the total burn surface area (TBSA) and age factor need to be considered, as their involvement would be a major contribution in predicting accurate level of injuries and probability of fatality to human. The results were compared and validated using several consequences model, such as the TNT Equivalent (BREEZE software), Baker-Strehlow model and ARIA investigation report. Software such as the Response Surface Methodology (RSM); the Mapping Application for Response, Planning, and Local Operational Tasks (MARPLOT); and Computer-Aided Management of Emergency Operations (CAMEO) were also utilized for a simplified approach in conducting the risk assessment. The simplified approach included age, TBSA and fatality inputs, where these inputs were then put into the RSM modelling. Based on the model validation result, the simplified model was able to identify the severity of injury experienced by receptors in the case of Feyzin accident.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

In the ever-growing process industry, accidents are bound to happen. The causes are chemically induced, while external conditions do play a role as one of the contributing factors. Contradicting the norm, thermal effects are not necessarily implied to explosions. Even so, the substance involved in causing a fireball after an explosion is usually fuel, where the types of explosions include vapor cloud explosion (VCE) and boiling liquid expanding vapor explosion (BLEVE) (J Casal, Arnaldos, Montiel, Planas-Cuchi, & Vilchez, 2001). An incident involving fire explosion is always associated to mechanical, blast wave and thermal effects, simultaneously. As such, for cases related to explosion, most researchers will use the blast wave effect (in kPa or psi unit) to determine the level of impact or damage done on the receptor. For fire incidents, researchers often use the thermal radiation effect (unit: kW/m^2) as a parameter in determining the health consequences caused by fire explosion on structures and human beings.

However, there are shortcomings in predicting the thermal impact to human from the uncertainties formed during the modeling of the physical phenomena. According to a study (Menin, 2017), the modeling of the physical phenomena is defined as establishing the specific foundations to represent the information theory for the optimal design of the model. A metric called comparative uncertainty is introduced, whereby a priori (i.e., general principles to suggest the likely effects) discrepancy between the chosen model and the observed material object is verified. The information quantity in the model can be evaluated, while the required number of variables that should be considered can be proscribed. Therefore, in most physically relevant cases, field tests or computer simulations can be used to realize the comparative uncertainty, provided they are utilized within the prearranged variation of the main recorded variable.

The inconstancy in modeling of the physical phenomena parameter values is said to produce ambiguous results in determining thermal radiation consequences (Bosch & Weterings, 2005; CCPS, 2000a; Papazoglou & Aneziris, 1999). This is