Fire Accidents and Safety Measures in Warehouse Fires

TOKIO MARINE INSURANCE GROUP

Compared to factories, warehouses have fewer ignition sources therefore it has lower risk of potential fires and lower frequency of fires. However, once a fire breaks out in a warehouse, it can spread over a wide area and causes extensive damage due to the large amount of combustible materials stored and the lack of openings that make firefighting difficult. In addition, in case a fire breaks out at night-time or at time when the warehouse is not occupied, the damage may exacerbate further.

In this article, we describe the recent trend of warehouse fire, actual example of fire accident, and preventive countermeasures against warehouse fire.

1. Cause of Fire and Economic Loss

Figure 1 shows the results of survey from National Fire Protection Association (NFPA) on the causes of warehouse fires. The highest percentage of warehouse fires is caused by electrical failures and malfunctions, indicating that the risk of fires caused by electrical equipment is high in that.

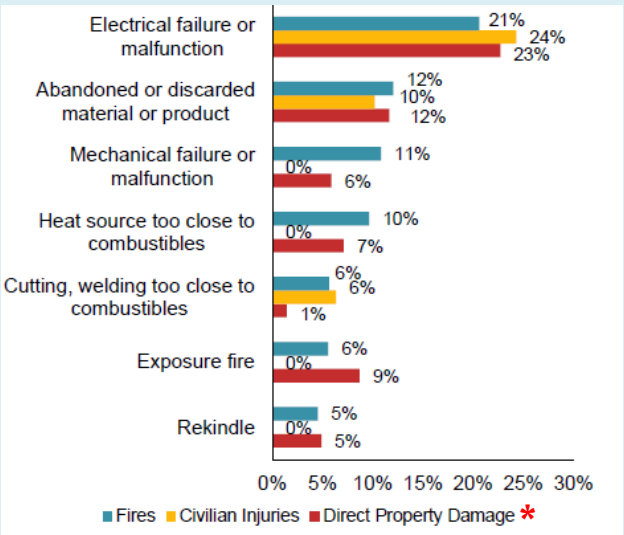

Figure 1. Causes of fire in warehouse

Source: Warehouse Structure Fires | NFPA[1]

* Fire: Based on the number of fires
Civilian Injuries: Based on the number of the injured
Direct Property Damage: Based on loss amount

Figure 2 shows the results of NFPA study on economic losses from warehouse fires. Between 1980 and 2020, the economic loss value of that has been increasing despite the number of warehouse fires has decreased by about 70%. One of the reasons for the growing amount of damage per warehouse fire is the increasing size of warehouses. Since warehouses can store many combustible materials, fire can spread quickly once ignited.

In addition, it is difficult to extinguish a fire because there are few openings, it is difficult for firefighters to extinguish the fire. In warehouses, it is important to take measures to prevent fires from breaking out.

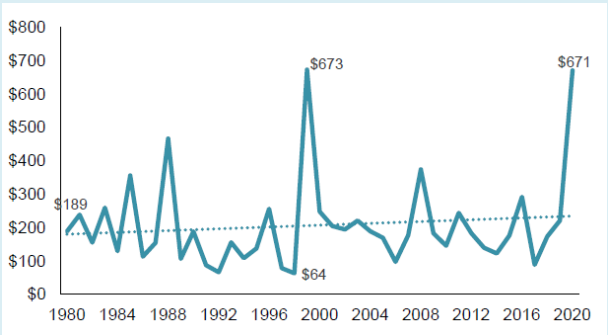

Figure 2. Economic losses due to warehouse fires
Source: Warehouse Structure Fires | NFPA[1]

2. Loss Examples of Actual Warehouse Fire

Two examples of losses from warehouse fires are described as followings.

■ Case 1

Fire at Warehouse (Tianjin, China: 2018)

A fire broke out due to malfunction in the electrical circuit of the video surveillance system. The sprinklers and fire shutters in auto mode did not function because they were manual mode. The fire spread to lubricating oil in cardboard packages and goods stored in the warehouse, and caused further spread of fire.

The security guard in security guard post was not qualified as a security guard, and effective initial firefighting activity was not carried out. The fire was extinguished the next day, and direct economic losses reached about 89.45 million CNY (about 13.41 million USD). Fortunately, no one was killed.[2][3]

■ Case 2

Fire in underground cold storage warehouse (Gyeonggi-do, South Korea: 2008)

A fire broke out in a room of an underground cold storage warehouse that was under construction. No clear information regarding the cause of fire. But it is assumed that a fire started due to the electrical circuit trouble because melted marks were observed on wiring. Workers on premises has not taken fire prevention training, hence initial fire fighting was not carried out and they evacuated. Fire detectors and fire shutters were set in manual mode because of concerns about malfunction during construction. Eventually, fire detectors and fire shutters were not activated. In addition, sprinklers did not work because all valves of pump were closed. The fire spread explosively because rigid urethane were used for the warehouse walls and flammable gas was retained at the work site after the urethane foaming process. The loss amount of the fire is unknown. However, the warehouse was completely destroyed and 40 of the 57 people were killed.[4]

Figure 3: Korean underground cold storage fire, 5 minutes after the fire was reported

Source: Investigation and analysis of a fire in a refrigerated warehouse that killed 40 people [4]

3. Fire Prevention Issues and Causes of Fires

This section describes fire prevention Issues and causes of fires in Section 2

A. Fire prevention issues

❑ **Lack of management of fire-fighting equipment (Case 1 and 2)**

Fire-fighting equipment did not operate well during a fire to mitigate spread of fire. It caused many casualties. This is because of the reasons as follow:

- No fire alarm during the fire as fire alarm system was set in manual. (Cases 1 & 2)
- Fire shutters did not work during the fire as they were set in manual mode. (Cases 1 & 2)
- Sprinkler was not able to activate as its valves were closed. (Cases 2)

❑ **Lack of knowledge regarding fire response (Case 1 and 2)**

- Two security guards sent from a security company were in security guard post. However, they did not have qualifications in fire protection management. In addition, the security company did not provide training on the specialized knowledge required for security services, and the security guard‘s knowledge of fire response was insufficient. As a result, they could not operate firefighting equipment during fire. (Case 1)
- Despite workers were foreign nationals and day laborers among the construction, management did not provide work safety training and evacuation drills. As a result, the day laborers who first discovered the fire called the fire department. However, they did not operate the fire alarm and directly evacuated. Many employees were unaware of the fire as there was no alarm and most of them perished. (Case 2)

❑ **Lack of housekeeping in work area (Case 2)**

- The work of urethane foaming operation onsite had been completed more than a week earlier. However, 15 cans (200-liter/can) of urethane material, a welding machine, and gas cylinders were found at the site after the fire. Insufficient housekeeping and organization contributes to the ease of spread of fire.

B. Cause of fire

Both cases describes that the fires broke out due to electrical problems. The fire was caused by deteriorating cables in Case 1. It was clear that no periodic inspections of the electrical circuits were ever carried out since day 1 the warehouse was built in 2012.

As shown in Figure 1, the number one cause of warehouse fires is "electrical failures and malfunctions," which again shows that maintenance of electrical equipment and wire is extremely important for controlling warehouse fires.

4-A. Fire Prevention Countermeasure

Based on the experience of Tokio Marine Group in fire risk investigations, effective preventive measures related to the warehouse fire issues in Section 3 are described below.

❑ **Fire-fighting equipment**

1) The fire-fighting equipment are always set in automatic mode and automatically activated in case of a fire.

   *When there is a risk of malfunction alarms due to hot work, construction manager submit a "Hot Work Permit" (stating the date, time of use, type of hot work and location) to the security guard post and fire control supervisor and set the fire-fighting equipment in manual mode only during hot work. Emergency response procedures including impairment control during the period must be informed to all concerned in advance. During hot work, fire protection shield, fire-fighting water and fire extinguishing equipment should be placed in the vicinity. Construction manager should attend the hot work, report to the security guard after the completion of the work, finally the fire-fighting equipment should be set in auto mode again.

2) Hot work should be prohibited at a compartment where rigid urethane is used for sandwich panels.

3) Fire-fighting equipment are inspected periodically.

   [Reference] Please refer to the regulations of each country. In Japan, Article 17 of the Fire Service Law requires that "buildings with a total floor area of 1,000m^2 or more and with unspecified public access" or "buildings with a total floor area of 1,000m^2 or more and designated by the fire chief or fire station chief" be inspected twice a year in the presence of a qualified person for fire-fighting equipment.[5]

4) The fire pump room is locked or located in a place that is inaccessible to outsiders.
5) Fire hydrants and sprinkler valves are properly controlled to open and closed.
6) Each valve is tagged and managed as "normally closed" or "normally open".
7) There are no obstacles around the sprinkler that could interfere with water distribution pattern and there is conducted daily inspection.
8) No unprotected areas with fire detectors.
9) The battery in the fire alarm panel is working.
10) No error indication on the fire alarm panel.
11) Fire detectors and fire alarms are equipped with an emergency power supply (e.g., storage batteries).
12) No objects around the fire door and checking if the fire door is operational is conducted.
13) No obstructions around fire hydrants and fire extinguishers, and Daily inspection of them is conducted.
14) The signboard is provided around fire extinguishers so that people know where the fire extinguishers are located.

❑ **Safety measures for employees**

1) Regular evacuation drill, fire fighting drill, and disaster prevention training are conducted for all employees (including temporary workers and part-time workers) .
2) If your company has nighttime operation, the drill that simulate nighttime operations is conducted.
3) If fire shutters are closed and normal passageways are blocked in case of a fire, alternative evacuation routes are provided, and all employees are trained on these details.
4) If your company hires employees of other nationalities, fire broadcast and contents is in the languages they understand are prepared.

❑ **Housekeeping in work area**

1) You are storing the equipment you brought in its designated place after working on site.
2) Patrols are (including management) conducted every month to check the tidiness of the work area.
3) When volatile hazardous materials (gasoline, thinner, etc.) are used, the work area is ventilated, and hazardous materials are sealed when not in use.
4) When bringing hazardous materials into the warehouse, the amount used for the day's work is brought in.

4-B. Fire Mitigation Countermeasure

Most warehouse fires are caused by electrical causes. The following is an excerpt from "TM-RE News No. 29: Fire Risk and Safety Measures in General Electrical Equipment" which provides a detailed explanation of electrical fires.

Table 1. Prevention perspectives for electrical fire[6]

Item	Check task
Cables	• Cable deterioration condition • Cleaning condition of dust at electrical outlets • Waterproofing of outdoor outlets • No clutter in cables • Whether the cable is completely pulled out from the cable drum before use
Generally Electronic equipment (Air conditioner, light, etc.)	• Is the supplier reliable? • Is the product subject to recall? • Are inspections being performed? • Is aging equipment being properly replaced? • Are there any unnecessary combustibles around the Electronic equipment?

Table 2. Maintenance contents and interval [6]

Item	Check task & Interval
Power cables	• Visual inspection (Annually) • Electrical test (1~3 years)
Electronic equipment	• Inspection (Annually) • Cleaning (3 years) • Adjustment / calibration (3~5 years)
Attachment plugs, code connector bodies	• Inspection (Monthly, When used)
Receptacles	• Inspection (Monthly, When used) • Operation check (Monthly, When used)
General-use snap switches	• Operation check (When used)
Electric tools	• Inspection / Cleaning (Monthly, When used) • Lubricant (Manufacturer's regulation) • Electrical tests (Quarterly)

5. Conclusion

In this article, fire prevention countermeasures and fire mitigation countermeasure were described based on warehouse fire incidents.

The most common cause of fire is electrical fires, and it is important to reduce the risk through daily inspections by internal team and periodic inspections by contractors.

It is also important to extinguish fires at their early stages. Establish an organization team to extinguish fires at their early stages through employee firefighting training and proper maintenance of fire extinguishing equipment.

Finally, it is important to conduct evacuation drills on a regular basis to ensure that employees do not delay in escaping from a fire. If your company has nighttime operation, it is also important to conduct nighttime drill. There have been cases where many people were killed in nighttime fires because part-time employees were not trained to evacuate.

Reference data
[1] Warehouse Structure Fires, NFPA Research, Richard Campbell, July 2022
[2] Investigation Report of "10-28" Major Fire Accident at Sinotrans Jiu Ling Storage and Transportation Warehouse in Zhongtang Town, Binhai New Area, Tianjin Emergency Management Bureau
[3] Tokio Marine RM-EYE “Learning from Accidents_Tianjin Binhai Warehouse "10-28" serious fire accident”, Tokio Marine China Co.
[4] Investigation and Analysis of a Fire in a Cold Storage Warehouse that Killed 40 people, Yi-Ping Lee, Hideo Otani
[5] Article 17 of the Fire Service of Japan
[6] TM-RE News No. 29 “Fire Risk and Safety Measures in General Electric Facilities”

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