



RESEARCH



Warehouse Structure Fires

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July 2022

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Key Findings

Local fire departments responded to an estimated average of 1,450 structure fires per year at warehouse properties in the US during the five-year period from 2016 through 2020. These fires caused an estimated average of two civilian deaths, 16 civilian injuries, and \$283 million in direct property damage. Fatalities are not included in the analysis for this report due to small numbers.

This report's major findings include the following:

- Warehouse fires were less common during overnight hours, but those fires were associated with higher property losses. Fires between midnight and 6 a.m. accounted for 18 percent of the fires but 45 percent of the direct property damage. Nearly one-half of the injuries (46 percent) were associated with fires that took place between 6 a.m. and 12 p.m.
- Electrical distribution or lighting equipment was involved in 18 percent of the warehouse fires and was responsible for 31 percent of the direct property damage.
- Arcing was the leading heat source in warehouse fires, responsible for 14 percent of the fires and direct property damage and one-fifth (21 percent) of the civilian injuries.
- Flammable and combustible liquids and gases, piping, and filters were the items first ignited in 6 percent of the fires, but these fires caused 34 percent of the civilian injuries.

More details information on these fires is available in the **supporting tables**.

Structure Fires in Warehouses: 2016–2020

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, is likely to have an impact on both the warehouse fire experience and warehouse fire protection systems.

From 2016 through 2020, local fire departments responded to an estimated average of 1,450 structure fires per year at warehouse properties in the US. These fires caused an average of two civilian deaths, 16 civilian injuries, and \$283 million in direct property damage. Fatalities are not included in the analysis for this report due to small numbers.

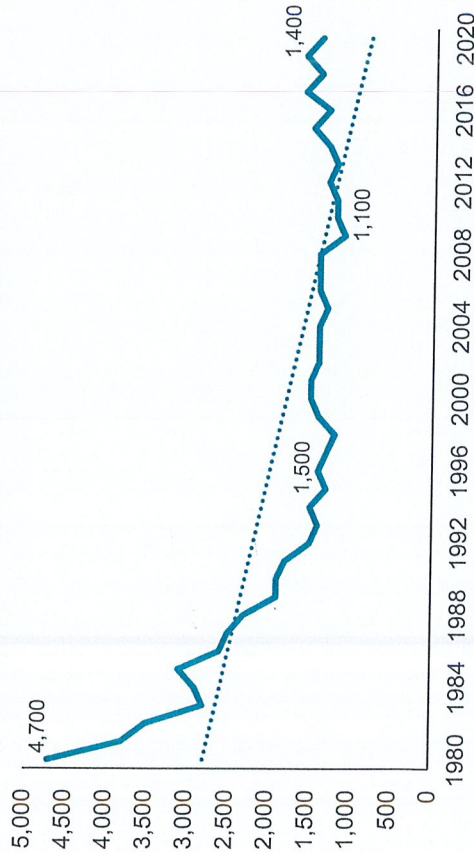
While many types of properties have warehouse space as part of their operations, only incidents in which the occupancy was recorded as a warehouse are included in this analysis. Warehouses that are part of manufacturing or retail properties and refrigerated storage facilities are not included in this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

Warehouse Fires: 1980–2020

Fires in warehouse properties have declined substantially over the past 30 years. The number of structure fires in US warehouses has been reduced by 74 percent since 1980, falling from 4,700 fires per year in 1980 to 1,200 in 2013. However, the value of 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 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 1,200 to 1,400 fires a year, with the exception of a historic low of 1,100 fires in 2009. In more recent years, the annual number of warehouse fires has ranged from a low of 1,300 fires in 2016 to a high of 1,600 fires in both 2017 and 2019.

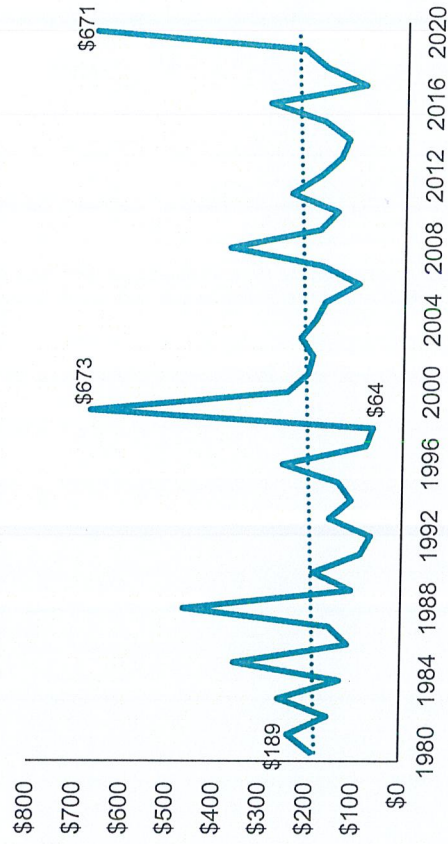
Figure 1. Structure Fires in Warehouses: 1980–2020



Losses in Warehouse Fires: 1980–2020

As illustrated in Figure 2, there has not been a corresponding decrease in the levels of direct property damage caused by warehouse fires between 1980 and 2020. 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.

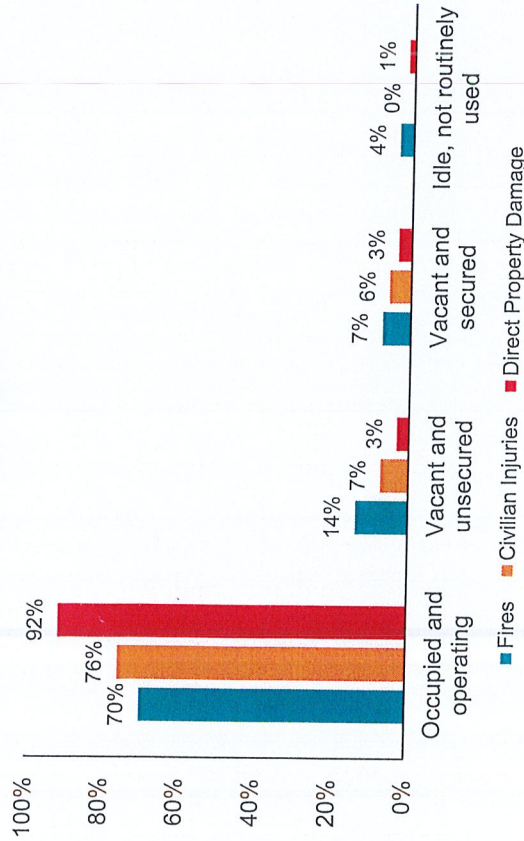
Figure 2. Inflation-Adjusted Direct Property Damage in Warehouse Structure Fires: 1980–2020



Warehouse Structure Fires by Structure Status: 2016–2020

The vast majority of warehouse fires were in facilities that were occupied and operating (70 percent), and these fires were associated with even greater shares of civilian injuries (76 percent) and direct property damage, as indicated in Figure 3. Buildings that were vacant and unsecured accounted for 14 percent of the fires, while those that were vacant and secured accounted for half that share of fires. A smaller share of fires occurred in warehouses that were idle and not routinely used. Not shown in Figure 3 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.

Figure 3. Warehouse Structure Fires by Structure Status: 2016–2020

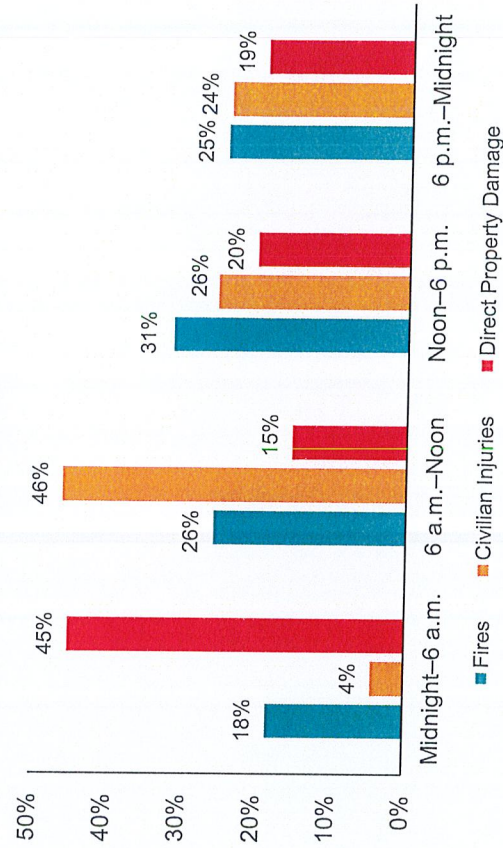


Timing of Warehouse Fires

Warehouse fires were less likely to take place on a Saturday (13 percent of fires) or Sunday (11 percent of fires), as is generally the case with business properties. All the other days of the week accounted for 15 percent or 16 percent of the fires. There was generally little seasonal variation in the distribution of fires by month. Other than January, which accounted for 10 percent of the fires, all the months averaged between 7 percent and 9 percent of the annual total.

Warehouse fires were less common during overnight hours, but these fires were associated with higher property loss, as indicated in Figure 4. Fires between midnight and 6 a.m. accounted for 18 percent of the fires, but 45 percent of the direct property damage. Nearly one-half of the injuries (46 percent) were associated with fires taking place between 6 a.m. and 12 p.m.

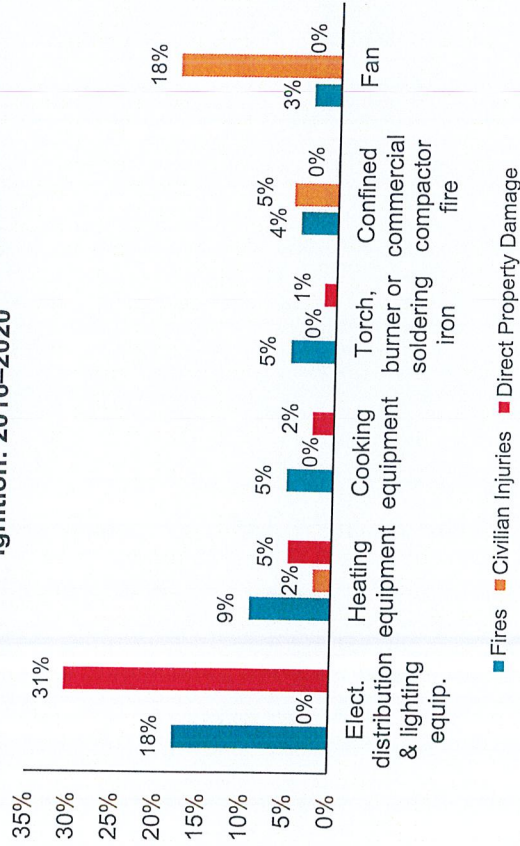
Figure 4. Warehouse Structure Fires by Time of Day: 2016–2020



Equipment Involved in Ignition

Electrical distribution or lighting equipment was involved in approximately one-fifth of the warehouse fires (18 percent) and was responsible for 31 percent of the direct property damage. Almost one in ten fires involved heating equipment, and these fires accounted for 5 percent of the direct property damage. Smaller shares of the fires involved cooking equipment (5 percent); torches, burners, or soldering irons (5 percent); or confined commercial compactors (4 percent). No equipment was involved in one-fifth of the fires and the other 15 percent were contained trash or rubbish fires with no equipment information.

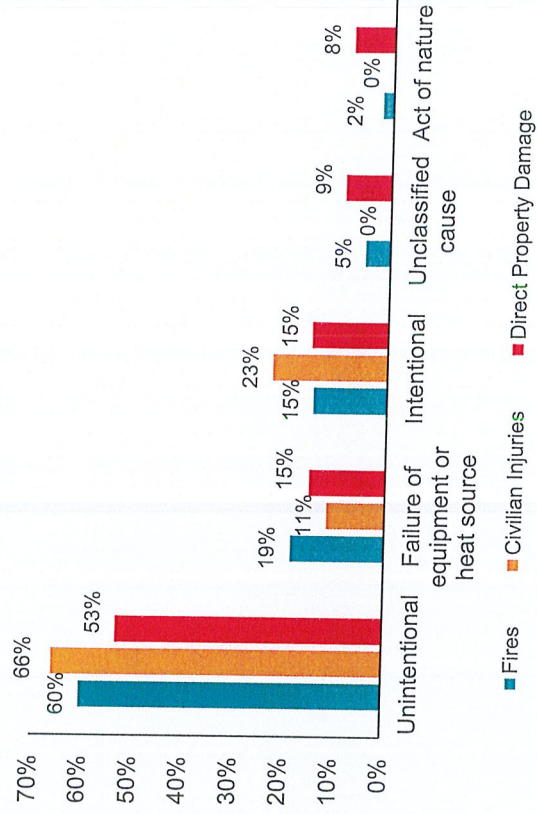
Figure 5. Warehouse Structure Fires by Equipment Involved in Ignition: 2016–2020



Cause of Ignition

The majority of the warehouse structure fires had an unintentional cause (60 percent) and these fires accounted for two-thirds of the civilian injuries (66 percent) and just over half of the direct property damage (53 percent). One-fifth of the fires (19 percent) were caused by a failure of equipment or heat source. Intentional fires accounted for 15 percent of the warehouse fires and nearly one-quarter of the injuries (23 percent), as well as 15 percent of the direct property damage. Fires caused by an act of nature accounted for a small share of the warehouse fires but 8 percent of the direct property damage.

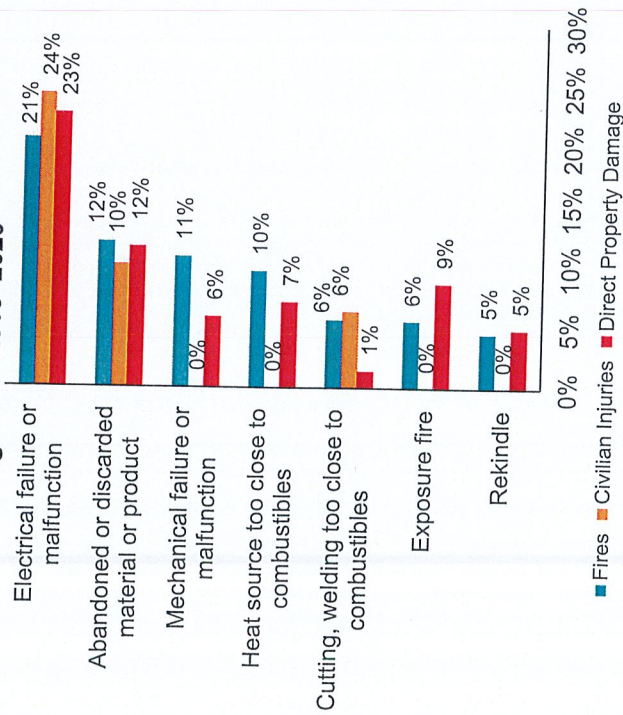
Figure 6. Warehouse Structure Fires by Cause of Ignition: 2016–2020



Factor Contributing to Ignition

Electrical failures or malfunctions contributed to one-fifth of the warehouse fires (21 percent) and approximately one-quarter of the civilian injuries (24 percent) and direct property damage (23 percent). Abandoned or discarded materials or products contributed to 12 percent of the fires and a similar share of the direct property damage, as well as one in ten injuries (10 percent). Mechanical failures or malfunctions contributed to approximately one in ten fires (11 percent) but a smaller share of the direct property damage (6 percent) and no civilian injuries. Fires in which cutting or welding too close to combustible materials contributed to 6 percent of the fires and injuries, while exposure fires also contributed to 6 percent of the fires and caused 9 percent of the direct property damage.

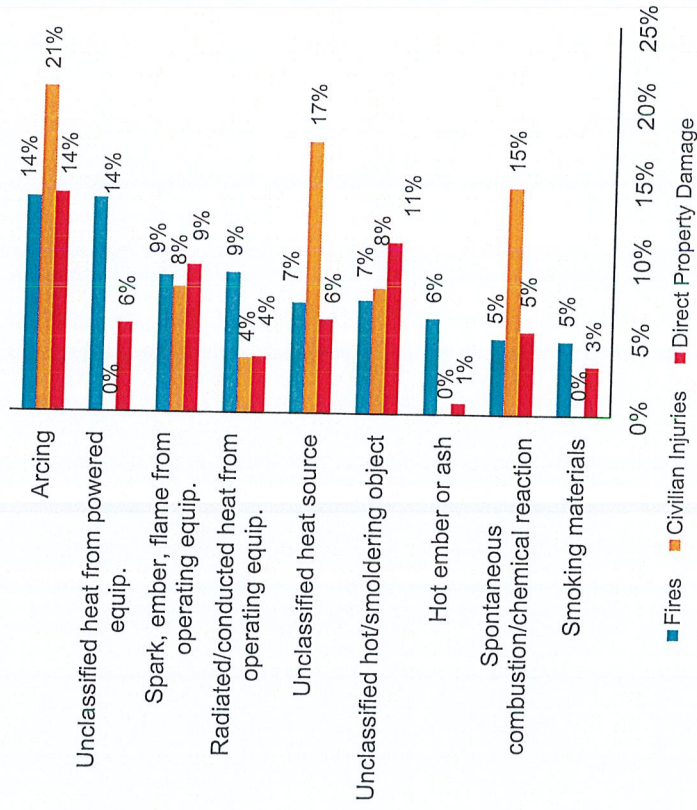
Figure 7. Warehouse Structure Fires by Factor Contributing to Ignition: 2016–2020



Heat Source

Arcing was the single leading heat source in warehouse fires, responsible for 14 percent of fires and direct property damage and one-fifth (21 percent) of the civilian injuries. Some type of powered or operating equipment provided the heat source for approximately one-third of the fires, either in the form of unclassified heat from powered equipment (14 percent); a spark, ember, or flame (9 percent); or radiated or conducted heat from operating equipment (9 percent), as indicated in Figure 8. Fires in which spontaneous combustion or chemical reactions served as the heat source accounted for 5 percent of the fires but 15 percent of the civilian injuries.

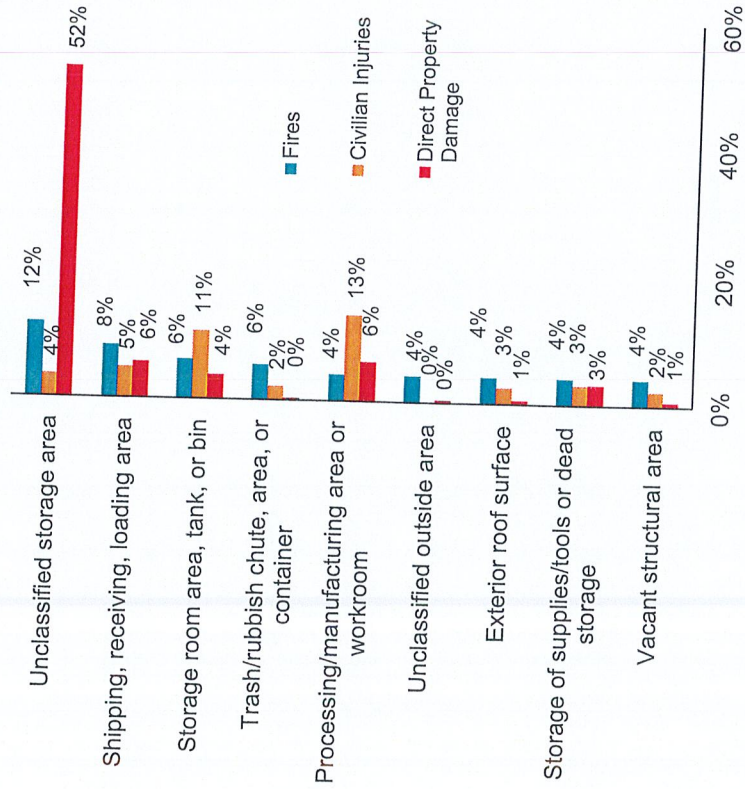
Figure 8. Warehouse Structure Fires by Heat Source: 2016–2020



Area of Origin

Fires that began in an unclassified storage area accounted for 12 percent of the fires but just over half of the direct property damage (52 percent). Shipping, receiving, or loading areas were the next most common area of origin (8 percent), followed by storage room areas, tanks, or bins (6 percent); trash or rubbish chutes; areas or containers (6 percent); and processing or manufacturing areas or work rooms (4 percent), the latter of which accounted for a disproportionate share of civilian injuries (13 percent).

Figure 9. Warehouse Structure Fires by Area of Origin: 2016–2020



Item First Ignited

Rubbish, trash, or waste was the item first ignited in 14 percent of the warehouse fires, but these fires accounted for just 3 percent of the injuries associated with these fires and minimal direct property damage. Flammable and combustible liquids and gases, piping, and filters were the items first ignited in 6 percent of the fires but caused 34 percent of the civilian injuries. (See Figure 10).

Figure 10. Warehouse Structure Fires by Item First Ignited: 2016–2020



*Flammable or combustible liquids or gases, piping, or filters

Concluding Observations

Warehouses pose substantial challenges for fire protection due to their building layouts, storage configurations and 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 in order to identify appropriate protection measures for specific warehouse environments.

Guidance for fire protection systems is available from **NFPA 13, *Standard for the Installation of Sprinkler Systems*** and **NFPA 230, *Standard for the Fire Protection of Storage***.

Acknowledgements

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 U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

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NFPA No. USS77