Fires in Structures under Construction

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Key findings

Local fire departments responded to an estimated average of 4,300 fires in structures under construction per year in 2016 through 2020. These fires caused an average of five civilian deaths, 62 civilian injuries, and $376 million in direct property damage annually.

Structures under construction

- The estimated number of fires in structures under construction has increased since 2014 after declining between 2008 and 2010.
- Three of every four fires in structures under construction involved residential properties.
- Cooking equipment is the leading cause of fires on construction sites; these fires tend to be minor.
- Fires that were intentionally set caused one in 10 fires, but nearly one-half (47 percent) of direct property damage.
- Fires in structures under construction were highest in January and lowest in September.
- Fires in structures under construction were most common in the afternoon and evening; fires that occurred between midnight and 6 a.m. accounted for more than half of direct property damage.
- The leading factors contributing to the ignition of fires in structures under construction included heat sources that were too close to combustible materials, abandoned or discarded materials or products, and electrical failures or malfunctions.

Fires in structures under construction

From 2016 to 2020, local fire departments responded to an estimated average of 4,300 fires in structures under construction per year. These fires caused an average of five civilian deaths, 62 civilian injuries, and $376 million in direct property damage annually. Only 1 percent of all reported structure fires were in structures under construction.

While large fires typically make the news, many of the fires in structures under construction were much smaller. As shown in the report with supporting tables, approximately one-half of these fires were confined fires. The presence of workers at construction sites who can detect and extinguish fires before they have an opportunity to spread may explain why many of these fires were relatively small.

Residential properties accounted for three-quarters (76 percent) of the fires in structures under construction, as well as the largest shares of deaths, injuries, and direct property damage (see Table A).

Another 6 percent of fires involved mercantile or business properties. This was followed by fires in outside or special properties which accounted for 5 percent of fires, but caused 13 percent of the direct property damage.

<p>| Table A. Fires in Structures under Construction by Property Use 2016–2020 Annual Averages |
|---------------------------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Property Use</th>
<th>Fires</th>
<th>Civilian Injuries</th>
<th>Direct Property Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>76%</td>
<td>77%</td>
<td>77%</td>
</tr>
<tr>
<td>Mercantile or business</td>
<td>6%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>Outside or special property</td>
<td>5%</td>
<td>3%</td>
<td>13%</td>
</tr>
<tr>
<td>Storage</td>
<td>4%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Assembly</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Health care, detention, correction</td>
<td>2%</td>
<td>7%</td>
<td>2%</td>
</tr>
<tr>
<td>Educational</td>
<td>2%</td>
<td>1%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Recent trends in fires in structures under construction

Figure 1 shows the estimated number of fires in structures under construction from 2008 through 2020. As indicated, the trend line shows an increase in these fires over this period, particularly in the years since 2015, after declining between 2008 and 2010.

Figure 1. Fires in Structures under Construction, 2008–2020.

Leading causes of fire in structures under construction

Some of the causes of fires in properties under construction are consistent with all structure fires. Figure 2 shows that cooking equipment is the leading cause of fires on construction sites. These cooking fires are usually minor, but they accounted for three in 10 (27 percent) injuries. Electrical distribution and lighting equipment accounted for 16 percent of fires, but nearly half (46 percent) of the direct property damage. Another 14 percent of fires were caused by heating equipment. Fires that were intentionally set caused one in 10 (11 percent) fires, but 47 percent of direct property damage. Smoking materials accounted for another 4 percent of fires and 3 percent of direct property damage.

Figure 2. Fires in Structures under Construction by Leading Cause 2016–2020 Annual Averages.

Under Construction, Virginia
Month: February – Time: 9:40 a.m. – Dollar Loss: $16,794,490

Property Characteristics and Operating Status: This was a five-story, 40,000-square-foot (3,716-square-meter), multi-property building containing both retail and 400 residential units. It was still under construction and was about 50 percent completed. There were workers on-site at the time of the fire.

Fire Protection Systems: There was no automatic detection system or automatic suppression equipment present.

Fire Development: The fire broke out in a clogged rubbish chute between the second and third floors when improperly discarded smoking materials were tossed in and ignited the combustibles in the chute.

Contributing Factors and Other Details: This fire was well involved on arrival of the first firefighters. During the fire, strong winds caused embers to ignite exposed properties, including single-family homes, townhouses, vehicles, and construction equipment. Damage to the structure was estimated to be at $12.8 million. There was an estimated $4 million in damage to the building’s contents. Two firefighters were injured.

Timing of fires in structures under construction

Figure 3 shows that fires in structures under construction were highest in January and lowest in September and October, possibly reflecting the use of heating devices for warmth or for heating food in colder weather. Fires in the remaining months accounted for either 8 percent or 9 percent of the annual average. It is important at construction sites—where combustible and flammable materials are present—that equipment be used for its intended purpose. It is also important for temporary heaters to be selected and used with fire safety in mind. Care is needed to ensure that temporary heaters are listed and properly set up per manufacturer instructions. It is important that the areas around temporary heaters be kept clear of combustible materials.

The peak periods for fires in structures under construction were the hours between noon and 9 p.m. and between 4 p.m. and 8 p.m. (Figure 4). Although approximately one-fifth (18 percent) of fires occurred between midnight and 6 a.m., these fires accounted for more than one-half (53 percent) of direct property damage. Fires may spread more easily before they are detected during overnight hours when workers are less likely to be at the construction site.

Figure 4. Fires in Structures under Construction by Time of Day 2016–2020 Annual Averages.
Leading items first ignited in structure fires under construction

Cooking materials were the item most often first ignited in structures under construction. However, approximately one-third of the fires involved the ignition of structural elements, including structural member or framing (10 percent); unclassified structural components (6 percent); exterior wall coverings or finishes (6 percent); insulation within structural areas (5 percent); and exterior roof coverings or finishes (5 percent), as indicated in Figure 5.

Waste materials were first ignited in 7 percent of fires, but these fires accounted for 15 percent of direct property damage. The ignition of flammable or combustible liquids or gases, piping, or filters accounted for 5 percent of fires, resulting in 17 percent of injuries.

Figure 5. Leading Items First Ignited in Structure Fires under Construction, 2016–2020 Annual Averages.

<table>
<thead>
<tr>
<th>Equipment Involved</th>
<th>Fires</th>
<th>Civilian Injuries</th>
<th>Direct Property Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooking equipment</td>
<td>19%</td>
<td>27%</td>
<td>3%</td>
</tr>
<tr>
<td>Electrical distribution and lighting equipment</td>
<td>15%</td>
<td>15%</td>
<td>46%</td>
</tr>
<tr>
<td>Wiring and related equipment</td>
<td>10%</td>
<td>12%</td>
<td>11%</td>
</tr>
<tr>
<td>Heating equipment</td>
<td>14%</td>
<td>27%</td>
<td>7%</td>
</tr>
<tr>
<td>Fixed or portable space heater</td>
<td>6%</td>
<td>20%</td>
<td>5%</td>
</tr>
<tr>
<td>Torch, burner, or soldering iron</td>
<td>7%</td>
<td>9%</td>
<td>17%</td>
</tr>
</tbody>
</table>

*Flammable or combustible liquid or gas, piping or filter.

Equipment involved in ignition

Fires in structures under construction most often involved cooking equipment, electrical distribution and lighting equipment, and heating equipment. Electrical distribution and lighting equipment accounted for a disproportionately large share of direct property damage. Cooking equipment and heating equipment each accounted for the largest shares of injuries (see Table B).

Temporary electrical wiring or lighting can emit heat or sparks if not properly installed or maintained and should be regularly reviewed by qualified personnel to ensure safety. Fires involving torches, burners, or soldering irons were involved in seven percent of fires, but these fires accounted for 17 percent of direct property damage. Hot work activities pose a variety of combustion hazards and should be carried out under a stringent permitting system. For more information on hot work safety, see nfpa.org/Training-and-Events/By-topic/Hot-Work.

Table B. Fires in Structures under Construction, by Equipment Involved in Ignition, 2016–2020 Annual Averages
**Factor contributing to ignition**

The leading factors contributing to the ignition of fires in structures under construction included heat sources being too close to combustible materials, abandoned or discarded materials or products, and electrical failures or malfunctions, as shown in Figure 6. Other factors contributing to construction fires included cutting or welding too close to combustible materials, unclassified misuse of materials or products, mechanical failures or malfunctions, and unattended equipment. Good worksite practices should include regular maintenance for the equipment. Fire safety procedures for the use of powered equipment and combustible materials should be established.

**Heat source**

The leading heat sources for fires in structures under construction involved either heat or sparks, embers, or flame from operating equipment; altogether, this accounted for nearly two of five fires, followed by arcing (Figure 7). Arcing acted as the heat source in approximately one in 10 fires (11 percent), while an unclassified heat source provided the heat source in seven percent of fires but accounted for one-quarter (2 percent) of fires. Unclassified hot or smoldering objects also accounted for 7 percent of fires, followed by hot embers or ash, spontaneous combustion or chemical reaction, and smoking materials.
Area of origin

There was no single dominant area of origin for fires in structures under construction. The leading area of origin for fires was a kitchen or cooking area, which accounted for 6 percent of fires.

Fires that originated in an attic or ceiling/roof assembly or concealed space, bedroom, exterior wall surface, and exterior roof surface each accounted for a 4 percent share of fires.

Fires that originated in a common room, wall assembly or concealed space, garage, unclassified structural area, or construction or renovation area each accounted for 3 percent shares of the total.

One quarter of civilian injuries resulted from fires that originated in a kitchen or cooking area. Fourteen percent of civilian injuries resulted from fires that originated in a bedroom. See Table 11 in the report with supporting tables for details.

Discussion

On average, firefighters responded to nearly 12 fires in structures under construction each day between 2016 and 2020. Fires at such construction sites are a longstanding problem, but their major causes are generally well-established—a good indication that they can be prevented through greater attention to fire hazards.

The most common causes of construction and renovation fires in the most recent five-year period, as well as historically, involve electrical distribution and lighting equipment, heating equipment, cooking equipment, a torch, burner, or soldering iron, or an intentional cause. For each of these causes, there are safety protocols that can be utilized to reduce the risk of fire.

The safety protocols can include the following:

- Ensure that the temporary electrical service lighting follows the installation requirements set forth in the National Electrical Code®; electrical equipment is maintained and regularly inspected; use of extension wiring is kept to a minimum; and machinery and equipment do not overload available circuits.
- Prohibit the use of temporary cooking equipment (such as hot plates or grills) or the use of improvised heating devices for warming food at the construction site.
- Ensure that unauthorized temporary heaters are restricted from the worksite; heaters permitted on the worksite are placed at safe distances from combustible and flammable materials; heaters are used in conformity with their listing and manufacturer instructions; and heaters are regularly checked to ensure that they are being safely operated and do not constitute a hazard (such as being overturned).
- Require a permit system for hot work activities and enforce a thirty-minute (or longer) cool-down interval after torches, burners, or soldering irons have been used.
- Reduce the risk of arson by safeguarding construction sites with fencing or other controls; these controls can include lighting or after-hours security personnel, as needed.
- Have an approved fire prevention program (also known as a fire safety plan) for the construction site.
- Ensure there is a fire prevention program manager to administer the fire safety plan to completion.

Guidance for preventing fires at structures under construction or undergoing renovation is available in NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities who 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 makes this analysis possible. Their contributions allow us to estimate the size of the fire problem.

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To learn more about research at NFPA, visit nfpa.org/research.

Email: research@nfpa.org
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Additional resources

To learn more about NFPA resources regarding fire safety in construction for your organization, please visit nfpa.org/ConstructionFireSafety or email grouptraining@nfpa.org.

Training resources include:

- Fire Prevention Program Manager Online Training Series
- Construction Site Fire Safety Fundamentals Online Training
- NFPA 241, Safeguarding Construction, Alteration, and Demolition Operations Online Training Series
- NFPA 70E®, Standard for Electrical Safety in the Workplace® Online Training Series
- Hot Work Safety Training Certificate (also available in Spanish)