THE INVESTIGATION OF FIRE SAFETY IN THERMAL POWER PLANTS IN THAILAND

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Abstract

The electric power industry is one of the most important businesses in Thailand. Recent reports have indicated that the rate of fires occurring in power plants is still high and continues to grow even though fire safety standards are strictly followed. Recent reports have also revealed that inspections are mostly verified by factory documents and that there is a lack of workplace inspections by highly trained safety professionals. Even though a factory's structure and equipment meet the standards, a few safety functions and indicators might be impaired. The main objective of this research project was to indicate the actual situation of safety in Thailand's electric power plants. Parameter selection and scoring point methods were used to calculate the deviation score. Five thermal power plants were selected for investigation in this research. Findings from this current research project revealed that the average deviation score for each parameter was 0 to 2.6 out of 5. Parameters were analyzed focusing on the difference of points to indicate possible fire safety improvements. Future study and the limitations of this research are also discussed.

Keywords: Electric power industry, thermal power plants, deviation score, actual situation

Introduction

Today, electricity is the main factor in driving various systems. Thailand's power demand is increasing every year (Electricity Generating Authority of Thailand, 2018). Therefore, the

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Thai government announced a policy to support the electric power industry (Department of Alternative Energy Development and Efficiency, 2017) as the number of power plants is rising (Energy Regulatory Commission of Thailand, 2017). But sadly, fire accidents are also increasing (Safety Technology Bureau, 2017).

Fire accident statistics referring to power plants were obtained from Thai government departments (Department of Labour Protection and Welfare, 2017; Safety Technology Bureau, 2017) and news articles (Khaosod online, 2015; Kom Chad Luek online, 2015) which indicated that the most common type of power plant accident involved thermal power plants. Moreover, accidents mostly occurred in private power plants.

The results of this research show the key parameters for fire safety inspections and the deviation scores of each parameter. The results also indicate the actual situations that power plants need to improve.

Materials and Methods

Safety Regulations in Thailand

All power plants are subject to the Building Control Act 2000 (B.E. 2543) under the Department of Public Works and Town & Country Planning. Power plants in Thailand are also under the supervision of the Department of Industrial Works of Thailand under the Ministry of Industry Notification No.126, 2009 to enforce industrial safety. Power plants also have to adhere to the Health and Environment Act 2011 (B.E. 2554) under the Ministry of Labour. Officers from the Ministry's Safety Technology Bureau inspect all matters covered by the regulations before allowing a power plant to operate. Even though the regulations require periodic monitoring, on site inspection cannot be performed because there are not enough officers to visit all the power plants and factories in Thailand. Therefore, most of the inspections that are performed are checked via factory documentation. This research classified the parameters and calculated the fire risk index for every parameter; the index values from all the parameters were collected to calculate the overall fire risk index (FRI) for power plants. A linear additive model was used to calculate the FRI as shown in Equation 1:

$$FRI = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i} \quad (1)$$

where w_i is the weight point for parameter i. The weight point shows the importance or potential of parameter i if parameter i is a failure and x_i is the score point of parameter i. The score point will be earned from actual visits; i is the parameter that was inspected and n is the number of the parameter.

Selection of the Parameter and Weights

Parameter selection in this research is derived from Thai building and safety codes such as the Building Control Act B.E. 2000 (2543), the Ministry of Industry Notification No.126, 2009, and the Health and Environment Act 2011 (B.E. 2554) and comments from experts. Comments from experts are widely used in fire safety research (Lo *et al*., 2005; Wadud *et al*., 2014; Omidvari *et al*., 2015; Liu *et al*., 2017). All parameters of the documents

Table 1. Explanation of the weight for each parameter

No.	Explanation
5	Very high damage to both life and property may occur
4	Considerable damage to both life and property may occur
3	Injuries are high and other losses may occur.
2	Loss of property and injuries are considerable
1	Not essential

Table 2. Parameters' list and weights

No.	Parameter	Weight average
1	Alternate power	4.4
2	Automatic fire extinguisher	4.8
3	Blocked furniture	3.4
4	Bottleneck corridor	4
5	Chemicals	4.6
6	Combustible	3.4
7	Command center	3.8
8	Communication	3.2
9	Door swing	3.8
10	Emergency light	5
11	Exit door	5
12	Exposed utility inside	3.6
13	Extinguisher operator	4
14	Fire announcement	4.8
15	Fire damper	4
16	Fire drill	4.8
17	Fire extinguisher	4.6
18	Fire pump access	4
19	Fire pump protection	2.4
20	First aid	3.2
21	Gas mask	2.4
22	Lightning protection system	3.6
23	Maintenance	4.4
24	Occupant load	5
25	Water for fire	5

Table 3. Score points for parameters

Point	Level	Deviation from regulations and laws *
5	Excellent	Less than 10%
4	Good	10-30%
3	Average	31-60%
2	Poor	61-80%
1	Very poor	More than 80%

***** (Building Control Act 2000 (B.E. 2543),. Ministry of Industry Notification No.126, 2009, and Health and Environment Act 2011 (B.E. 2554)

from each power plant are reviewed by officers of the Safety Technology Bureau, Department of Industrial Works. Therefore, all parameters have to be excellent before a plant starts operation under the regulations. This research focuses on actual situations and focuses on the possible deficiencies in them which could cause accidents. Five safety officers were used as experts in this research. The parameter weights were set by the experts. The weight point of each parameter was set at 5 levels with the most important being 5 and the least important being 1. Every level was detailed to avoid a difference in perception among the experts (Dodd and Donegan, 1994), as shown in Table 1. The key parameters identified by the experts and details of this research are shown in Table 2.

Figure 1. Chemical leak in pipeline system

Figure 2. Access to fire extinguishers was blocked

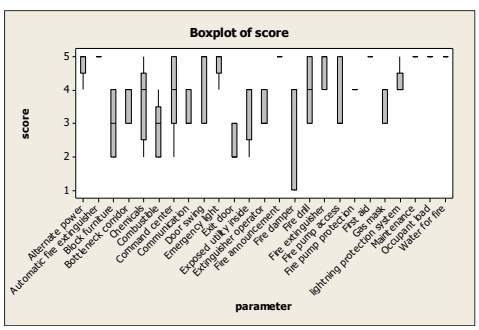

Figure 3. Box plot of parameters' scores

Parameter Rating Schedule

This research used score points to evaluate the safety capabilities of each plant. Score points can express the value in terms of quantity. This research collected data and score points from each plant and the research applied the scoring method for each parameter from Wadud and Huda (2017), as shown in Table 3.

As mentioned previously, the highest number of power plant accidents in the last decade occurred in private thermal power plants. Therefore, this research selected private thermal power plants to visit. Data collection was conducted by a team of researchers with experts to assess and collect the data. The team checked the parameters from the actual workplace, as shown in Figures 1 and 2. This included reviews of the documentation sections for a few parameters such as fire drill or maintenance. A few values may not have been measured from the visit, so it was necessary to use an expert to determine the appropriate score.

Results and Discussion

The results of this research are expressed in terms of the FRI of power plants in Thailand. The scale of the FRI is 1-5 (5 is the maximum). If the FRI score is high, the fire safety level will be high. The 5 power plants in this research operate using different types of fuel (biomass and refuse-derived fuel (RDF)) and they have different capacities. The overview of the FRI for the power plants in this research has a high level at 4.06 and the results of this research are shown in Table 4.

Figure 3 shows the distribution of the scores for the 5 power plants. Figure 3 also indicates that the power plants have good management in many parameters such as automatic fire extinguishers, fire announcements, and maintenance. The safety standard of the electric power industry is high, but there are few low score parameters such as fire dampers, blocked furniture, and so on.

Table 4. Details of private power plants

No.	Capacity	Fuel	Fire risk index
1	<10 mw	Biomass	3.89
2	<10 mw	Biomass	4.02
3	>10mw	RDF	4.26
4	>10mw	RDF	4.25
5	>10mw	RDF	3.90

Conclusions

The purpose of this study was to present the current state of the power plants in Thailand. The actual situation is different from what is recorded in the documents. The number of factories in Thailand and the limited number of staff makes it difficult to verify in the actual work area, thus the most important inspection process is performed via factory documents. The results of this research have indicated important issues in power plant safety. This research selected important issues from previous literature and combined it with comments from fire safety experts to design the parameters. Data results from the 5 plants indicate that many parameters deviate from the documents.

Limitation and Future Work

This research only focused on 5 thermal power plants and the results showed a deviation between the documents and the actual situation. The name of the power plants which were visited cannot be revealed because of confidentiality agreements. Therefore, future work will implement a systematic risk assessment and show quantitative results. Moreover, the number of power plants in the study will be increased. Other statistics should be used to analyze factors that may relate to fire risk such as the size of the plant, the technology, and the type of fuel.

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