EXCELLENT PUBLISHERS

International Journal of Current Research and Academic Review

ISSN: 2347-3215 Special Issue-1 (October-2014) pp. 1-4

www.ijcrar.com

Event Tree Analysis for Analyzing Probable Fire Scenario in the Plastic Manufacturing Extra Building

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KEYWORDS

Event tree analysis, Fire, Plastic Manufacturing

A B S T R A C T

Industrial plant no.53 is a type of industrial plant that had many occurrence of fire, where the number of injuries, deaths and property damage are greater than average for all types of industry. Many large industrial plants are susceptible to high fire risk deaths, injuries and loss of property because, they have not installed fire prevention and fire suppression systems such buildings were not required to comply with the Ministerial Regulation no.33 (B.E.2535) but, must now follow the Ministerial Regulation no.47(B.E.2540) when requires the installation of fire alarm systems, automatic fire detection, and manual fire detection including portable fire extinguishers. The main purpose of the current study is to apply to Event Tree Analysis: ETA technique for analyzing probable fire scenario in the plastic manufacturing extra building of Thailand built before the Ministerial Regulation no.33 (B.E.2535). Stochastic analysis on probability of every fire scenario using ETA showns that there are seven fire scenaris. It was found that the fire scenario 2,3 and 7, there is a possibility that the fire could not be controlled due to the failure of equipment, 35.2%, 17.6% and 7.2% respectively. Occupant evacuation, risk of danger to life due to the fire dynamics, building environment and occupant characteristics/pre-movement and movement behaviors, limitations and future work of this study are also discussed.

Introduction

"Industrial plant" means a building or part of a building used as a factory under the Factory Act (1). Industrial plants are dangerous places for fires. Many industries are at high risk of fire due to the nature of work, which can result in fire that can cause deaths, serious injuries and significant damages to properties.

According to accidental statistics, industrial accidents caused by fire during 2001 to 2012 found that the number of fire accidents account for 63.16, 73.91, 59.32, 64.15, 66.67, 58.82, 59.52, 26.09, 70.83, 52.17, 62.71 and 65.22 percent respectively; a higher percentage of fire accidents

compared with other industrial accidents (2). When considering statistics of fire each year was found that industrial plant no.53 is a type of industrial plant that has many occurrence of fire, where the number of injuries, deaths and property damage was valued at more than the average for all types of industry.

According to the Ministerial Regulation no.33 (B.E.2535) issued under the Building Control Act(B.E.2522) high rise and extra buildings must have fire alarm systems on every floor. Fire alarm systems consist of signaling devices, initiating devices (automatic detection or manual detection). Moreover, high rise and extra buildings shall be installed with fire protection systems which, consists of standpipes, water storage reserves and a fire department connection. In addition to the fire protection systems, high rise and extra buildings shall be installed with portable fire extinguishers and automatic sprinkler or other equivalent systems. The high rise and extra buildings constructed before enforcement of the Ministerial Regulation no.33(B.E.2535)shall be exempted from having to provide such fire protection systems. Therefore,many high rise and extra buildings are at high risk from fire resulting in deaths,injuries and loss of property.

However, high rise and extra buildings constructed before enforcement of Ministerial Regulation no.33(B.E.2535)must comply with Ministerial Regulation no.47(B.E.2540)issued under the Building Control Act(B.E.2522). High rise buildings, large buildings, extra buildings, public buildings, residents, factories, restaurantsand offices shall be installed with fire alarms system on every floor such fire alarm systems must consist of signaling devices, initiating devices (automatic detection or manual detection) and portable fire extinguishers. The aim the Ministerial Regulation no.47(B.E.2540) issued mandatory for buildings constructed before the Ministerial Regulation no.33 (B.E.2535) which,the buildings are subject tothe risk of deaths,injuries and property loss in the event of fire because the buildings have not installed the fire alarmsystems, fire protection systems, automatic fire suppression systems due to not required to comply with the MinisterialRegulation no.33(B.E.2535)

Fire alarm systems and portable fire extinguishers is a system continuously functioning, so that when a fire occurred the automatic fire detection will be achieved or the witness can press the manual detection by hand when fire occurred to signal a warning to occupants in the building. After that occupants use portable fire extinguisher for quelling fire or evacuate to a safe area. Event Tree Analysis: ETA is a technique used to identify hazards in the inductive method by determining an initiating event that may occur due to failure of equipments or human error and continuous analysis is tree like branches; ETA is usually a technique used to analyze the sequence of fire detection, fire alarm systemsand automatic fire suppression systems. The main purpose of the current study is to apply to ETA technique for analyzing probable fire scenarios in the plastic manufacturing extra building of Thailand built before the Ministerial Regulation no.33 (B.E.2535) was enforced.

The secondary data of fire statistics of all types of industry were collected to analyze for getting the Fire Frequency Index (FFI)**,** Fire Injury Index(FII)**,**Fire Death Index(FDI) and Fire Property Damage Index(FPDI). ETA technique was conducted in the plastic manufacturing extra building in Thailand for analyzing probable fire

scenarios with consideration of the interval reliability of equipments are shown in table 1 based on statistical data**(**3-4**)**.

ETA is a technique used to describe the serverity of an initial event and probability of possible outcomes. It is represented by the operating conditions, success(YES) or failure(NO) of equipment, based on the reliability of each equipment. It is usually a technique used to analyze the sequence of fire detection, fire alarm systems and automatic fire suppression systems such as Guanquan C.,Jinhui W. and Qingsong W.,2012(5). Using the ETA for analyzing fire scenario with uncertainty for probability distribution is a function of automatic sprinkler,manual detection and portable fire extinguisher,Guanquan C. and Jinhui W.,2012(6). Using ETA for studying fire scenarios to analyze the uncertainty for probability distribution is a function of automatic detection, manual detection, portable fire extinguisher and automatic sprinklers, Guanquan C. and Jinhua S.,2008(7) have analyzed decisions on fire safety design based on risk assessment by using ETA technique and Guanquan C. et al.,2007(8) using ETA for studying probabilistic risk assessment for evacuees in the building fire by considering the sequence of operating devices such as automatic sprinkler, automatic detection,manual detection and mechanical smoke control systems. In this event, the first event was the fire occurrence by considering the sequence of operating devices are automatic detection, manual detection,fire alarms system and portable fire extinguisher.

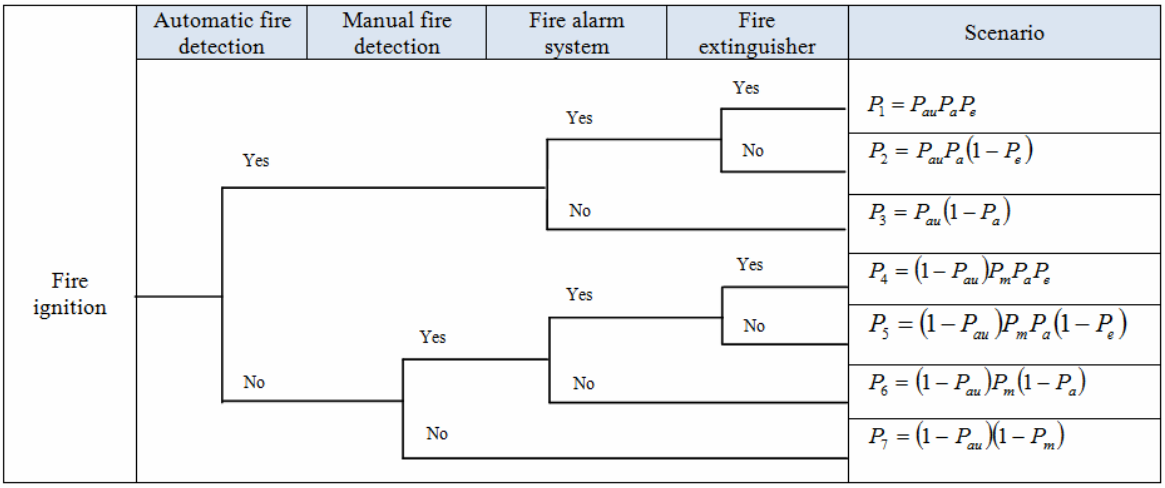

Figure.1 Probability analysis of each fire scenarios

Table.2 Operational fire protection systems probability of each fire scenarios

Scenarios i(i=1,2,3…,7)	Fire scenarios probability i(i=1,2,3…,7)
1	0.352(35.2%)
2	0.352(35.2%)
3	0.176(17.6%)
4	0.0192(1.92%)
5	0.0192(1.92%)
6	0.0096(0.96%)
7	0.072(7.2%)

Result and Discussion

Fire Frequency Index(FFI)**,**Fire Injury Index (FII)**,**Fire Death Index(FDI) and Fire Property Damage Index(FPDI) was analyzed from fire statistics and each type of industry in Thailand during 2001 to 2013. Probability analysis of each fire scenarios by using ETA technique which considering the operational interval reliability of each equipment are shown in table 2. Therefore**,** probability of fire scenarios are shown in figure 1.
Where P_{au} is probability of automatic detection; P_m is probability of manual detection; P_a is probability of warning system and P_e is probability of portable fire extinguisher.

Many large industrial plants have high fire risk resulting in deaths**,** injuries and loss of property due to not having installed fire alarm systems**,** fire protection systemsand fire suppression systems**,** because they were not required to comply with the Ministerial Regulation no.33(B.E.2535). Therefore**,** the buildings constructed before the Ministerial Regulationno.33(B.E.2535) should comply with the Ministerial Regulation no.47(B.E.2540). These buildings should be installed fire alarm systems on every floor**,** initiating devices (automatic detection and manual detection) and portable fire extinguishers. ETA was taken for analyzing probable fire scenarios in the plastic manufacturing extra building with the sequence of operating fire protection and suppression systems constructed before the Ministerial Regulation no.33(B.E.2535) was enforced. Stochastic analysis on the probability for seven fire scenarios. It was found that the fire scenario was 2**,**3 and 7 when fire occurred. There is possibility of uncontrolled fire due to the failure of equipment**,** 35.2%**,** 17.6% and 7.2% respectively. Occupants must be evacuated from the industrial plant**,**due to risk of danger to life because of fire dynamics**,**building environment and occupant characteristics/pre-movement and movement behaviors. Therefore**,**the future work of this study will focus on analyzing probable fire scenario with time**,** calculate pre-movement time and evacuation time for the plastic manufacturing extra building.

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