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Warehouse Structure Fires

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Key Findings

From 2018 to 2022, there was an estimated 1,508 warehouse fires annually. These fires were less common during overnight hours, but they were associated with higher property losses. Fires between midnight and 6 a.m. accounted for 18 percent of the fires but 38 percent of the direct property damage. Nearly one-half of the injuries (42 percent) caused by warehouse fires were associated with fires that occurred between 6 a.m. and 12 p.m.

Shop tools and industrial equipment were involved in 19 percent of the warehouse fires and were responsible for 17 percent of civilian injuries and 21 percent of the direct property damage.

Electrical distribution or lighting equipment was involved in 19 percent of the warehouse fires and was responsible for 22 percent of the direct property damage.

Operating equipment was the leading heat source in warehouse fires, responsible for 44 percent of the fires, 36 percent of the civilian injuries, and 35 percent of the direct property damage. Arcing from operating equipment was responsible for an estimated 14 percent of fires, 12 percent of civilian injuries, and 21 percent of direct property damage.

Flammable and combustible liquids and gases were the materials first ignited in 8 percent of the fires, but these fires caused 34 percent of the civilian injuries.

Structure Fires in Warehouses: 2018–2022

Local fire departments responded to an estimated annual average of 1,508 structure fires per year at warehouse properties in the US during the five-year period from 2018 to 2022. These fires caused an estimated average of three civilian deaths, 19 civilian injuries, and $323 million in direct property damage.

Warehouses are properties that are used for the storage of commodities. Despite their common purpose, warehouses vary by size, types of materials stored, design, storage configuration, construction, and other factors. The National Fire Protection Association has long recognized that warehouses present special challenges for fire protection because their contents and layouts are conducive to fire spread and present obstacles to manual fire suppression efforts. An increase in the number of very large warehouses in recent years, with attendant increases in their potential fuel loads, has likely had an impact on both the warehouse fire experience and warehouse fire protection systems.

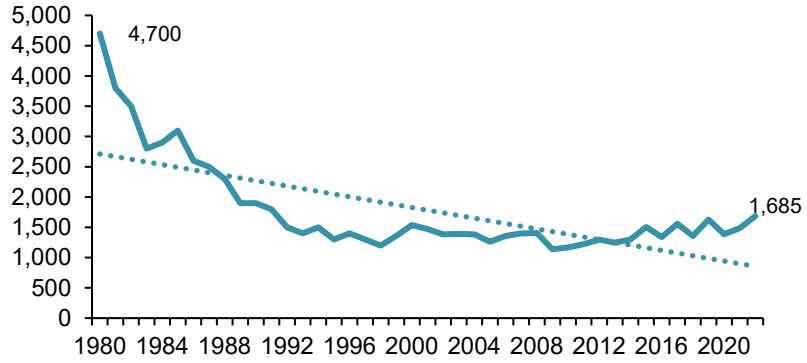
While many properties have warehouse space as part of their operations, only incidents in which the main occupancy was recorded as a warehouse have been included in this analysis. Warehouses that are part of manufacturing or retail properties and refrigerated storage facilities have not been included in this report.

Warehouse Fires: 1980–2022

Fires in warehouse properties have declined substantially over the past 30 years. The number of structure fires in US warehouses has been reduced by 73 percent since 1980, falling from an estimated 4,700 fires per year in 1980 to 1,246 in 2013. However, the direct property damage caused by warehouse fires has not shown a similar decrease when adjustments are made for inflation.

As shown in Figure 1, the decline in warehouse fires was sharpest during the 1980s, when the number of estimated warehouse fires fell by 60 percent between 1980 and 1989 from an estimated 4,700 to 1,900. The number of warehouse fires fell an additional 37 percent between 1990 (1,900 fires) and 1998 (1,200 fires). Between 2002 and 2014, fires in warehouse properties ranged from 1,223 to 1,404 fires a year, with the exception of a historic low of 1,138 fires in 2009. In more recent years, the annual number of warehouse fires has ranged from a low of 1,339 fires in 2016 to a high of 1,685 fires in 2022. The most recent two years, 2021 and 2022 have shown an uptick in these fires.

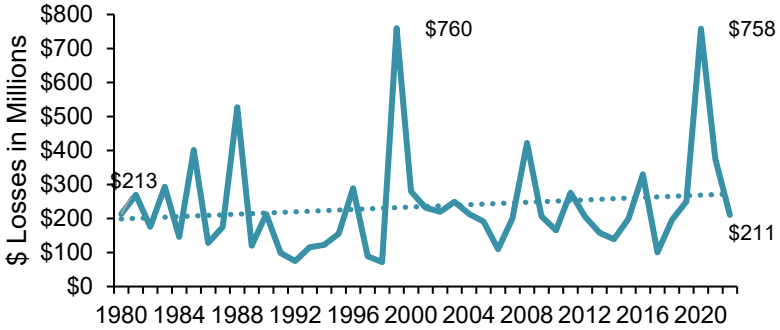
Figure 1a. Structure Fires in Warehouses: 1980–2022 Annual Averages



Losses in Warehouse Fires: 1980–2022

As illustrated in Figure 2, there has not been a corresponding, sustained decrease in the levels of direct property damage caused by warehouse fires between 1980 and 2022. Although the trend line indicates a fairly modest increase in losses over time, the data show substantial fluctuations in direct property losses from year to year, with decreases in financial losses regularly followed by increases, some of which were very sharp. It is worth noting that economic losses in any given year can be strongly influenced by a small number of very large fires.

Figure 1b. Inflation-Adjusted Direct Property Damage in Warehouse Structure Fires: 1980–2022 Annual Averages

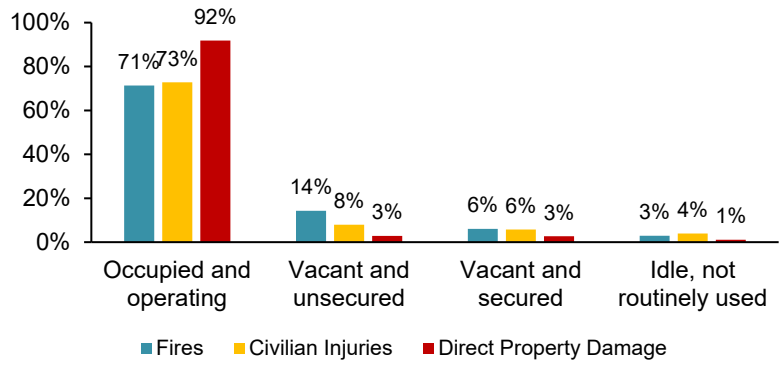


Warehouse Structure Fires by Structure Status: 2018–2022 Annual Averages

The majority of the warehouse fires occurred in facilities that were occupied and operating (71 percent), and these fires were associated with even greater shares of civilian injuries (73 percent) and direct property damage (92 percent), as indicated in Figure 2. Buildings that were vacant and unsecured accounted for 14 percent of the fires, while those that were vacant and secured accounted for only 6 percent

of fires. A smaller share of fires occurred in warehouses that were idle and not routinely used. Not shown in Figure 2 are fires in structures under construction (2 percent) or major renovation (1 percent), which accounted for a small share of the fires and minimal direct property damage. More details are available in supporting Table 2.

Figure 2. Warehouse Structure Fires by Structure Status: 2018–2022 Annual Averages



Timing of Warehouse Fires

Warehouse fires were less likely to take place on a Saturday (12 percent of fires) or Sunday (11 percent), as is generally the case with business properties. All the other days of the week accounted for 14 to 16 percent of the fires. Direct property damage caused by these fires peaked on Friday.

There was generally little seasonal variation in the distribution of fires by month. All the months averaged between 7 and 9 percent of the annual total. The peak in civilian injuries in March as well as the peak for property damage in June are due to single incidents where the reported losses were much greater than the average. As seen in supporting Table 4, there was an average of two civilian injuries (8 percent) and $27 million (8 percent) in property damage each month. One incident that deviated from these averages could greatly influence the figures.

Warehouse fires were less common during overnight hours, but these fires were associated with higher property loss, as indicated in Figure 5. Fires between midnight and 6 a.m. accounted for 18 percent of the fires, but 38 percent of the direct property damage. Nearly one-half of the injuries (42 percent) were associated with fires taking place between 6 a.m. and 12 p.m.

Figure 3. Warehouse Structure Fires by Day of the Week: 2018–2022 Annual Averages

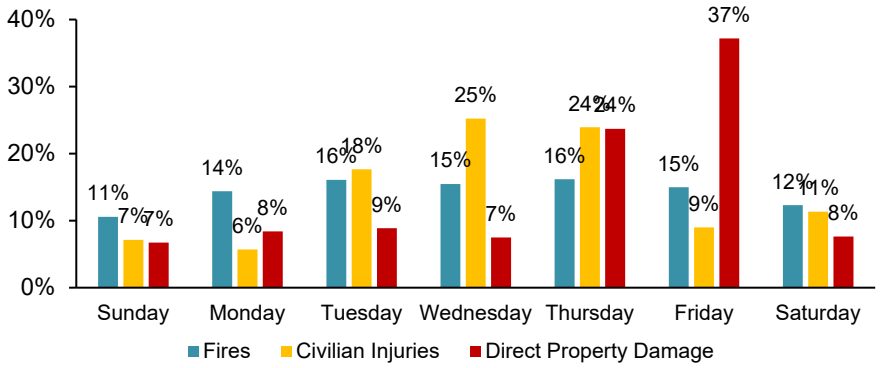


Figure 4. Warehouse Structure Fires by Month: 2018–2022 Annual Averages

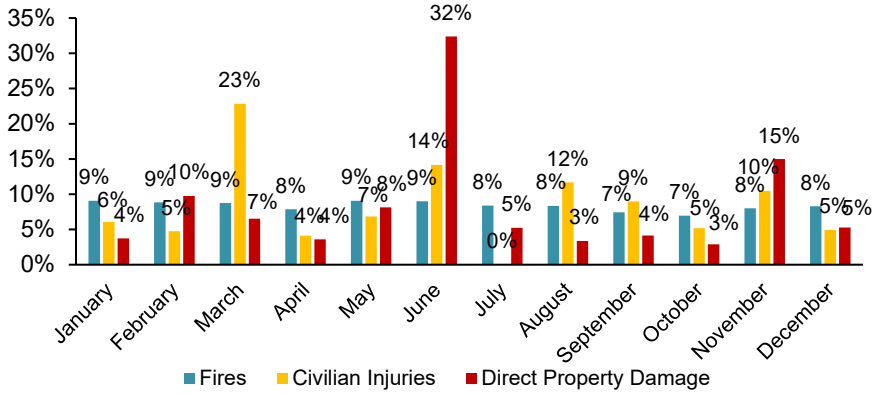
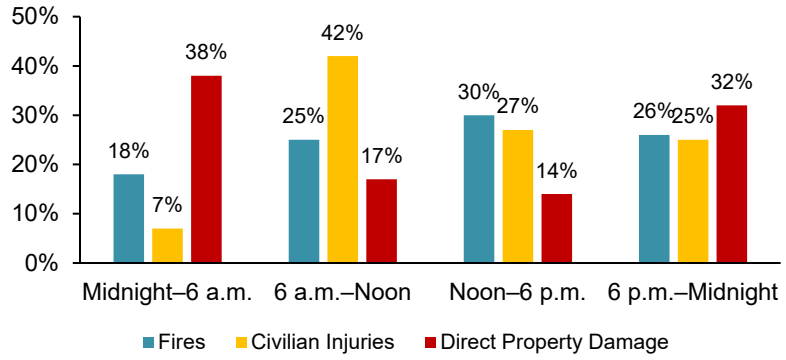


Figure 5. Warehouse Structure Fires by Time of Day: 2018–2022 Annual Averages



Equipment Involved in Ignition

Two categories of equipment, electrical distribution or lighting equipment and shop tools and industrial equipment, were each estimated to have been involved in approximately one-fifth of the warehouse fires. These categories also contributed to 22 percent and 21 percent of the total estimated direct property damage, respectively. Heating, ventilating, and air conditioning equipment is estimated to have been involved in 16 percent of warehouse fires. Smaller shares of the fires involved kitchen and cooking equipment (7 percent) and personal or household equipment (5 percent). These categories are broken down into further detail in supporting Table 6.

Cause of Ignition

The majority of the warehouse structure fires had an unintentional cause (30 percent), and these fires accounted for 42 percent of the civilian injuries and 15 percent of the direct property damage. One-tenth of the fires (10 percent) were caused by a failure of equipment or a heat source. Intentional fires accounted for 7 percent of the warehouse fires, 9 percent of the injuries, and 4 percent of the direct property damage.

Figure 6. Warehouse Structure Fires by Equipment Involved in Ignition: 2018–2022 Annual Averages

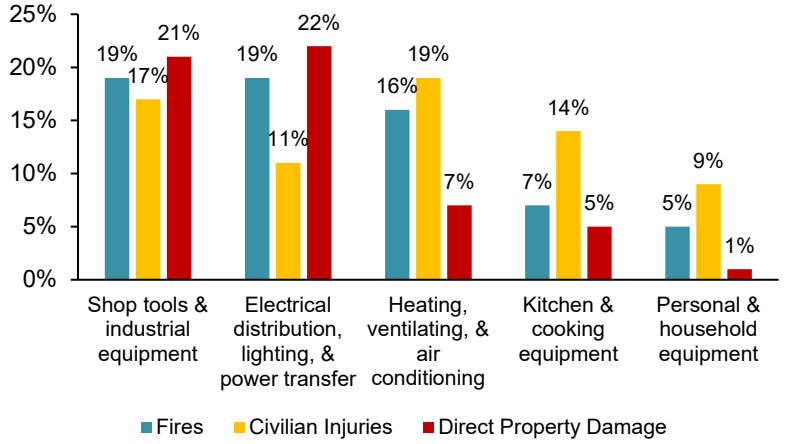
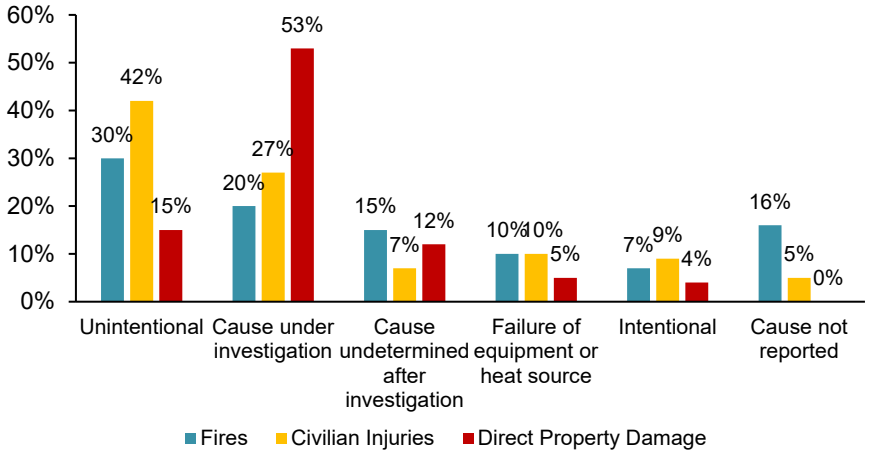


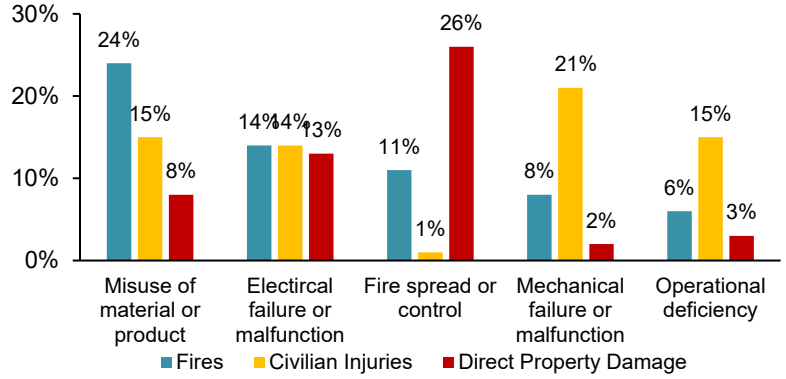
Figure 7. Warehouse Structure Fires by Cause of Ignition: 2018–2022 Annual Averages



Factor Contributing to Ignition

Misuse of materials and/or products was the leading factor contributing to ignition in warehouse fires from 2018–2022, causing an estimated 24 percent of the fires, 15 percent of the civilian injuries, and 8 percent of the direct property damage. A mechanical failure or malfunction accounted for 21 percent of the civilian injuries in warehouse structure fires. Other leading contributing factors are indicated in Figure 8 and further details are available in supporting Table 8.

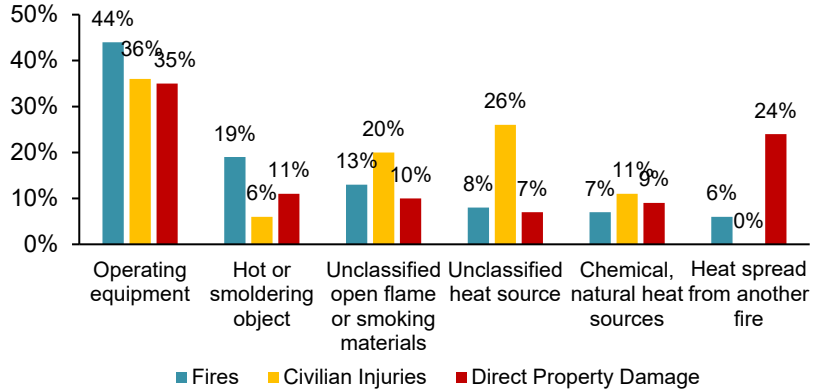
Figure 8. Warehouse Structure Fires by Factor Contributing Ignition: 2018–2022 Annual Averages



Heat Source

Operating equipment was the leading heat source in warehouse fires, responsible for 44 percent of the fires, 36 percent of the civilian injuries, and 35 percent of the direct property damage. Within the operating equipment category, arcing was the leading heat source, causing 14 percent of the fires, 12 percent of the civilian injuries, and 21 percent of the direct property damage. Further details can be found in supporting Table 9.

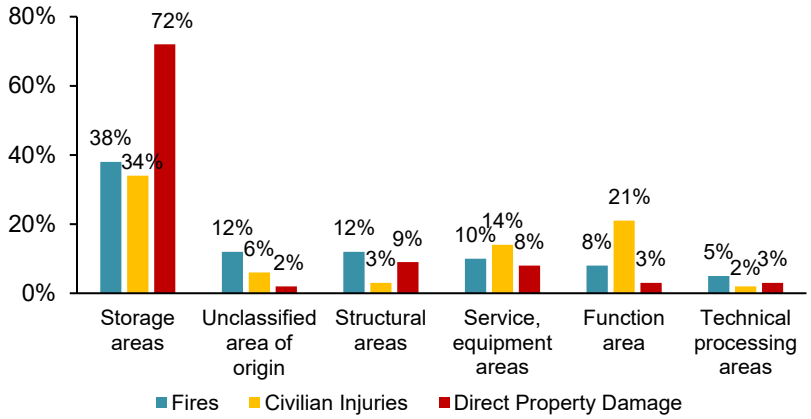
Figure 9. Warehouse Structure Fires by Heat Source: 2018–2022 Annual Averages



Area of Origin

Not surprisingly, most warehouse fires began in storage areas. These incidents accounted for an estimated 38 percent of the fires, 34 percent of the civilian injuries, and 72 percent of the direct property damage. This category includes shipping and receiving areas, trash chutes and containers, and other storage rooms. More details are available in supporting Table 10.

Figure 10. Warehouse Structure Fires by Area of Origin: 2018–2022 Annual Averages

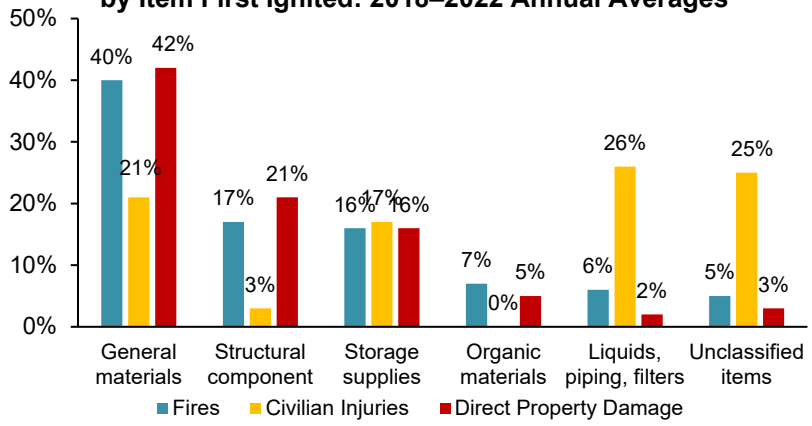


Item First Ignited

Items in the "General Materials" classification were the items first ignited in a majority of the warehouse fires during 2018–2022. These incidents accounted for 40 percent of the fires, 21 percent of the civilian injuries, and 42 percent of the direct property damage. Within this category, rubbish, trash, or waste accounted for 15 percent of the total warehouse fires.

Items in the "Liquids, Piping, Filters" category accounted for an estimated 26 percent of the total civilian injuries. This category included items further classified as flammable or combustible liquid or gas. Incidents where flammable or combustible liquid or gas was the item first ignited accounted for an estimated 4 percent of warehouse fires, but an estimated 24 percent of the civilian injuries. More details can be found in supporting Table 11.

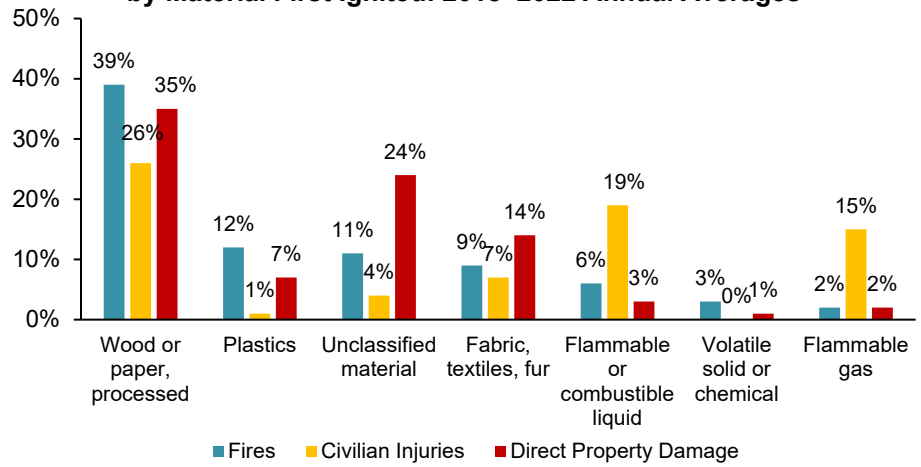
Figure 11. Warehouse Structure Fires by Item First Ignited: 2018–2022 Annual Averages



Material First Ignited

Figure 12 shows the items first ignited. In an estimated 39 percent of the warehouse fires, wood or paper was the item first ignited. These incidents accounted for approximately 26 percent of the civilian injuries and 35 percent of the direct property damage. Incidents where the material first ignited was a flammable or combustible liquid accounted for an estimated 6 percent of the fires but 19 percent of the civilian injuries. Incidents where the material first ignited was a flammable gas also had a disproportionate ratio of fires to injuries, accounting for an estimated 2 percent of fires but 15 percent of the civilian injuries. More details are available in supporting Table 12.

Figure 12. Warehouse Structure Fires by Material First Ignited: 2018–2022 Annual Averages



Concluding Observations

Warehouses pose substantial challenges for fire protection due to their building layouts, storage configurations, technologies, ceiling heights, and types of commodities stored, with the specific challenges influenced by the characteristics of a given warehouse.

Properly designed sprinkler systems are an essential element of warehouse fire protection. Other protective measures generally applicable to warehouse properties include automatic alarms to the fire department and building security systems. Pre-fire inspections and planning are recommended to identify appropriate protection measures for specific warehouse environments.

Guidance for fire protection systems is available in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

Acknowledgments

The National Fire Protection Association thanks all the fire departments and state fire authorities that participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

We are also grateful to the US Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

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