

FIRE LOSS PREVENTION MEASURES DURING CONSTRUCTION

A CONTRACTOR'S LOSS PREVENTION GUIDE

ALLIANZ RISK CONSULTING



This guide discusses the fire hazards and loss prevention considerations during construction operations

AT-A-GLANCE

- The construction process involves many fire hazards
- In recent years, insurance companies have experienced major claims due to significant fire events involving new construction works and properties undergoing refurbishment or extension

LOSS EXPERIENCE

Between 2010 and 2014, municipal fire departments in the U.S. responded to an average of 3,750 fires each year in structures under construction, 2,560 fires in structures undergoing major renovation, and 2,130 fires in structures being demolished for a total of \$310 million in annual property damage¹.

¹ National Fire Protection Association (NFPA), Fires in Structures Under Construction Undergoing Major Renovation or Being Demolished, April 2017

SEVERAL LARGE, NOTABLE FIRES HAVE OCCURRED DURING THE CONSTRUCTION OF NEW BUILDINGS OR THE REFURBISHMENT OF EXISTING LOCATIONS, INCLUDING



Source: YouTube

Flames engulf the El Camino Real Apartments in Santa Clara, California, June 28, 2019

- 1890 El Camino Real Condominium fire in Santa Clara, California: on June 28, 2019. A massive blaze occurred at a housing construction site destroying more than 50 partially built condominiums and resulting in an estimated loss of \$200mn. The exact cause of the fire remains undetermined.



Source: Wikimedia Commons

Flames sweep over the Notre-Dame Cathedral after hot work ignited scaffolding on the roof, April 15, 2019

- Cathedral of Notre-Dame, in Paris France: on April 15, 2019. A fire started during renovations on the cathedral's spire when a massive fire engulfed the Paris landmark. The fire was believed to have been caused by either a burning cigarette or an electrical malfunction. The repair costs have been estimated at more than a billion dollars.



Source: Wikimedia Commons

The burned out Windsor Tower in Madrid, Spain, February 13, 2005

- Windsor Tower in Madrid, Spain on February 12, 2005. During the refurbishment of this 135 m high rise building, a fire started on the 21st floor during the night when there were no employees on site. The fire spread quickly throughout the entire building, leading to a total loss. Firefighters needed almost 24 hours to extinguish the fire, which was caused by an electrical fault. The total loss was estimated at €122mn, including around €20Mn of demolition work.

Buildings under construction and renovation are particularly vulnerable to fire. The potential for fire loss can be greatly reduced by instituting stringent management controls, effective project site supervision and enforcement measures, adherence to sound fire prevention principles, and the provision of portable fire extinguishers and fixed fire suppression and detection systems, when feasible.

WHY CONSTRUCTION SITES ARE EXPOSED TO FIRES

Various ignition sources may be present on construction sites, including but not limited to:

- Temporary equipment using internal combustion engines, including generators, pumps, vehicles, etc
- Temporary heating equipment
- Temporary electrical equipment, including wiring and lighting
- Hot work – open flame or spark-producing operations, including welding, soldering/brazing, cutting, grinding, etc.
- Roofing operations involving heated asphalt and tar kettles, torches, heat guns, etc.
- Smoking

Normally, a variety of flammable and combustible materials are stored on site during construction operations, such as flammable liquids and gases, combustible waste materials, construction materials, such as timber joists, floorboards, roof trusses, joinery, foamed plastic insulation, etc.

The variety of construction activities and inherent difficulties associated with supervising many different subcontractors and trades involved in the construction process can often complicate fire prevention due to lack of coordination and poor communication.

Furthermore, fixed fire protection systems are generally not functional until late in the construction project or in the case of a renovation project, may be taken out of service or “impaired”. For these reasons, both new and refurbished buildings are particularly vulnerable to the risk of fire.

ARC RECOMMENDATIONS

Fire safety should be an integral part of the management strategy for every construction project. The strategy should comply with the most recent editions of NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, as well as other state and local requirements.

1. DESIGN PHASE

Start fire prevention during the design and planning stages, as thorough initial planning can significantly reduce the fire risk. Contractors often can also reduce fire risk through value engineering in the early stages of a project:

- Use non-combustible materials whenever possible
- Select reputable contractors/subcontractors that utilize an effective fire safety policy regarding construction operations
- Use mechanical assembly methods where possible, eliminating the need for hot work operations. For example, the use of grooved fitting assemblies makes welding operations unnecessary for piping systems

2. FIRE SAFETY PLANNING

A good fire safety plan should include many key considerations. Some of those considerations follow:

- The designation of a person or a group of persons responsible for fire safety management. The responsibilities minimally include the identification and mitigation of all fire hazards. Such persons should be officially appointed and appropriately trained
- A fire risk assessment that considers all fire exposures during the project
- A fire safety management plan that identifies and records all fire hazards. The plan should include formal checklists reviewed and revised on a weekly or more frequent basis
- Emergency procedures should include fire instructions (emergency communication), fire escape signs and lighting, escape routes, fire drills procedures, locations of portable fire extinguishers, manual alarm call points or pull stations etc. Additionally, responsibilities for notifying fire responders should be officially assigned

- Ensure all subcontractors and third parties are trained and informed regarding fire safety topics. Fire safety is the responsibility of everyone on the site!
- A pre-emergency plan should be established with the local fire department. Ideally, the fire department should be invited to conduct a tour of the project, identifying fire hazards and becoming familiar with the existing and future layouts. A layout plan should indicate at least entrance points, fire hydrants and extinguishers, emergency escape routes, temporary buildings and hazardous areas (combustible and flammable materials). There should be a discussion of fire protection equipment available and fire department apparatus access
- A hardstand should be designated for emergency response vehicles. This should be as flat and level as possible. The location should be carefully selected considering access to the premises and firefighting water supply connection locations
- This plan should be updated on a regular basis as work progresses and placed in a location available to emergency personnel

3. MANAGEMENT OF IGNITION SOURCES

Hot Work Operations

Minimize hot work operations as much as possible. Where hot work operations are required, the hot work management program should include:

- A formal hot work permit procedure developed and implemented with all subcontractors adopting the general contractor’s program for the ease of job site review and enforcement of the hot work policy. The policy should comply with the most recent editions of NFPA 241 and NFPA 51B
- A complementary client-training module is available on the Allianz Global Corporate & Specialty (AGCS) website: <https://www.agcs.allianz.com/news-and-insights/risk-advisory/hot-work-management.html>. Also available on the AGCS website is the guidance document Hot Work Management during Construction. <https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/pdfs-risk-advisory/risk-bulletins/ARC-Hot-Work-Management-During-Construction.pdf>
- Training, at least annually, for all people involved with hot work activities, including permit issuers, hot work operators and fire watches. ARC also offers a complimentary hot work eLearning course at the above link covering the following topics:
 - What is hot work?
 - Hot work loss lessons
 - Managing hot work
 - ARC hot work procedures

Welding, Cutting and Grinding

- Avoid flame cutting in combustible buildings. Do not utilize this technique/method when cutting through combustible walls, floors or roofs, particularly where concealed spaces or cavities exist
- When welding, cutting, grinding, etc. on the roof or other elevated areas be aware of the potential for fires to occur due to falling slag, sparks, embers, etc., igniting combustible materials below

Frequent Sources of Fire

In addition to controlling hot work, consider other frequent sources of fire.

- Attention should be given to electric cables/wires, which should be protected from mechanical or other damage
- Temporary electrical wiring should be kept to a minimum. All temporary electric circuits should be properly installed to prevent physical damage and should be provided with overload protection as specified in the NFPA 70, *National Electrical Code*
- Floodlights are preferable to individual unprotected lamps. LED temporary lights are preferred over fluorescent, high-intensity discharge or incandescent lamps, however; care should be taken regarding the safe location of any LED driver units
- Hot applications of mastics or insulating materials should be avoided inside the building. When this type of application is necessary in the building interior, adequate ventilation should be provided to prevent the build-up of flammable vapor concentrations and appropriate fire extinguishing equipment should be maintained in the area during the entire operation
- If temporary heaters are used within buildings, they should be safely located with proper clearance from combustible materials, have enclosed heating elements, and be thermostatically controlled. The devices should be listed or approved by recognized testing laboratories for the intended use

Locate portable kerosene heaters with built-in fans to circulate heated air outside buildings under construction and far away from combustible material. If ducting to the building enclosure is necessary, it should be fabricated out of noncombustible materials only. Ensure a capable employee operates and maintains the heaters, following all safeguards recommended by the manufacturer. Locate a minimum 20 lb. portable dry chemical extinguisher in the vicinity of heating equipment.

- Inspect, test and maintain any contractor equipment that could be a source of ignition on a regular basis (e.g. quarterly). Records should be maintained detailing remedial measures
- The location of temporary electrical equipment should be maintained well clear of any combustible construction materials or storage. Ideally, electrical equipment should be turned off during non-working hours and when the site is unattended

Smoking

Address the management of smoking. Carelessly and improperly discarded smoking materials are a major cause of accidental fires.

- A formal smoking policy for the entire site should be written, implemented and enforced
- Limiting smoking to designated areas reduces the likelihood of a fire. Designate safe smoking areas away from the building and stored combustibles, provided with non-combustible disposal receptacles for cigarette butts
- Conduct daily self-inspections to ensure the policy is being observed/enforced

4. COMBUSTIBLE AND FLAMMABLE MATERIALS

Combustible material storage

Combustible material storage can provide fuel for a fire and should be located outside the building under construction. Where combustible materials need to be stored inside the building, the area should:

- Have controlled access to prevent unauthorized entry
- Be free of ignition sources, such as hot work operations, heating and electrical equipment, designated smoking areas, etc.
- Be equipped with adequate firefighting equipment and fire detection and notification devices

Waste Materials

- Remove all waste materials including wood, plastic, pallets, oily rags, paper, cardboard, trash, sawdust, etc. from the workplace at least once a day. The waste storage area should be located at an adequate distance from the structures under construction
- The burning of trash or scrap wood should be prohibited

Other Combustible risks

- Utilize only fire retardant tarps. It is recommended that all tarpaulins and poly-sheeting used on construction sites meet the requirements of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films* or equivalent. All tarpaulins and poly-sheeting should be stamped or otherwise marked by the manufacturer as Flame Retardant. As a rule, ensure that no hot work operations take place within thirty-five (35) feet of tarpaulins or poly-sheeting, unless protected by fire blankets or other suitable protective devices or barriers. Ensure that tarpaulins and poly-sheeting are well secured, preventing them from being moved into sources of ignition
- Insulation materials required for the curing of concrete should be non-combustible. The use of straw or foamed plastics is not recommended
- Whenever a chute is to be utilized for debris removal, install it on the outside of the building. Ensure its construction is non-combustible. Ensure the main artery of the chute is as straight as possible to help prevent

accumulations or clogging of combustible materials within the chute. Post “No Smoking” signs in dumpster area and on all floors/accesses to chute

Flammable gases and liquids

- Gas bottles should be secured in the upright position within cages, separating oxidizers and fuel gasses
- Flammable liquids should be stored in approved safety containers
- Allow only minimal quantities within the building and remove them at the end of each shift. If not possible, approved storage cabinets should be provided
- In the event large fuel tanks are utilized, they should be located as far away as practical from valuable property and should be located in accordance with all applicable codes and coordinated with the local fire authority. Care should be taken to ensure that the grade of the storage area slopes away from buildings and other valuables and the surrounding area is free of dried vegetation and other combustible materials

Gas Systems Cleaning and Purging:

To mitigate the risk of a potential natural gas explosion during start up and testing, reference NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems*, in addition to any federal, state and local requirements. For additional details please see **Appendix A**.

5. SECURITY AND INTRUSION SYSTEMS

In addition to accidental fires, the contractor should remain aware and work to prevent intentionally set fires. The implementation of a security plan can reduce the potential for arson.

Implement a security policy, which may include:

- Security fencing around the site
- Surveillance and securing of all entry points and openings (i.e. walls, basements, doors, windows, etc.)
- Guard service trained in fire department notification procedures, fire hazards, use and operation of fire protection equipment, and location and use of construction elevators, where provided
- A best practice is fire protection surveillance by security patrols during nights, weekends and holidays on an hourly, basis during nights and bi-hourly during idle days until such a time that the smoke detection and permanent fire protection systems are operational
- If permanent security personnel cannot be provided, consider installing a video monitoring system with advanced video analytics capability designed to detect and alert in the event of intrusion, vandalism, theft and fire. Consider a remotely monitored system with notification to authorities and management personnel in the event of an incident

- A temporary, internal, motion-sensor intruder alarm system monitored at a constantly attended location
- Lockable containers or Conex boxes for worker materials, equipment and tools
- Adequate site lighting

The installation of intruder alarms is recommended in all temporary buildings.

- Also available on the AGCS website: is the guidance document Construction Site Security, A Contractor's Loss Prevention Guide
<https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/pdfs-risk-advisory/risk-bulletins/ARC-Construction-Site-Security.pdf>

6. VEHICLES (E.G. FORKLIFTS, SCISSOR LIFTS, ETC.)

As these vehicles generate heat and may contain fuel, they can be potential ignition/fuel sources for fires.

Do not store or handle fuel inside or near buildings. Fuel tanks should be filled only in designated outdoor areas while engines are shut off and allowed to cool.

Recharge electric vehicles in dedicated areas free of combustible storage.

Protect all buildings and equipment against any accidental impact.

Prohibit cars, trucks, etc. from parking in buildings or near the construction site except for loading or unloading operations.

7. ROOFING OPERATIONS

Roofing operations involving open flames or hot processes present a significant fire hazard. Ignition sources include heated kettles of tar and asphalt, open flame torches and hot-air guns. The installation of torch-applied roofing systems can be particularly hazardous. Torching can reach temperatures over 1000°C (1800°F) and the temperatures generated by torching applications have been known to start fires that may smolder out of sight, only to burst into flame later, well after torching is over.

If roofing operations involving tar or asphalt kettles are planned, fire prevention precautions should be implemented during these operations. The hot work policy and program should address this work. Additionally, please reference the NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, with specific attention to Chapter 9 Safeguarding Roofing Operations (additional federal, state and local requirements may apply).

Details regarding fire prevention practices for Safeguarding Roofing Operations can be found on the AGCS website:

<https://www.agcs.allianz.com/news-and-insights/risk-advisory/tech-talk-volume-13-safeguarding-roofing-operations.html>

8. TEMPORARY BUILDINGS

NFPA statistics reveal that many fires start in temporary buildings and enclosures for two main reasons:

- There are numerous electrical devices, such as heaters, cooking devices, etc.
- Malicious intruders searching for the theft of attractive, high value tools and equipment on site

All temporary contractor's offices, storage sheds, workman shanties, etc. should be well detached from the building under construction (preferably at least 50 ft. away). Temporary buildings and enclosures should be constructed of non-combustible materials when possible.

If workers are authorized to eat in temporary buildings, the installation of microwave ovens is preferred over other types of cooking equipment.

9. FIRE DETECTION AND SUPPRESSION

Fire detection and suppression during construction are critical aspects requiring consideration. It is important that fire detection utilized to ensure incipient fires are detected. Once detected, it is imperative that fire suppression equipment is available so appropriate and rapid action can be taken to stop the fire. Fire detection and suppression considerations are included in **Appendix B and C**, respectively.

Appendix A

Gas Systems Cleaning and Purging

The NFPA 56 standard was developed in the wake of the 2010 explosion at a power plant construction site. The incident investigation resulted in urgent recommendations being issued by the US Chemical Safety Board (CSB) for NFPA to develop requirements for the "safe conduct of fuel gas piping cleaning operations."

NFPA 56 addresses not only the cleaning practice known as "gas blows", but also a broad range of gas process activities, such as pipe cleaning, repair, replacement, and removal procedures conducted at power plants, and industrial, institutional, and commercial applications.

Highlights of the requirements in NFPA 56 include:

- Prohibits use of flammable gas for internal cleaning of piping systems
- Covers activities including cleaning new or repaired piping systems, placing piping systems into service, and removing piping systems from service
- Requires development of written procedures and a safety validation of procedures by competent persons
- Provides example of purge procedure based on requirements in the standard

Appendix B

Fire Detection

Install and maintain a temporary fire detection system at least in the following areas:

- Temporary buildings and enclosures if their location exposes the construction site or existing building to fire
- Where combustible materials are stored inside the building or in storage areas
- Where use of combustible construction materials is ongoing

An interlinked fire alarm system should be considered during both new and renovation construction projects. Wired fire alarm systems are often suitable for finished buildings where change is unlikely or infrequent, but radio systems allow system components to be easily positioned and re-located where necessary and are therefore often more appropriate and cost effective for construction sites.

In addition, the following should be considered:

- All systems should comply with applicable standards
- If a radio system is selected, battery life should be for a minimum of three years. If a hard-wired system is selected, the installation should include fire-resistant cabling
- System design should be in line with the site fire risk assessment and in conjunction with advice from the equipment provider
- All call points and detectors should be capable of being numbered or named in order to enable a quick and accurate location of a fire at the central base station unit
- The devices should be carefully selected and positioned with respect to potential water, impact or weather damage to help reduce false alarm potential
- It is recommended that the fire alarm incorporate both a delay function and pre-alarm mode to both reduce false alarms and improve site safety during evacuation

Connect the alarms to a fire alarm system. The alarms should be reported either on-site if there is a 24-hour security presence or to a listed/approved central station.

Appendix C

Fire Suppression

Typically, the interior fire suppression systems will not be operational until well into construction of the structures. Properly selected and located fire extinguishers are essential for controlling incipient stage fires.

Install and maintain an adequate number of fire extinguishers covering the entire site. It is important to ensure the number, location, expiration date and adequacy of extinguisher types are regularly audited and updated on a frequent basis depending on work operations.

Provide a minimum of (1) 20 lb. ABC-rated extinguisher unit for every 3000 ft² throughout the building(s). Travel distance to the nearest extinguisher should not exceed 75 ft. in accordance with the latest edition of NFPA 10, *Standard for Portable Fire Extinguishers*. These units should be positioned in readily visible and accessible locations. Extinguishers should have a rating of 4A-80B:C or other as appropriate based on a fire risk assessment.

Additionally, always install extinguishers at the exit points at each level of the building, where combustible materials and vehicles are stored, and where hazardous operations are performed. Ensure that workers are trained in the practical use of extinguishers.

Temporary or permanent fire protection water supply should be available before combustible material accumulates on the site. Where underground water mains and hydrants are to be provided, they should be in service prior to commencing construction work on any structure.

Ensure that new and or existing fire hydrants are installed and activated as quickly as possible to provide protection in the event of fire. The availability and location of active hydrants should be discussed with the local fire department visiting the project.

If automatic sprinkler protection is to be provided in the new or refurbished building(s), the installation should be placed in service as soon as possible. Combustible materials should not be moved into the building(s) until the automatic sprinkler protection is in service.

Ideally, sprinkler system water flow alarm supervision will be operational at the time that systems are placed in service. In the absence of local or remote sounding alarms, minimally, the sprinkler protected areas should be routinely patrolled by security personnel, vigilant for water leakage or flowing sprinklers.

The fire protection systems should be kept operational as long as possible during renovation operations to reduce the duration of impairments.

Try to ensure that new or refurbished fire protection systems can be operational as early as possible.



Range of fire smoke detectors, central alarm and fire point which are wireless devices compliant with EN-54 – Copyright Ramtech Wes +

REFERENCES

CFPA-E Guideline No 21, *Fire prevention on construction sites*

CFPA-E Guideline No 26, *Fire protection of temporary buildings on construction sites*

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*

QUESTIONS OR COMMENTS?

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