

Fire Risk Assessment and Safety Improvement Strategies in Industrial Facilities: A Comprehensive Review

Yamini Deshvena¹

Abstract

Fire incidents in industrial facilities continue to pose significant threats to human life, infrastructure, production continuity, and the environment despite continuous advancements in industrial safety practices. The increasing complexity of manufacturing processes, the widespread use of flammable materials, and the integration of automated systems have intensified the need for systematic fire risk assessment and effective safety management. This review paper examines the major sources of fire hazards in industrial environments, including electrical faults, combustible materials, equipment malfunction, human error, and chemical reactions. It critically reviews established fire risk assessment methodologies such as qualitative risk assessment, quantitative risk assessment, Hazard Identification and Risk Assessment (HIRA), Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA), and Fire Risk Index approaches. The study also discusses fire prevention and protection measures, including passive fire protection, active fire suppression systems, emergency evacuation planning, regular safety inspections, employee training, and compliance with national and international fire safety standards. Furthermore, the paper highlights the growing role of emerging technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), smart fire detection sensors, wireless monitoring systems, digital twins, and predictive analytics in enhancing real-time fire detection, risk prediction, and emergency response. Based on the reviewed literature, several practical safety improvement strategies are proposed to strengthen industrial fire safety management, reduce accident frequency, improve organizational preparedness, and enhance overall operational resilience. The findings indicate that combining comprehensive fire risk assessment with advanced monitoring technologies, proactive maintenance, continuous workforce training, and strong safety culture can significantly reduce fire-related losses and improve industrial sustainability. This review provides valuable insights for researchers, industrial safety professionals, policymakers, and plant managers seeking to develop safer and more resilient industrial workplaces.

Keywords: Fire risk assessment, industrial fire safety, fire hazard identification, hazard identification and risk assessment (HIRA), fire prevention, fire protection systems, industrial safety engineering, artificial intelligence (AI), internet of things (IoT), emergency response planning

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INTRODUCTION

Fire safety is a fundamental component of industrial safety engineering because fire-related accidents can result in catastrophic consequences, including fatalities, severe injuries, environmental pollution, property destruction, production downtime, and substantial financial losses. Modern industries such as manufacturing plants, petrochemical facilities, pharmaceutical industries, power generation units, warehouses, textile mills, and chemical processing plants utilize highly

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combustible materials, complex machinery, electrical systems, and hazardous chemicals that significantly increase the probability of fire incidents. As industrial operations become increasingly automated and technologically advanced, the need for comprehensive fire risk assessment and effective fire safety management has become more critical than ever[1].

Industrial fires occur due to a combination of technical failures, unsafe working conditions, equipment malfunction, inadequate maintenance, human errors, and improper storage or handling of flammable substances. According to international safety reports, electrical faults, overheating equipment, combustible dust, chemical reactions, gas leakage, welding activities, and poor housekeeping remain among the leading causes of industrial fires. Many of these incidents are preventable through systematic hazard identification, regular inspections, employee training, and implementation of engineering controls[2–3].

Fire risk assessment is a structured process that identifies potential fire hazards, evaluates the likelihood of fire occurrence, estimates the severity of possible consequences, and recommends suitable preventive and mitigation measures. A comprehensive fire risk assessment enables industries to prioritize hazards, allocate resources efficiently, and establish effective emergency response strategies. Various assessment techniques such as Hazard Identification and Risk Assessment (HIRA), Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA), Event Tree Analysis (ETA), and Quantitative Risk Assessment (QRA) are widely adopted to improve workplace safety and regulatory compliance[4].

Recent technological advancements have transformed traditional fire safety management into intelligent and data-driven systems. Artificial Intelligence (AI), the Internet of Things (IoT), wireless sensor networks, cloud computing, thermal imaging, machine learning algorithms, and digital twins enable continuous monitoring of industrial environments and provide early warning of abnormal conditions that may lead to fire incidents. These technologies support predictive maintenance, automated fire detection, real-time risk analysis, and rapid emergency response, thereby significantly reducing fire-related losses[5–7].

Despite improvements in fire protection systems and safety regulations, fire accidents continue to occur due to inadequate risk assessment, insufficient safety culture, aging infrastructure, and poor implementation of preventive measures. Therefore, industries must adopt integrated fire safety management systems that combine engineering controls, administrative practices, employee awareness, and advanced monitoring technologies to achieve sustainable industrial safety[8–9].

This review paper presents a comprehensive analysis of fire hazards in industrial environments, examines commonly used fire risk assessment methodologies, reviews recent developments in fire prevention and protection technologies, and proposes practical safety improvement strategies for enhancing industrial resilience and minimizing fire-related risks.

LITERATURE REVIEW

Fire risk assessment has become one of the most extensively studied areas of industrial safety engineering due to the increasing complexity of industrial processes and the potentially catastrophic consequences of fire accidents. Researchers have developed numerous methodologies to identify fire hazards, evaluate risks, and recommend effective preventive measures for different industrial sectors[10].

Early studies primarily focused on conventional fire safety management practices, including compliance with fire codes, installation of fire detection systems, emergency evacuation planning, and routine inspections. While these approaches significantly reduced accident rates, they often relied on periodic assessments rather than continuous monitoring, limiting their effectiveness in rapidly changing industrial environments[11].

Several researchers have emphasized the importance of systematic hazard identification techniques such as Hazard Identification and Risk Assessment (HIRA). HIRA enables industries to recognize hazardous conditions, estimate risk levels, prioritize corrective actions, and establish preventive controls before accidents occur. It has become one of the most widely accepted approaches in manufacturing, chemical processing, power generation, and construction industries[12].

Failure Mode and Effects Analysis (FMEA) has also gained considerable attention as a proactive tool for identifying equipment failures that may initiate fire incidents. By evaluating the severity, occurrence, and detectability of potential failures, FMEA assists organizations in improving equipment reliability and reducing operational risks. Similarly, Fault Tree Analysis (FTA) and Event Tree Analysis (ETA) provide logical frameworks for investigating accident causes and predicting possible fire scenarios, thereby supporting decision-making for safety improvements[13].

Recent literature demonstrates a growing interest in Quantitative Risk Assessment (QRA), which employs mathematical models and statistical analysis to estimate the probability and consequences of fire events. QRA is particularly valuable in high-risk industries such as oil and gas, petrochemical processing, and nuclear power plants, where accurate risk estimation is essential for regulatory compliance and emergency planning[14].

The emergence of Industry 4.0 technologies has significantly influenced modern fire safety research. Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), and Internet of Things (IoT)-based monitoring systems have enabled predictive fire risk analysis using real-time environmental data. Smart sensors continuously monitor temperature, smoke concentration, gas leakage, humidity, vibration, and equipment health, while AI algorithms analyze these data streams to detect abnormal operating conditions before fire ignition occurs[15].

Researchers have also explored wireless sensor networks, cloud computing, unmanned aerial vehicles (UAVs), thermal imaging cameras, and digital twins for industrial fire monitoring. Digital twins create virtual representations of industrial facilities, allowing engineers to simulate fire scenarios, evaluate evacuation plans, optimize emergency response, and improve maintenance strategies without interrupting production[16].

Several studies highlight that employee behavior remains a significant contributor to industrial fire incidents. Inadequate safety training, violation of operating procedures, improper use of electrical equipment, poor housekeeping, and insufficient awareness of emergency protocols continue to increase fire risk across industrial sectors. Consequently, many researchers recommend integrating technical safety measures with organizational safety culture, continuous training programs, and leadership commitment[17].

Overall, the reviewed literature indicates that effective industrial fire safety requires a combination of systematic risk assessment methodologies, modern monitoring technologies, engineering controls, preventive maintenance, regulatory compliance, and active employee participation. The integration of intelligent technologies with traditional fire protection practices represents the future direction of industrial fire safety engineering[18].

SOURCES OF FIRE HAZARDS IN INDUSTRIES

Industrial facilities contain numerous ignition sources, combustible materials, and operational processes that can initiate or accelerate fire incidents. Identifying these hazards is the first step in developing an effective fire risk management strategy. The major sources of fire hazards in industrial environments are discussed below[19].

Electrical Hazards

Electrical failures are among the most common causes of industrial fires. Damaged insulation, overloaded circuits, loose electrical connections, short circuits, defective switchgear, overheating

transformers, and poor maintenance of electrical equipment can generate excessive heat and electrical sparks capable of igniting combustible materials[20]. Aging electrical infrastructure further increases fire risk if regular inspections and preventive maintenance are not performed.

Flammable and Combustible Materials

Many industries store and process highly flammable liquids, gases, solvents, lubricants, paints, plastics, paper products, wood, textiles, and packaging materials. Improper storage, leakage, poor ventilation, and accidental spills increase the probability of fire ignition and rapid flame propagation. Chemical manufacturing and petroleum industries are particularly vulnerable due to the large quantities of combustible substances handled during production.

Hot Work Operations

Maintenance activities involving welding, cutting, brazing, soldering, grinding, and metal fabrication generate sparks and molten metal particles that can ignite nearby combustible materials. Inadequate hot work permits, insufficient fire watch personnel, and failure to isolate combustible substances significantly increase fire hazards during maintenance operations.

Equipment Malfunction and Mechanical Failure

Industrial machinery operating under high temperatures and heavy loads may overheat because of friction, poor lubrication, bearing failure, misalignment, or inadequate cooling systems. Continuous operation without preventive maintenance can lead to equipment failure and fire initiation. Regular condition monitoring and predictive maintenance are essential for minimizing these risks.

Chemical Reactions

Chemical industries frequently handle reactive substances capable of spontaneous combustion, oxidation, polymerization, or violent exothermic reactions. Mixing incompatible chemicals, improper storage conditions, contamination, or process deviations may trigger uncontrolled reactions resulting in fire or explosions. Strict adherence to chemical safety protocols is necessary to prevent such incidents.

Gas Leakage

Leakage of combustible gases such as liquefied petroleum gas (LPG), methane, hydrogen, acetylene, and natural gas creates highly explosive atmospheres when mixed with air. Even a small ignition source can result in devastating fires or explosions. Continuous gas monitoring systems, leak detection sensors, and proper ventilation are essential safety measures.

Human Error

Unsafe work practices remain a major contributor to industrial fire incidents. Smoking in prohibited areas, improper handling of flammable substances, bypassing safety systems, inadequate housekeeping, negligence during equipment operation, and failure to follow standard operating procedures significantly increase fire risk. Continuous employee training and safety awareness programs help reduce human-related hazards.

Poor Housekeeping

Accumulation of combustible waste materials, oil spills, dust deposits, packaging materials, and cluttered workspaces facilitates rapid fire spread. Poor housekeeping also obstructs emergency exits and firefighting equipment, delaying evacuation and emergency response. Maintaining clean work environments is one of the simplest yet most effective fire prevention measures.

Static Electricity

Static electricity generated during material handling, powder transfer, conveyor operations, and fuel movement can produce sparks capable of igniting flammable vapors or combustible dust. Proper grounding, bonding, humidity control, and use of anti-static equipment minimize this hazard.

Combustible Dust

Industries handling wood, coal, grain, sugar, aluminum, pharmaceuticals, plastics, and other fine particulate materials are susceptible to combustible dust explosions. Dust suspended in air can ignite rapidly when exposed to sparks or hot surfaces, causing severe explosions and secondary fires. Effective dust collection systems, ventilation, and routine cleaning are essential preventive measures.

The identification and control of these fire hazards form the foundation of an effective fire risk assessment program. A systematic evaluation of these hazards enables industries to implement appropriate engineering controls, administrative measures, and emergency response strategies to minimize fire-related accidents and ensure safe industrial operations.

FIRE RISK ASSESSMENT METHODOLOGIES

Fire risk assessment is a systematic process used to identify fire hazards, evaluate the probability of fire occurrence, estimate the potential consequences, and recommend appropriate control measures. It enables industries to prioritize risks, comply with safety regulations, and improve emergency preparedness. A comprehensive fire risk assessment generally includes hazard identification, risk analysis, risk evaluation, implementation of control measures, and periodic review.

Hazard Identification and Risk Assessment (HIRA)

HIRA is one of the most widely adopted methodologies in industrial safety engineering. It systematically identifies hazards associated with industrial operations and evaluates the likelihood and severity of fire incidents. Risk is commonly classified into low, medium, high, and extreme categories using a risk matrix.

The HIRA process includes:

- Identification of fire hazards
- Analysis of potential ignition sources
- Assessment of vulnerable personnel and assets
- Evaluation of existing control measures
- Recommendation of additional preventive actions

Failure Mode and Effects Analysis (FMEA)

FMEA is a proactive technique used to identify possible equipment or process failures that could initiate a fire. Each failure mode is evaluated based on:

- Severity (S)
- Occurrence (O)
- Detection (D)

The Risk Priority Number (RPN) is calculated as:

$$RPN = S \times O \times D$$

Higher RPN values indicate higher priority for corrective actions.

Fault Tree Analysis (FTA)

FTA is a deductive analytical technique that starts with an undesirable event, such as an industrial fire, and traces backward to identify all possible causes. Logical gates (AND and OR) are used to determine combinations of failures leading to the accident.

FTA assists industries in:

- Identifying root causes
- Evaluating system reliability
- Improving preventive maintenance
- Supporting engineering design improvements

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Event Tree Analysis (ETA)

ETA is an inductive method that evaluates the sequence of events following an initiating incident. Beginning with a fire ignition event, it predicts multiple possible outcomes depending on the performance of safety systems such as alarms, sprinklers, and emergency response teams.

ETA is particularly useful for emergency planning and consequence analysis.

Quantitative Risk Assessment (QRA)

QRA applies mathematical models, probability theory, and statistical analysis to estimate both the likelihood and consequences of fire incidents. It is commonly used in petrochemical plants, refineries, LNG terminals, and chemical processing industries.

QRA evaluates:

- Individual risk
- Societal risk
- Fire frequency
- Thermal radiation
- Explosion overpressure
- Economic losses

Fire Risk Index Methods

Fire Risk Index (FRI) approaches assign numerical values to various fire safety parameters such as building design, occupancy, combustible load, fire detection systems, and emergency preparedness. The overall index helps compare safety performance across facilities and prioritize improvements.

Bow-Tie Analysis

Bow-Tie Analysis combines Fault Tree Analysis and Event Tree Analysis into a single visual framework. It illustrates:

- Causes leading to fire
- Preventive barriers
- Fire event
- Mitigation barriers
- Consequences

The methodology provides a clear representation of risk control strategies and is increasingly adopted in high-hazard industries.

Recent research indicates that integrating AI, IoT, and machine learning with conventional methodologies enables continuous, dynamic fire risk assessment rather than periodic inspections alone.

FIRE PREVENTION AND PROTECTION SYSTEMS

Fire prevention aims to eliminate conditions that may cause fires, whereas fire protection focuses on limiting fire growth, protecting occupants, and minimizing damage once a fire occurs. An effective industrial fire safety program integrates engineering controls, administrative measures, and emergency response systems.

Fire Prevention Measures

Primary preventive measures include:

- Electrical system inspection and maintenance
- Proper storage of flammable liquids and gases
- Good housekeeping practices
- Hot work permit systems

- Preventive equipment maintenance
- Explosion-proof electrical installations
- Static electricity grounding and bonding
- Smoking control policies
- Hazard communication programs

Passive Fire Protection

Passive fire protection reduces fire spread without requiring activation.

Examples include:

- Fire-resistant walls
- Fire doors
- Fire compartments
- Fire-rated ceilings
- Fireproof structural steel
- Fire stopping materials
- Smoke barriers

These systems increase evacuation time and reduce structural collapse.

Active Fire Protection

Active systems automatically detect, suppress, or control fires.

Common systems include:

- Automatic sprinkler systems
- Fire hydrants
- Fire extinguishers
- Fire alarm systems
- Smoke detectors
- Heat detectors
- Flame detectors
- Gas suppression systems
- Foam suppression systems
- Water mist systems

Automatic detection and suppression significantly reduce fire damage when activated during the early stages.

Emergency Preparedness

Effective Emergency Preparedness Includes:

- Emergency response plans
- Evacuation maps
- Assembly points
- Fire drills
- Rescue procedures
- Incident command systems
- Mutual aid coordination

Regular drills improve response efficiency and reduce panic during emergencies.

Fire Safety Training

Employee awareness remains one of the strongest preventive measures.

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Training should cover:

- Fire hazards
- Safe work practices
- Fire extinguisher operation
- Emergency evacuation
- Alarm procedures
- First aid
- Incident reporting

Continuous competency development strengthens organizational safety culture.

INDUSTRIAL SAFETY IMPROVEMENT STRATEGIES

Improving industrial fire safety requires a combination of engineering solutions, organizational commitment, regulatory compliance, and technological innovation.

Major Strategies Include:

Engineering Controls

- Process automation
- Intrinsically safe equipment
- Explosion-proof electrical systems
- Improved ventilation
- Fire-resistant construction
- Automatic shutdown systems

Administrative Controls

- Standard Operating Procedures (SOPs)
- Permit-to-work systems
- Maintenance scheduling
- Contractor safety management
- Safety audits
- Incident investigations

Safety Culture Development

Organizations Should Encourage:

- Leadership commitment
- Employee participation
- Hazard reporting
- Continuous learning
- Safety observations
- Near-miss reporting

Maintenance Management

Predictive and preventive maintenance reduces equipment failures that may initiate fires.

Maintenance should include:

- Thermographic inspection
- Electrical testing
- Lubrication programs
- Vibration monitoring
- Gas leak inspection

Regulatory Compliance

Industries should comply with standards such as:

- NFPA Codes
- OSHA Regulations

- ISO 45001
- ISO 31000
- Local fire safety regulations

A systematic safety management system improves legal compliance and operational resilience.

ROLE OF MODERN TECHNOLOGIES (AI, IOT, SMART SENSORS, DIGITAL TWINS)

Industry 4.0 technologies are transforming industrial fire safety from reactive to predictive systems.

Artificial Intelligence (AI)

AI algorithms analyze historical accident records and real-time sensor data to predict abnormal operating conditions before fire ignition.

Applications include:

- Fire prediction
- Smoke recognition
- Thermal image analysis
- Predictive maintenance
- Emergency decision support
- Computer vision-based fire detection

AI enables faster and more accurate fire identification than conventional monitoring systems.

Internet of Things (IoT)

IoT connects sensors and equipment through wireless communication networks.

IoT-based fire safety systems monitor:

- Temperature
- Smoke concentration
- Carbon monoxide
- Gas leakage
- Humidity
- Equipment vibration

Real-time monitoring enables immediate alerts and rapid response.

Smart Sensors

Modern smart sensors provide continuous monitoring of industrial environments.

Examples include:

- Thermal sensors
- Infrared detectors
- Flame detectors
- Optical smoke detectors
- Multi-gas sensors
- Wireless sensor networks

Sensor fusion improves detection accuracy while reducing false alarms.

Digital Twins

Digital twins create virtual replicas of industrial facilities.

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Applications include:

- Fire scenario simulation
- Risk visualization
- Evacuation analysis
- Equipment health monitoring
- Maintenance optimization
- Emergency planning

Digital twins support informed decision-making without interrupting production.

Robotics and Drones

Robots and unmanned aerial vehicles assist firefighters by:

- Entering hazardous areas
- Detecting toxic gases
- Thermal imaging
- Damage assessment
- Remote firefighting
- Search and rescue

These technologies reduce human exposure during emergencies.

CHALLENGES AND FUTURE RESEARCH

Despite significant advancements, several challenges continue to hinder effective industrial fire safety management.

Major challenges include:

- Aging industrial infrastructure
- Limited adoption of AI-based monitoring systems
- High implementation costs
- Inadequate employee training
- Cybersecurity risks in IoT systems
- Lack of standardized datasets for AI models
- False alarms from intelligent detection systems
- Integration difficulties with legacy industrial equipment
- Limited availability of real-time fire data
- Regulatory differences across industries

Future research should focus on:

- Explainable AI for fire risk assessment
- Digital twin-based emergency simulation
- Autonomous firefighting robots
- Edge AI for real-time fire detection
- Federated learning for industrial safety
- Integration of Building Information Modeling (BIM) with fire safety
- Blockchain-secured industrial safety data
- Smart wearable safety devices
- 5G-enabled emergency communication
- Self-learning predictive fire risk models

These developments will enable intelligent, adaptive, and resilient industrial fire safety systems.

CONCLUSION

Fire safety remains one of the most critical aspects of industrial safety engineering due to its direct impact on human life, operational continuity, environmental protection, and economic sustainability.

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This review examined the major sources of industrial fire hazards, including electrical failures, combustible materials, equipment malfunction, chemical reactions, gas leakage, and unsafe work practices. It further discussed widely accepted fire risk assessment methodologies such as HIRA, FMEA, FTA, ETA, QRA, and Bow-Tie Analysis, highlighting their importance in systematic hazard identification and risk reduction.

The review also demonstrated that effective fire prevention requires an integrated approach combining engineering controls, administrative measures, passive and active fire protection systems, emergency preparedness, and continuous workforce training. Recent advances in Artificial Intelligence, the Internet of Things, smart sensors, digital twins, and predictive analytics have transformed traditional fire safety practices into intelligent, real-time monitoring systems capable of detecting hazards before fire initiation. These technologies significantly enhance early warning capabilities, improve emergency response, optimize maintenance activities, and support data-driven decision-making.

However, challenges such as aging infrastructure, implementation costs, cybersecurity concerns, limited interoperability, and insufficient safety culture continue to affect industrial fire safety performance. Future research should therefore emphasize explainable AI, intelligent sensor fusion, autonomous firefighting systems, digital twin simulations, and standardized risk assessment frameworks to improve industrial resilience.

Overall, integrating conventional fire safety practices with advanced digital technologies provides a robust pathway toward safer, smarter, and more sustainable industrial operations, reducing fire-related accidents while improving occupational safety and organizational performance.

REFERENCES

1. Mullen R. Fire Safety Engineering: Principles and Practice. 3rd ed. London: ICE Publishing; 2021.
2. Drysdale D. An Introduction to Fire Dynamics. 4th ed. Chichester: Wiley; 2021.
3. Hurley MJ, Gottuk DT, Hall JR Jr, Harada K, Kuligowski ED, Puchovsky M, et al. SFPE Handbook of Fire Protection Engineering. 6th ed. Cham: Springer; 2024.
4. Hall JR. Fire loss in the United States during 2023. Fire Technol. 2024;60(4):1457–1472.
5. Zhang S, Song Y, Dong Q, Yang H, Shi LX. Developing an indicator system for urban fire risk assessment. Fire Saf J. 2025;158:104536.
6. Desikan J, Singh SK, Jayanthiladevi A, Singh S, Yoon B. Dempster Shafer-empowered machine learning-based scheme for reducing fire risks in IoT-enabled industrial environments. IEEE Access. 2025;13:46546–46567.
7. Morchid A, Oughannou Z, Khalid HM, Qjidaa H, El Alami R, Siano P. Fire risk assessment system for food and sustainable farming using AI and IoT technologies: Benefits and challenges. Internet Things. 2025;33:101704.
8. Kumar R, Kaur A, Dangi HK, Kumari P, Kumar N. Artificial intelligence in fire safety: A critical perspective on policy, stakeholders and emerging technologies in India. Indian J Public Adm. 2025.
9. Dong X, Zhou J, Shen J, Li C, Zhang T, Fan S, et al. A review of the application of machine learning in the field of fire public safety: From risk assessment to emergency decision-making. Energy Build. 2026;117951.
10. Karger E, Jeppe A, Ziolkowski R, Korn F, Hackel T, Harr M, et al. Artificial intelligence for wildfire detection and management. Discover Artificial Intelligence. 2026;6:304.
11. ISO. ISO 45001:2018 Occupational health and safety management systems—Requirements with guidance for use. Geneva: ISO.
12. ISO. ISO 31000:2018 Risk Management—Guidelines. Geneva: ISO.
13. National Fire Protection Association. NFPA 1: Fire Code. Quincy (MA): NFPA; 2024.
14. National Fire Protection Association. NFPA 72: National Fire Alarm and Signaling Code. Quincy (MA): NFPA; 2022.
15. National Fire Protection Association. NFPA 13: Standard for the Installation of Sprinkler Systems. Quincy (MA): NFPA; 2022.

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Details References

16. National Fire Protection Association. NFPA 101: Life Safety Code. Quincy (MA): NFPA; 2024.
17. Occupational Safety and Health Administration. Process Safety Management of Highly Hazardous Chemicals. Washington (DC): OSHA; 2024.
18. International Labour Organization. Safety and Health at the Heart of the Future of Work. Geneva: ILO; 2023.
19. Fire Protection Research Foundation. Advances in industrial fire protection technologies. Quincy (MA): FPRF; 2023.
20. Wang L, Chen X, Li Y. Intelligent fire detection using deep learning and computer vision: A review. *Fire Saf J*. 2024;145:103980.

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