Journal of Entrepreneurship and Management
10 (1) 2021, 01-17
http://publishingindia.com/jem/

Assessment of Corporate Proactiveness Towards Fire Safety - A Case Study

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Abstract

With the worldwide increase in the incorporation of fire safety issues in business practice, some research has emerged that evaluates the need of incorporation of fire safety issues in business practice to gain competitive advantage. However, there is little information about how much fire safety issues are being incorporated in business practice by Indian companies, what is the position of industrial units in India regarding fire safety management, what are the different fire safety performance indicators, how far the units are proactive in management of fire safety issues and how is the fire safety performance of the business units measured has yet to be demonstrated. Studying the status of fire safety proactiveness would enhance our understanding of the conceptual issues to a much greater degree. We analyze these issues collecting some primary data from some sample high risk units of West Bengal. Our results show that facilities that are motivated to incorporate the fire safety issues in business practice of the units observe greater overall fire safety proactiveness.

Keywords: Fire Safety, Fire Safety Performance Indicators, Fire Safety Performance, Fire Safety Proactiveness, Fire Safety Scorecard, India

Introduction

Corporate proactiveness towards fire safety leads the corporate sector towards facing with the challenge of integrating fire safety considerations into their overall corporate planning and strategic management. The major concern to fire safety management is determining ways in which industrial action can be made compatible with fire safety.

Fire outbreak is the 3rd biggest risk to business continuity and operations, according to India Risk Survey (IRS), 2018, a jump from the 12th position in 2014. In IRS, 2016, fire outbreak was ranked 8th biggest risk to businesses (Sengupta & Pandey, 2019). There has been numerous fire accidents recently causing significant loss of life and property. According to NCRB, 2015, fire accidents kill daily 48 Indians, whereas in 5 years (2011-2015), fire accidents have killed over 1 lakh Indians. Mumbai witnessed more than 49,000 fire incidents in the last 10 years leading to death of over 600 people (Source: https://www.business-standard.com dated Sept 5, 2019). The Ministry of Home Affairs in 2017 told Parliament that the country in 2012 had just 2,987 fire stations against the requirement of 8,559, a shortfall of 65%. India needs additional 559,681 trained fire personnel, 221,411 fire-fighting equipment, and 9,337 fire-fighting vehicles and specialised fire safety equipment (Sengupta & Pandey, 2019).

In India, as we at Beyond Carlton keep saying, fire safety takes a backseat and we can spot a fire safety violation very easily. Most of the fire accidents tell us about the dreadful status of fire safety implementation and general slackness amongst the public. It is believed only with a mass drive to educate the general public and strict adherence to fire safety laws can help to avoid these incidents in future.

In this context, it is attempted to aim at taking a holistic and integrated approach towards fire safety management in corporate scenario for its sustenance. Researchers have evaluated the motivations to improve corporate fire safety performance (e.g., Sengupta & Pandey, 2019; Pal

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& Ghosh, 2014; Ayers, 2011; Schroll, 2002) and also identified the fire safety performance indicators (FSPIs) to trigger the proactiveness (Frost et al., 2016; Frost et al., 2015; Sanmiquel, 2014; Elliot et al., 2004; Rider, 2001) and measured corporate fire safety proactiveness (Doherity, 2019). However, as yet, we know little about the extent of incorporation of fire safety issues in business practice in case of Indian companies. Even, no extensive study has yet been made in the Indian context attempting to assess the position of units in the field of fire safety management.

In understanding the significance of corporate proactiveness towards fire safety, it is important to identify the indicators for adopting these management systems and explore empirically the position of industrial units regarding fire safety management. Previous research utilizes differing theoretical perspectives. On one hand, a group of authors suggest that organizations are motivated to increase their internal efficiency and external legitimacy, which also can lead to competitive advantage. According to them, there are a number of economic benefits from fire safety considerations. A more effective use of fire safety equipments or fire prevention and control devices results in diminishing extent of damage during emergency for example, and a safer corporate image leads to an increase in market share. On the other hand, scholars have relied on the resource-based view of the firm to explain that presence of trained fire personnel, fire control devices, etc. lead to the adoption of proactive fire safety management strategies and improved business performance. By implementing these strategies, these authors suggest that organizations are more likely to gain competitive advantage.

Finally, it is perceived that Indian Companies are not fully focused in managing fire safety related issues. While a good number of researches had been undertaken on fire safety issues, very few of them focused on the fire safety performance of the existing units. However, most of the previous research examining the motivations to improve corporate fire safety performance (Sengupta & Pandey, 2019; Pal & Ghosh, 2014; Ayers, 2011; Schroll, 2002); identifying the fire safety performance indicators to trigger the proactiveness (Frost et al., 2016; Frost et al., 2015; Sanmiquel, 2014; Elliot et al., 2004; Rider, 2001) and measuring corporate fire safety proactiveness (Doherity, 2019) generally has focused on organizations operating in the foreign industries. As yet, we know little about whether these techniques of measuring fire safety proactiveness can be generalized to developing country like India. It appeared that there is further scope of exploring the condition of Indian companies. However, as it was found that Indian companies are not proactive compared to those in developed, questions remain about how much fire safety issues are being incorporated in business practice by Indian companies? Do they ever think of corporate social responsibility? How much proactive they are? Studying the status of proactiveness of the business units towards fire safety would enhance our understanding of the conceptual issues to a much greater degree.

In this paper, we make 4 contributions to the existing literature. First, we review various recent industrial fire incidences in India. Second, we identify the fire safety performance indicators for triggering corporate proactiveness towards fire safety at the facility level. For the purpose, we choose certain aspects of business process including certain strategic issues (e.g., corporate mission, compliance with safety regulations, quality certification, etc.) that may reflect the level of incorporation of fire safety issues in business practice. Third, we measure proactiveness of the business units towards fire safety considering the relative contribution of each of the FSPIs to a facility's overall business performance. Fourth, this study takes a significant step forward in advancing our understanding of fire safety management in making an endeavour to categorize the business units in a matrix for better classification of units on the basis of proactiveness towards fire safety and other suitable criteria.

The rest of the paper is organized as follows:

In the next section (Section 2), we describe the objectives of the study in the context of issues described above. Next 4 sections (Sections 3, 4, 5 and 6) contain a brief review of existing literatures on 3 main aspects of the study, namely, recent industrial fire incidences in India, fire safety performance indicators and measurement of corporate proactiveness towards fire safety. Section 7 describes the research methods including identification of fire safety performance indicators. Further this section

presents the results of the study and in the process develops a matrix of proactiveness towards fire safety for better classification of the surveyed units. The last section (Section 8) concludes the study.

Objective of the Study

The prime objectives of the present study were:

- To review the recent industrial fire incidences in India;
- To explore the position of sample units regarding fire safety management;
- To assess empirically how far the sample units are proactive in management of fire safety issues;
- To make an endeavour to categorize the business units in a matrix for better classification of units on the basis of fire safety performance and other suitable criteria.

Fire Incidences in India

The National Crime Records Bureau Data indicates that a total of 1,31,661 people lost their lives due to Fire accidents from 2010 to 2015 (Fig. 1). This is an average of 60 deaths a day. Between 2010 and 2015, a total of 1.40 lakh fire accidents of various types took place in the country claiming more than 1.32 lakh lives. The figure shows that both the number of accidents and deaths is steadily coming down in the last few years. From 26,025 fire accidents in 2010, the number of accidents has come down to 18,450 in 2015, a drop of more than 29%. The number of deaths on the other hand came down from 24,414 in 2010 to 19,513 in 2014, a 27.5% drop (Dubbudu, 2016).

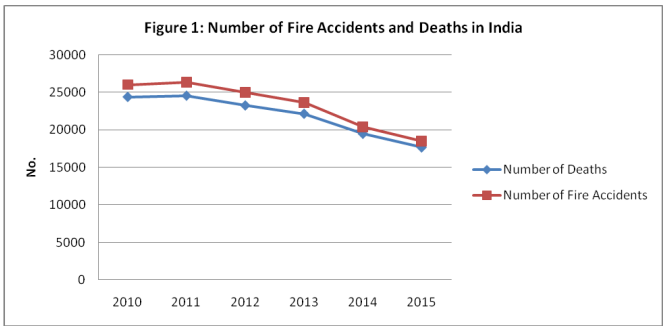


Fig. 1: Number of Fire Accidents and Death in India

The NCRB categorizes fire accidental deaths into 4 broad groups. Deaths caused by Electric Short Circuit, by Gas Cylinder/Stove Burst, by Fireworks and by any other cause. From 2010 to 2014, the number of deaths due to Electric Short Circuit was about 7,743 or 7% of all the deaths (Fig. 2). The number of deaths due to firework accidents like the one in Kollam was 1,630 (1% of the total deaths). 19,491 (17%) deaths were caused by burst of Gas Cylinder/Stove. 85,081 i.e. three fourths (75%) deaths were caused by other reasons like fire in buses, trains, buildings etc.

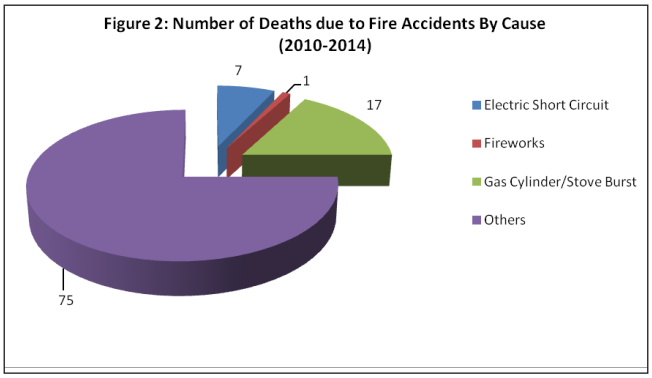


Fig. 2: Number of Death due to Fire Accidents by Cause (2010-2014)

Scenario of Industrial Fire Incidences in India

Here are some of the worst industrial fire accidents of recent years in India (Table 1):

Jun 17, 2019: In Raigad district of Maharashtra at a plant of the Reliance Industries Limited (RIL), a fire incident occurred, but no casualty or damage was reported. There was a spark in a chemical stored in the unit which led to the fire in a boiler.

Sept 8, 2018: The incident occurred when workers of the private cracker unit in Kakivadanpatti were mixing chemicals. 3 persons were killed and 3 others were injured in an explosion at a fireworks unit in Virudhunagar district.

Aug 9, 2018: At least 43 people were severely injured in a boiler blast at Bharat Petroleum Refinery in Chembur area of Mumbai. The accident took place at the state-run BPCL refinery. No casualties were reported in the incident.

Jul 4, 2018: A cracker factory situated in Warangal, Telangana was surrounded by fire that caused the death of 10 workers who were trapped inside the factory. A short circuit is seen as the probable cause of the massive fire that broke out in the factory.

Apr 6, 2018: 4 workers were killed and 6 others injured in separate fire accidents reported in 2 cracker units in Vembakottai Taluk of Virudhunagar district. Violation of safety norms has caused both the fatal accidents.

Mar 3, 2018: A massive fire broke out inside a chemical factory in Asalfa village in Ghatkopar, a Central Mumbai suburb. No casualties have yet been reported.

Feb 7, 2018: A fire broke out in a cloth mill in Mumbai's Goregaon area. The ground floor of Parekh Cloth mill in the Italian Industrial Estate caught fire. The three-floor building is situated in the suburban area of Goregaon. 8 fire engines, 6 jet tankers and 1 water tanker were rushed to the spot. No casualties were reported.

Jan 20, 2018: On the outskirts of Delhi, an illegal firecracker manufacturing factory was set up in the lieu of a plastic manufacturing factory in the Bawana district. The illegal unit caught fire trapping laborers inside due to the exit being blocked by construction activity going around in the vicinity. 17 people died. 2 months later, the owners were booked under IPC sections 304, 377 and Explosives Act.

Dec 28, 2017: This is one of the recent fire tragedies. Kamala mills fire accident is one of the worst tragedies of 2017 that shook India. The accident occurred in 2 rooftop pubs in Mumbai. The accident claimed 14 lives. The origin of the fire is claimed to be from a hookah. Moreover, there were series of fire safety violations in these pubs. The pubs neither have emergency exits nor did it have fire safety equipment in working condition.

Nov 20, 2017: The fire accident at a plastic factory in Ludhiana took place. 13 people, including 3 firemen were killed and dozens were seriously injured. The 5-storey building allegedly had approval only for 2 storeys and also had been stocking up hazardous chemicals. Due to these violations, the fire accident led to building collapse. Moreover, there was no fire safety system or fire safety equipment in the building. Many houses near the factory also got damaged because of this incident.

Nov 1, 2017: The NTPC power plant explosion was a boiler explosion that occurred at a newly commissioned 500-megawatt unit of the Feroze Gandhi Unchahar coal-fired power plant. The plant is operated by government-owned National Thermal Power Corporation (NTPC) Limited, in Unchahar, Raebareli distrct, Uttar Pradesh. The explosion killed 32 people who may have been cleaning ash from the boiler's interior.

Oct 15, 2017: Multi-storied hosiery unit in Ludhiana gutted fire. Fire spread speedily as the fire department was ill-equipped. The unit was allowed to operate in the residential area.

Jun 1, 2017: The 7 storeyed building of Chennai Silk House in buzzing streets on TNagar was engulfed in fire. The estimated loss was Rs. 420 crore and the structure had a series of fire safety and building code violations.

Mar 11, 2017: A blast at a factory belonging to Nagamalli Fireworks at Vetrilai Oorani near Sivakasi claimed the lives of 5 workers, including 3 women.

Oct 20, 2016: A major fire broke out at cracker manufacturing hub in Tamil Nadu. 8 people died and 10 others got injured in this accident. At around 1.30 pm, workers at Raghavendra Agency on the Sivakasi - Virudhunagar road were unloading fireworks from a minivan. The fireworks exploded when a bundle fell on the ground.

Jun 9, 2016: 2 workers died in a massive explosion at a Fireworks Factory at Maraneri near Sivakasi. The explosion, which occurred had razed down 2 godowns and left a huge plume of smoke blanketing the area. Friction caused while handling highly inflammable chemicals led to the fire.

Feb 25, 2016: An explosion in a cracker unit at a village in the district damaged 5 rooms and destroyed some fancy fireworks, but there were no causalities. The fireworks stored in one of the 40 rooms at Jonal Fireworks unit at Chokkalingapuram village caught fire and exploded, they said, adding that the blaze quickly spread and completely gutted 5 rooms.

Aug 22, 2013: A major explosion ripped through a cracker factory near Sivakasi in the Virudhunagar district in southern Tamil Nadu. No casualties have been reported. At least 4 explosions were heard at the Chidambaram Fireworks factory in the Vilampatty village. 17 of its 40 units were gutted in the fire.

May 15, 2013: Three women including an woman, were killed on the spot and 19 others including a child sustained injuries in an explosion at Meenakshi Fire works at Kichanayakkanpatti in Sivakasi Taluk. The accident occurred when the workers were busy manufacturing fireworks at small unit.

Jan 6, 2013: A major fire broke out at a petrol storage tank of state-owned Indian Oil Corp's (IOC) Hazira terminal in Gujarat. No casualties were reported immediately. Fire was reported at one of IOC's 5 petrol storage tanks at the Hazira depot. The tank had held almost 5,000 kilolitre of petrol, half of its capacity, when it caught fire.

Sept 5, 2012: Due to explosion at the Om Sakthi Fireworks Industries fireworks factory in Sivakasi, India, 40 people were killed and more than 70 injured. The tragedy occurred in a fireworks factory which did not have a valid licence. The explosion occurred while workers were mixing certain chemicals to produce fireworks. Some reports suggest the high ambient temperature in the factory, reported to be 69°C (156°F), may have been a factor. Fire fighter entry to the buildings was delayed by a lack of equipment, including breathing apparatus. Cause of the accident is the impact & friction or heat while ramming explosives composition into a shell of an aerial fireworks item by an inexperienced worker might have caused a spark which initiated fire and explosion. The erratic stocking and drying of fireworks outside the working sheds contributed spread up of fire in the factory and to the fireworks transit shed which exploded later. Keeping of excess quantity of black and colour pellets, in this shed significantly contributed to the enormity of the power of explosion which instantly killed the people around. 15 major violations of Explosives Rules 2008 was reported in the accident investigation report.

Oct 29, 2009: The Jaipur oil depot fire broke out at the Indian Oil Corporation (IOC) oil depot's giant tank holding 8,000 kilolitres (280,000 cu ft) of petrol, in Sitapura Industrial Area on the outskirts of Jaipur, Rajasthan, killing 12 people and injuring over 300. The incident occurred when petrol was being transferred from the Indian Oil Corporation's oil depot to a pipeline. There were at least 40 IOC employees at the terminal (situated close to the Jaipur International Airport) when it caught fire with an explosion. As per eyewitnesses having factories and hotels around Indian Oil's Sitapura (Jaipur) Oil Terminal they felt presence of petrol vapour in the atmosphere. Within the next few hours the concentration of petrol vapour intensified making it difficult to breathe. Adjacent to the terminal wall was the workshop of Morani Motors (P) Limited where cars parked on the roof top were thrown up into the air to about 10 feet and 35 new Hyundai brand cars were completely destroyed. A huge ball of fire with loud explosion broke out engulfing the leaking petrol tank and other nearby petrol tanks with continuous fire with flames rising 30-35 m (98-115 ft) and visible from a 30 km (19 mi) radius.

Sept 23, 2009: The 2009 Korba chimney collapse occurred in the town of Korba in the Indian state of Chhattisgarh. It was under construction were under contract for the Bharat Aluminium Co Ltd (BALCO). Construction had reached 240 m (790 ft) when the chimney collapsed on top of more than 100 workers who had been taking shelter from a thunderstorm. At least 45 deaths were recorded.

July 20-Aug 3, 2009: The explosions at 5 fireworks units in and around Sivakasi, in Virudhunagar district, between July 20 and August 3 have brought to various irregularities, illegalities and inadequacies in the fireworks industry in Tamil Nadu. 43 people died and several were injured, ripped apart the claim of the authorities that safety norms are strictly adhered to in the industry. 4 of the 6 units where the blasts took place are in the licensed sector.

Table 1: Recent Industrial Fire Incidences in India

Date	Place	Name of Plant	Causes of Fire	Extent of Injury
Jun 17, 2019	Raigad district of Maharashtra	Reliance Industries Limited (RIL)	Spark in a chemical stored in the unit which led to the fire in a boiler	No casualty or damage was reported.
Sept 8, 2018	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Factory belonging to Krishnasamy Industries - Kakkivadanpatti	During mixing of chemicals, an explosion occurs at a fireworks unit.	3 persons were killed and 3 others were injured.
Aug 9, 2018	Chembur area of Mumbai	Bharat Petroleum Refinery	Boiler blast	At least 43 people were severely injured in a boiler blast. No casualties were reported.
Jul 4, 2018	Warangal, Telangana	Cracker factory	Short circuit	Death of 10 workers
Apr 6, 2018	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	SKS fireworks – Kakkivadanpatti	Violation of safety norms has caused both the fatal accidents	4 workers were killed and 6 others injured
Apr 6, 2018	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	ARV fireworks – Ramuthevanpatti		
Mar 3, 2018	Asalfa village in Ghatkopar, a central Mumbai suburb	Chemical factory	-	No casualties have yet been reported.
Feb 7, 2018	Mumbai's Goregaon area	Cloth mill	-	No casualties were reported.
Jan 20, 2018	Bawana district, on the outskirts of Delhi	Illegal firecracker manufacturing factory	Illegal unit caught fire trapping laborers inside due to the exit being blocked by construction activity going around in the vicinity	Claimed the lives of 17 people
Dec 28, 2017	Mumbai	Kamala mills	From a hookah	Claimed 14 lives
Nov 20, 2017	Ludhiana	Plastic factory	Stocking up hazardous chemicals	13 people, including 3 firemen were killed and dozens were critically injured
Nov 1, 2017	Unchahar, Raebareli distrct, Uttar Pradesh	Feroze Gandhi Unchahar coal-fired power plant	Boiler explosion	32 people killed.
Oct 15, 2017	Ludhiana	Hosiery unit	-	No casualties were reported.
Jun 1, 2017	TNagar, Chennai	Chennai silk House	Unplanned growth and a lackadaisical attitude towards basic safety measures	No casualties or injuries reported
Mar 11, 2017	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Nagamalli Fireworks - Vetrilai Oorani	Mishandling of chemicals combined with the rising heat levels	5 Workers killed.
Oct 20, 2016	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Whole Sale Shop - Raghavendra Agency – Sivakasi	The fireworks exploded when a bundle fell on the ground.	8 people lost their life and 10 others got injured
Jun 9, 2016	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Krishnasamy Fireworks – Maraneri	Friction caused while handling highly inflammable chemicals	2 killed.
Feb 25, 2016	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Jonal Fireworks – Chokkalingapuram	The fireworks stored caught fire and exploded	No casualities.

Date	*Place*	*Name of Plant*	*Causes of Fire*	*Extent of Injury*
Aug 22, 2013	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Chidambaram Fireworks – Vilampatty	-	No casualities.
May 15, 2013	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Meenakshi Fireworks - Kichanayakkanpatti	-	3 women including a women, were killed on the spot and 19 others including a child sustained injuries.
Jan 6, 2013	Gujarat	Indian Oil Corp's (IOC) Hazira terminal	Petrol storage tank	About 12 people lost their lives due to burns and asphyxia and more than 300 suffered injuries. Many of the dead were the employees of Indian Oil Corporation
Sept 5, 2012	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Om Sakthi Fire works – Mudhalaipatti	Impact & friction or heat while ramming explosives composition into a shell of an aerial fireworks item by an inexperienced worker	40 people were killed and more than 70 injured
Oct 29, 2009	Sitapura Industrial Area on the outskirts of Jaipur, Rajasthan	the Indian Oil Corporation (IOC)	Transferring of petrol from the Indian Oil Corporation's oil depot to a pipeline	Killing 12 people and injuring over 300
Sept 23, 2009	Korba, Chhattisgarh	Bharat Aluminium Co Ltd (BALCO)	Chimney	At least 45 deaths were recorded
Aug 3, 2009	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Classic Fireworks - Meenampatti	Irregularities, illegalities and inadequacies	43 people dead and several injured
Jul 28, 2009	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Anil Fireworks - Keezha Tiruthangal		
Jul 20, 2009	Sivakasi in Virudhunagar District in the the State of Tamil Nadu	Sri Krishna Fireworks – Namaskarithanpatti		

Source: http://www.beyondcarlton.org/7-worst-fire-accidents-india-2018/ dated 5.9.2019
http://www.beyondcarlton.org/8-worst-fire-accidents-2017/ dated 5.9.2019
https://en.wikipedia.org/wiki/Category:Industrial_fires_and_explosions_in_India dated 5.9.2019
http://www.walkthroughindia.com/lifestyle/ten-major-and-worst-fire-incidents-in-india/ dated 5.9.2019

Fire Safety Performance Indicators

A considerable number of studies (Sengupta & Pandey, 2019; Doherity, 2019; Frost et al., 2016; Frost et al., 2015; Dubbudu, 2016; Sanmiquel, 2014; Trivedi, 2014; Pal and Ghosh, 2014; Ayers, 2011; Elliot et al., 2004; Schroll, 2002; Rider, 2001) have been undertaken to select the indicators for assessing the proactiveness. In the field of fire safety performance, some authors used the term fire safety performance indicators (FSPIs), which are presented briefly as follows:

- Fire Fighting Installation System
- Fire Detection & Alarm System (FDA)
- Means of Escape
- Daily Operative & Preventive Maintenance
- Fire Training & Mock Evacuation Drill
- Electricity and Emergency Power Supply
- Hazard Mitigation System
- Air Conditioning & Ventilation System (Passive & Active Protection System)
- Law Enforcement & Inspection/Certification
- Disaster Management Committee

Measurement of Corporate Proactiveness Towards Fire Safety

In some studies, fire safety performance indicators have been weighted on the basis of their relative importance to the proactiveness towards fire safety. The weights used have either been determined by the researcher or taken from previous studies. While in some other studies, unweighted indicators have been used. In such an index, equal weight, i.e. 'one' has been assigned to each fire safety performance indicator of the proactiveness towards fire safety on the assumption that all the fire safety performance indicators are equally important to arrive at proactiveness score (where all fire safety performance questions were equally weighted and the section as a whole accounted for 50% of the overall score). Any weighted index may involve an element of subjectivity, but it may facilitate the true measurement of the score recognizing perceived importance of different primary indicators to overall fire safety management. It is most unlikely that each primary indicator has equal weightage in framing a real life fire safety policy.

In addition, it was stated that the weighting factor is subjective and will ultimately change over time due to the priorities of the decision maker. Arguing in the same tune, some authors put weightage of each performance level based on priority during the evaluation of fire safety performance. In some studies the weights assigned to various criteria were varied substantially across the sectors based on their inherent characteristics. Fiksel (1994) stated that there is no universal weighting scheme that will suit the needs of diverse organizations and each industry and/or company should develop a scheme that suits its business characteristics.

For awarding score to different fire safety performance indicators, most researchers have followed a dichotomous procedure in which an fire safety performance indicator has been awarded its assigned weight or score (i.e. 'one' in the case of unweighted index and a weighted score in the case of weighted index), if it was present. On the other hand, if the fire safety performance indicator was not present, and it was found that the indicator was applicable to the concerned company, a score 'zero' has been awarded. However, a few researches have awarded score to fire safety performance indicators on the basis of their merit of proactiveness towards fire safety.

A scorecard was also produced with a simple weighting scale for various categories of fire safety performance areas of 'maintenance carried periodically' and 'maintenance carried occasionally'. This produced later a ranking of companies through the use of values that ranged from 0 (worst) to 10 (best) for performance in 20 key fire safety areas.

To measure corporate safety, weightage was also put for each of the statements or presence of fire safety indicators by rating them on a 1-5 Likert-type scale (1 = do not agree at all, 2 = do not agree, 3 = neutral, 4 = agree, 5 = strongly agree). Similarly, to undertake a study on implementation of fire safety management system, weightage was put for each of the fire safety indicators by rating them on a 5 point Likert scale, where 1 = Not at all and 5 = To a very large extent.

Research Methods

Description of Data and Methodology

During pilot survey, we got a list of high risk units in West Bengal from the Annual Report of West Bengal Pollution Control Board (WBPCB), 2018 - 2019. Major concentrations of those units were seen in 6 districts (Howrah, Burdwan, Kolkata, 24 Pgs. (N), Hooghly and Medinipur) that covered about 84.75% of total high risk units in West Bengal. Considering time and resource constraints, it was decided to restrict the survey among 25% of those units. Accordingly, 55 high risk units were target units for our study.

Based on the nature of sample units, we identified 5 major industry segments, namely, 'chemical'; 'ferrous metal'; 'food & beverage'; 'non-ferrous metal' and 'thermal power'. Rest of the sample units that did not fall under these 5 industry segments were clubbed under head 'others'.

To collect the information from the target units, a specific questionnaire was developed. Various government officials viz., Chief Factory Officer, Senior Safety Officer, Fire Safety Officer and/or Fire Safety Engineers/ Operators were consulted for designing the questionnaire. Further, various officials from the regulatory agency viz., Safety Engineers, WBPCB and / or senior officials dealing with fire safety issues as well as corporate image building were also involved for the purpose.

The information was collected on the basis of personal interview and group discussions with executives and workers of the target units as well as officials of the various regulatory agencies including the various Chambers of Commerce.

The results of the questionnaire survey were collated to draw valuable inferences about the approaches adopted by the sample units to address the fire safety related issues. Our aim was to look into the fact that how they are adopting and implementing fire safety management and quality management practices in their units. For this purpose, we used statistical measures like central tendency, dispersion, correlation, etc. For the purpose of evaluation of proactiveness of the selected sample units towards fire safety, 6 fire safety indicators were selected and some score was assigned to the fire safety indicators. Next, to know the portfolio of the surveyed unit regarding fire safety management, the study developed Fire Safety Proactiveness Matrix.

In the following section, we 1st described on selection of fire safety performance indicators and the methodology adopted for quantitative measurement of proactiveness towards fire safety that has ultimately resulted in Fire Safety Proactiveness Score for each of the sample units. Thereafter, we have described findings of the questionnaire survey.

Selection of Fire Safety Performance Indicators

Based on the previous studies and further discussions with the Chairman, WBPCB and also with the top personnel of other trade bodies, viz., Indian Chamber of Commerce, BCCI, FICCI, etc., out of all fire safety performance indicators, the study concentrated on 4 primary indicators and some major sub-indicators that may lead the units towards fire safety proactiveness. The primary 4 indicators are as follows:

- Fire Detection & Alarm System (FDA)
- Means of Escape
- Daily Operative & Preventive Maintenance
- Fire Fighting Installation System

We have 1st described the basis of selection of above 4 fire safety performance indicators in the following section:

Fire Detection and Alarm System (FDA)

Fire detection systems are designed to discover fires early in their development when time will still be available for the safe evacuation of occupants. Early detection also plays a significant role in protecting the safety of emergency response personnel. Through early detection property loss can be reduced and downtime for the operation minimized because control efforts are started while the fire is still small.

Means of Escape

The principle on which means of escape provisions are based is that the time available for escape (an assessment of the length of time between the fire starting and it making the means of escape from the workplace unsafe) is greater than the time needed for escape (the length of time it will take everyone to evacuate once a fire has been discovered and warning given).

Daily Operative and Preventive Maintenance

Daily operative and preventive maintenance is maintenance that is regularly performed on a piece of equipment to lessen the likelihood of it failing. It is performed while the equipment is still working so that it does not break down unexpectedly. In terms of the complexity of this maintenance strategy, it falls between reactive (or run-to-failure) maintenance and predictive maintenance.

Fire Fighting Installation System

A fire fighting system is probably the most important of the building services, as its aim is to protect human life and property. Fire fighting systems and equipment vary depending on the age, size, use and type of building construction. A building may contain some or all of the following features: fire extinguishers; fire hose reels; fire hydrant systems; automatic sprinkler systems.

Measurement of Proactiveness of Sample Units towards Fire Safety

Based on the empirical studies mentioned in section 3, it was decided to attribute some score/weightage to each of the indicators mentioned above considering their

perceived importance towards fire safety proactiveness for any unit. The break up of maximum achievable score for each indicator is given below:

Table 2

Primary Indicator	*Score/ Importance*
Fire Detection & Alarm System	340
Means of Escape	290
Daily Operative & Preventive Maintenance	240
Fire Fighting Installation System	130
Total	1,000

Source: Results computed.

Further, the Fire Safety Performance Indicators are divided into various sub-indicators to measure Fire Safety Proactivenesss Score (EPS). For each of such sub-indicators sample units were assigned scores on the basis of their performance in that particular area after consulting experts in the field and government officials. Each of the sub-indicators was categorized into different scales based on responses obtained from surveyed units during collection of primary data. The interval of the scale was determined based on the nature of collected data. Again, some score/weightage was given to each interval of each sub-indicator. Though it was subjective, but it was considered unavoidable (Wallace, Naser & Mora, 1994). The detailed scorecard that showed the proactiveness score value for each of the sub-indicators has been given in Annexure. It is pertinent to mention here that after designing the scorecard, some revision was made based on discussion with the government officials as well as company executives working in the field of fire safety. Ultimately, to obtain FSPS, following formulae was applied:

$$FSPS = \frac{ScoreObtained}{MaximumAchievableScore} x100$$

Accordingly, the study evaluated the combined proactiveness score value of the surveyed units based on performance with respect to all of the 4 primary indicators.

Empirical Results

In this section, the major empirical findings of the present study are reported under the following 2 heads:

- Findings relating to the position of sample units regarding fire safety performance indicators.
- Findings relating to the quantitative evaluation of proactiveness of the sample units towards fire safety.

Major findings relating to the position of sample units regarding Fire Safety Performance Indicators:

Relating to Fire Detection & Alarm System:

- 50.91% (28) of the surveyed units had operational Fire Detection & Alarm System.
- Out of 28 surveyed units having Fire Detection & Alarm System:
  - In case of 67.86% cases, detection system is of conventional type. About 15% surveyed units had intelligent type detection system.
  - 67.86% (19) had regularly check/maintain the FDA system.
  - 78.57% had false ceiling.
  - 50% of the units having false ceiling had detectors above it.
  - 50% had installed Fire Detection & Alarm System as per relevant standard.
  - In case of 57.14% units, Fire Detection & Alarm System had been installed at proper location.
  - 53.57% units had public address system.

Relating to Means of Escape

- Out of 55 surveyed units, 38.18% (21) of the surveyed units did not have adequate space for walking/running as means of escape.
- Out of 34 surveyed units having adequate space for means of escape,
  - In case of 67.65% units, there is possibility of horizontal evacuation.
  - In case of 64.71% units, there is availability of corridors.
  - In case of 61.76% units, there is availability of lobbies.
  - In case of 55.88% units, there is accessibility from each floor to all staircases.
  - In case of 52.94% units, there are electrical panels, gas pipes in staircases.

- In case of 32.35% units, there is fire tower in staircase.
- In case of 38.24% units, there is fire check door in all entrance.
- In case of 73.53% units, there is hand rail in staircase.
- In case of 73.53% units, there is sign at lift landings.
- In case of 91.18% units, there is floor numbering signs.
- In case of 85.29% units, there is exit route signs.
- In case of 85.29% units, there is stair identification signs.
- In case of 73.53% units, there is stair re-entry signs.
- In case of 64.71% units, there is presence of fire lift.
- In case of 44.12% units, there is presence of ramp from the top floor to ground.
- In case of 35.29% units, there is presence of ramp from the basement to ground.

Relating to Daily Operative and Preventive Maintenance:

- Majority (87.27%) of the cases surveyed units had daily operative and maintenance system.
- Out of 48 surveyed units that had daily operative and maintenance system:
  - In majority (62.50%) of the cases, fire hydrants were operated and maintained occasionally.
  - In majority (58.33%) of the cases, pump & pump house were operated and maintained periodically.
  - In majority (68.75%) of the cases, fire brigade inlet were operated and maintained occasionally.
  - In majority (79.17%) of the cases, monitor nozzle were operated and maintained occasionally.
  - In majority (70.83%) of the cases, mainline strainer were operated and maintained occasionally.
  - In majority (66.67%) of the cases, draining arrangement of water tanks were operated and maintained periodically.
  - In majority (70.83%) of the cases, stop valve of sprinkler system were operated and maintained occasionally.
  - In majority (66.67%) of the cases, valve monitor of sprinkler system were operated and maintained occasionally.
  - In majority (70.83%) of the cases, alarm valve of sprinkler system were operated and maintained occasionally.
  - In majority (70.83%) of the cases, pressure switches of sprinkler system were operated and maintained occasionally.
  - In majority (68.75%) of the cases, flow switches of sprinkler system were operated and maintained occasionally.
  - In majority (58.33%) of the cases, installation control valve of sprinkler system were operated and maintained occasionally.
  - In majority (60.42%) of the cases, sprinkler head were operated and maintained occasionally.
  - In majority (70.83%) of the cases, drain valve of sprinkler system were operated and maintained occasionally.
  - In majority (58.33%) of the cases, emergency lighting arrangements were operated and maintained periodically.
  - In majority (62.50%) of the cases, escape route lighting arrangements were operated and maintained occasionally.

Relating to Fire Fighting Installation System:

- In the majority (92.73%) of the cases surveyed units had fire fighting installation system.
- Out of 51 surveyed units that had fire fighting installation system:
  - Majority (60.78%) had portable extinguishers.
  - 88.24% of the surveyed units having portable extinguisher, they were not placed as per Standard Rules.
  - 64.71% of the surveyed units, landing valves were not placed properly.
  - 60.78% of the surveyed units, hose and branch were not placed properly.

- 41.18% of the surveyed units did not have stand-by pump.
- 45.10% of the surveyed units did not have jockey pump.
- 41.18% of the surveyed units did not have DG Back up.

Major findings relating to the quantitative evaluation of proactiveness of sample units towards fire safety:

Combined Proactiveness Score based on Overall Fire Safety Performance:

- Out of 55 surveyed units, 23 units (41.82%) obtained less than 50% score, out of maximum achievable score.
- Out of these 23 units, 4 were ISO 9001 certified and the rests 19 did not have any certification.
- 25 (45.45%) units obtained 50 - 70% score, out of which some (56%) were ISO 9001 certified and the rests did not have any certification.
- Out of all ISO 9001 certified units, majority (77.77%) obtained score in the range of 50-70%.
- Units that were ISO 14001 certified had scored more than 70%.

The overall statistics relating to Fire Safety Proactiveness Score by industry segment considering the status of all the four primary indicators is reported in Table 3.

Table 3: Summary Statistics of Fire Safety Proactiveness Score by Industry Segment

Sr. No.	*Industry Segments*	*Fire Safety Proactiveness Score (%)*		
		Mean (%)	*Std. Dev.*	*Range (%)*
1	Chemical	53.60	17.46	27.76 - 82.60
2	Ferrous Metal	44.21	10.71	27.03 - 61.76
3	Food & Beverage	52.36	4.43	46.27 - 56.89
4	Non-Ferrous Metal	53.76	11.77	36.72 - 76.40
5	Thermal Power	64.36	13.10	40.14 - 74.52
6	Others	55.17	13.37	31.33 - 75.38
Overall		52.03	13.89	27.03 - 82.06

Source: Questionnaire Survey. Results computed.

Table 3 reveals that the highest mean score value was obtained by the units of thermal power. Poor performance was observed in case of units of ferrous metal industry. Medium performance was reflected in case of other industry segments.

Development of Fire Safety Proactiveness Matrix

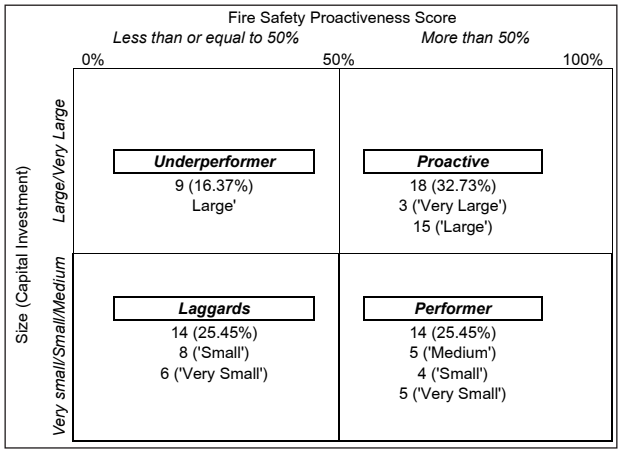
To know the portfolio of the surveyed units regarding fire safety management, the study developed Fire Safety Proactiveness Matrix. Each surveyed unit was rated in terms of two major dimensions – 'Fire Safety Proactiveness Score' and 'Size'. The vertical axis here, was categorized into 2 zones – 'large/very large' and 'very small/small/medium'. As 'Size' was determined based on capital investment, therefore 'very small/small/medium' zone indicates the units having capital investment of 'less than or equal to Rs. 100 crores' and 'large/very large' zone indicates the units having capital investment of 'more than Rs. 100 crores'. Similarly, 'Fire Safety Proactiveness Score', which was measured on the horizontal axis, ranged from 0% to 100%. Fire Safety Proactiveness score above 50% was considered high proactiveness score. Further, 'Size' i.e. 'Capital investment' served here as a proxy for unit attractiveness, and 'Fire Safety Proactiveness Score' served as a proxy for being proactive towards fire safety issues and gaining competitive advantage. The Fire Safety Proactiveness Matrix thus, mapped the business unit positions within these two important determinants of proactiveness.

In the Fig. 3, the Fire Safety Proactivenes Matrix was divided into 4 cells, each indicated a different types of business practice based on the extent to which fire safety issues are incorporated in the business practice. Those 4 cells are as follows:

- *Proactive:* Units that obtained more than 50% overall proactiveness score and were of large/very large size were designated as 'Proactive' [Upper Right Cell of Fig. 3].
- *Performer:* Units that obtained more than 50% overall proactiveness score, though were of very small/small/medium size were designated as 'Performer' [Lower Right Cell of Fig. 3].
- *Underperformer:* Units that were of large/very large size, but obtained less than or equal to 50%

overall proactiveness score were designated as 'Underperformer' [Upper Left Cell of Fig. 3].

- *Laggards:* Units that obtained less than or equal to 50% overall proactiveness score and were of very small/small/medium size were designated as 'Laggards' [Lower Left Cell of Fig. 3].



Source: Questionnaire Survey. Results computed.

Fig. 3: Fire Safety Proactiveness Matrix

After plotting all the 55 surveyed units in the Fire Safety Proactiveness Matrix, the study identified the portfolio of each of the surveyed units, which was tabulated as follows:

Out of all surveyed units:

- 18 (32.73%) units were 'Proactive' in nature. All 'very large' units and 15 'large' units fell in this category.
- 14 (25.45%) units were 'Performer' in nature. All 'medium' units, 4 'small' units and 5 'very small' units fell in this category.
- 9 (16.37%) units were 'Underperformer' in nature. All of these 9 were 'large' units.
- 14 (25.45%) units were 'Laggards' in nature. 8 'small' units and 6 'very small' units fell in this category.

It is pertinent to mention here that size parameter has no role in scoring and any unit would not be necessarily having high score for its size. Regulations also do not discriminate between large scale and small scale units regarding fire safety control requirements. Hence small units also need to be proactive towards fire safety issues and our attempt of this 2 x 2 matrix is aimed at identifying proactive and non-proactive groups in the same size class and also between different size classes.

Thus, from the perspective of strategic response to fire safety issues, it was concluded that for 'Proactive' units, they are showing the best fire safety performance and their business strategy is excellent; for 'Performer's, it is good. These 2 types of units can sustain for long time. Whereas, 'Underperformer's due to having high capital investment can properly allocate the fund for fire safety issues and it will not be difficult to revive. But competition is tough for 'Laggard's – they are too minor to consider and they may face problem to achieve long-term sustainability.

Our analysis revealed the logic behind the poor proactiveness score of 'Underperformer' though they were 'large/very large' units. Similarly, the study identified the problems with 'Laggards'. Some of the major lacuna that were identified are: sometimes they had conventional type detection system or the detection system was not regularly checked/maintained or they didn't have detectors above false ceiling or they didn't have any public address system; or they didn't have adequate space as means of escape; or they didn't have handrails in staircase or if they didn't have any fire lift; or they didn't have ramp from top floor to ground and basement to ground or fire hydrants/draining arrangement of water tanks/Alarm valve or Pressure switches of Sprinkler Systems/Emergency lighting arrangements, etc. were not maintained periodically; or Portable Extinguisher was not placed as per Standard Rules; or they did not have stand-by pump/jockey pump/D.G Back up.

Conclusion

The results of this research build on prior studies identi-fying the fire safety performance indicators (FSPIs) to trigger the proactiveness and measuring the proactiveness towards fire safety. First, this study provides empirical evidence of the potential business value created by incorporating fire safety issues in the business practices. After selecting fire safety performance indicators and it measures proactiveness of the business units towards fire safety. These findings fuel the ongoing discussion regarding whether or not it pays to be "safe," and offers evidence about how corporate proactiveness towards fire safety, in particular, fit into this debate.

Second, the results of this study broaden our understanding of fire safety performance indicators by identifying them and exploring their relative contributions to the decision to incorporate fire safety issues in business practice. While this study confirms that presence of four FSPIs encourage more comprehensive incorporation of fire safety issues, facilities that are measured mainly by their FSPIs are more likely to be proactive in the area of fire safety. The FSPIs also help to improve organizational reputation and strategically align the facility with future changes in the general business environment. Facilities that fail to maintain their fire safety indicators, therefore, appear to forego these competitive advantage opportunities.

Third, this study takes a significant step forward in advancing our understanding of exploring the fire safety performance of the existing units and classifying them in the form of fire safety proactiveness matrix. While previous research has examined the fire safety performance indicators to incorporate fire safety issues in business practice and the measurement of corporate proactiveness towards fire safety, most of these empirical studies were based on foreign industries. By exploring the fire safety performance for business units in developing country like India, results of this research can be generalized to a much broader setting and makes an important contribution to existing scholarship.

2 limitations of our research should be noted. First, the scope of the research has been restricted to proactiveness towards fire safety in the business practice as obtained through questionnaire survey. Other company documents that provide information such as annual report, filings with regulatory agencies, media reports, etc. have not been considered in this study.

Second, in measuring proactiveness towards fire safety, a weighted index has been used. Assignment of weights to different fire safety performance indicators involves subjective assessment. However, in attenuation of this apparent deviation we have tried to argue that measurement of proactiveness towards fire safety is always subjective irrespective of the use of unweighted index or weighted index. Since unweighted index is constructed based on the assumption that all the fire safety performance indicators are equally important to arrive at proactiveness score, which is not right in our assessment. Hence, we have attempted to capture the relative importance of each of the fire safety performance indicators to sample units by applying a weighted index.

These findings have important implications for future research. The concept of proactiveness towards fire safety in business practice is broad in scope and several issues come within its purview. Hence, improvements and extensions of the present study can not be ruled out. There is need for continuing more exploratory and empirical research on different aspects of proactiveness towards fire safety. An empirical study may be pursued to explore the presence of any unit specific determinant(s) that explain the variation in the extent of fire safety proactiveness score. If yes, then how those determinants are interrelated and significant. An in-depth study on fire safety performance may be made in specific areas of business practice particularly where extent of proactiveness towards fire safety is found to be poor, such as fire detection and alarm system, means of escape, etc. Furthermore, in future, fire safety management practices in sample units for several years may be examined, after taking steps to standardize year wise data or reduce their asymmetries, instead of focusing on one-year data, as this could provide stronger and more relevant result. Future research may also pursue a comparative study of business practice and proactiveness of Indian companies towards fire safety and of that in developed countries, to see how far business practice and fire safety management practices in Indian companies are lagging behind the International level.

In summary, this study attempts to explore empirically the position of industrial units in West Bengal regarding fire safety management. It is desired to assess how far the sample units are proactive in management of fire safety issues. In addition, it is desired to analyze the nature of variation in proactiveness score among the surveyed units. Further, it makes an endeavour to categorize the business units in a matrix for better classification of units on the basis of proactiveness towards fire safety and other suitable criteria. In this context, such matrix can serve as a simple tool for viewing a corporate business portfolio at a glance and may serve as a starting point for discussing incorporation of fire safety issues among strategic business units.

Annexure

Fire Safety Management Proactiveness Scorecard

Sr. No.	*Parameter*		*Score*
1	Having Fire Detection and Alarm System (340)		
1. 1	Present Type of Detection System	Conventional	20
		Addressable	30
		Intelligent	50
1.2	Regularly Checked / Maintained	No	0
		Yes	50
1.3	Presence of False Ceiling	No	0
		Yes	50
1.4	Detectors Above the False Ceiling	No	0
		Yes	50
1.5	Installed as per Relevant Standard	No	0
		Yes	50
1.6	Proper Location or Not	No	0
		Yes	40
1.7	Presence of Public Address System	No	0
		Yes	50
2	Having Means of Escape (290)		
2.1	Physical condition of the occupants	Able to run	35
		Able to walk	25
		Able to walk slowly	15
		Disable	0
2.2	Expected reaction hearing alarm	Can react	15
		Can not react	0
2.3	Possibility of horizontal evacuation	No	0
		Yes	15
2.4	Available corridors	No	0
		Yes	15
2.5	Available lobbies	No	0
		Yes	15
2.6	Accessibility from each floor to all staircases	No	0
		Yes	15
2.7	Electrical panels, gas pipes present in staircases	No	0
		Yes	15
2.8	Presence of fire tower in staircase	No	0
		Yes	15
2.9	Fire check doors in all entrance	No	0
		Yes	15
2.10	Presence of hand rails in staircase	No	0
		Yes	15
2.11	Signs at lift landings	No	0
		Yes	15
2.12	Floor numbering signs	No	0
		Yes	15
2.13	Exit route signs	No	0
		Yes	15
2.14	Stair identification signs	No	0
		Yes	15
2.15	Stair re-entry signs	No	0
		Yes	15
2.16	Fire lift present or not	No	0
		Yes	15
2.17	Presence of ramps from the top floor to ground	No	0
		Yes	15

Sr. No.	Parameter		Score
2.18	Presence of ramps from the basement to ground	No	0
		Yes	15
3	Having Daily Operative and Preventive Maintenance (240)		
3.1	Fire hydrants	Periodically	15
		Occasionally	5
3.2	Pump & pump house	Periodically	15
		Occasionally	5
3.3	Fire brigade inlet	Periodically	15
		Occasionally	5
3.4	Monitor nozzle	Periodically	15
		Occasionally	5
3.5	Mainline strainer	Periodically	15
		Occasionally	5
3.6	Water Tanks - Draining arrangement	Periodically	15
		Occasionally	5
3.7	Sprinkler Systems - Stop valve	Periodically	15
		Occasionally	5
3.8	Sprinkler Systems - Valve monitor	Periodically	15
		Occasionally	5
3.9	Sprinkler Systems - Alarm valve	Periodically	15
		Occasionally	5
3.10	Sprinkler Systems - Pressure switches	Periodically	15
		Occasionally	5
3.11	Sprinkler Systems - Flow switch	Periodically	15
		Occasionally	5
3.12	Sprinkler Systems - Installation control valve	Periodically	15
		Occasionally	5
3.13	Sprinkler Systems - Sprinkler head	Periodically	15
		Occasionally	5
3.14	Sprinkler Systems - Drain valve	Periodically	15
		Occasionally	5
3.15	Fire detection & alarm system - Emergency lighting arrangements	Periodically	15
		Occasionally	5
3.16	Fire detection & alarm system - Escape route lighting arrangements	Periodically	15
		Occasionally	5
4	Fire Fighting Installation System (130)		
4.1	Portable Extinguisher	No	0
		Yes	20
4.2	Location of Portable Extinguisher as per Standard Rules or Not	No	0
		Yes	20
4.3	Proper Location of Landing Valve	No	0
		Yes	20
4.4	Hose & Branch In Proper Place	No	0
		Yes	20
4.5	Presence of Stand by Pump	No	0
		Yes	20
4.6	Presence of Jockey Pump	No	0
		Yes	10
4.7	Presence of D.G Back up	No	0
		Yes	20
GRAND TOTAL			1,000

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