Kidde Fire Systems

Guide to Data Center Fire Protection

Protecting Your Digital Assets

KiddeFenwal

Guide to Data Center Fire Protection

Protecting Your Digital Assets

Protecting Your Digital Assets

According to the Data Center Market Size, Share & Trend Analysis Report by Grand View Research, the global data center market size was valued at about $195 billion in 2022 and is expected to reach about $437 billion in 2030 at a CAGR projected at about 10.9%.

The initial one-time cost of fire protection for data centers varies depending on the size of the data center (square feet) and the type of system required. Fire detection systems range from a few thousand dollars to tens of thousands, while fire suppression systems can cost between tens of thousands to hundreds of thousands of dollars. In most data centers, the cost of implementing fire protection systems is a fraction of the data center itself and significantly lower when compared to the potential losses incurred due to downtime caused by a fire. The average cost of data center downtime is considerably higher, often thousands if not millions of dollars per minute depending on the size, criticality, owner and use of the data center operations.

In this guide, we will explore data center fire suppression systems, their importance, and how Kidde Fire Systems has revolutionized this vital field.

The Importance of Data Center Fire Protection

Data centers contain the servers necessary to store your data in a secure environment. Investing in a fire protection system can help protect your business from the financial impact of replacing damaged hardware and other costly infrastructure damage caused by fires, in addition to reducing the risk of lost data. The impact of data center fires reaches far beyond the risk of lost data and damage to the data center itself. In a reported incident, an electrical fire broke out at a colocation data center in Seattle, WA servicing several Fortune 500 companies. According to reports, the incident resulted in almost $7 billion in damages, lost revenue and downtime. In addition to the dangers they pose to employees and other building occupants, data center fires can result in extended downtime, inconvenience to customers, cost companies millions of dollars and erode trust over time.

Data centers have many inherent fire risks such as:

- Failing or damaged wires and cables
- Hardware and HVAC equipment
- Suspended ceilings and raised floors
- Heat generated by servers, network equipment and storage devices
- Emergency power supply equipment

7 main causes of fires in data centers

1. **Restricted Airflow:**
   Inefficient cooling may occur if equipment is packed too closely together. This can cause temperatures to rise high enough to create localized hotspots and ignite.

2. **Issues with cooling:**
   Faults in data center cooling systems can cause temperatures to rise rapidly, overheat equipment and ignite.

3. **Electrical faults:**
   Sparks and/or excessive heat from electrical faults, short or overloaded circuits, and faulty wiring, can lead to fires. Inadequate maintenance or aging electrical infrastructure can worsen these risks.

4. **Battery faults:**
   Uninterruptible power supplies (UPS) and other backup power solutions often utilize batteries that can overheat or fail.

5. **Contaminants and debris:**
   Particulate matter, like dust or fibers can accumulate and have the potential to insulate heat generating components or cause short circuits especially in environments without strict cleanliness protocols.

6. **Human error:**
   Misconfiguring equipment, inadequate maintenance procedures, accidental damage to equipment, or mishandling of electrical systems can inadvertently cause fires.

7. **Arson:**
   Intentionally starting fires to disrupt services or as a diversion from a broader attack.

Consequences of fires in data centers

Fire detection and suppression systems are designed to detect fires within seconds and stop them as a priority to minimize the consequences of an outbreak including:

- Data loss that can lead to extended business interruptions.
- Implication to businesses relying on the data center due to interruption in service.
- Client dissatisfaction resulting in erosion of trust and reputation damage:
- Financial loss due to expensive equipment damage and replacement.
- Danger and injury to employees, visitors and other occupants.
- Potential to spread beyond the data center and cause damage in the wider area.

Fire Risk Acceleration
GPUs are now being used alongside CPUs at data centers to meet the elevated computational demands of emerging use cases such as AI and analytics. Data center operators and users know that CPUs and GPUs serve complementary roles, CPUs managing the overall system flow and GPUs accelerating computationally intense tasks and thus, requiring more power than CPUs. The primary fire risk associated with GPU acceleration in data centers includes:

High Heat Dissipation:
GPUs are designed for high performance, which means they generate a large amount of heat during operation, requiring robust cooling systems to maintain safe temperatures.

Component Stress:
Excessive heat can stress components within the GPU, increasing the risk of failure or malfunction, which could lead to electrical sparks or overheating of nearby components.

Dense Packing:
Data centers often pack servers tightly to maximize space utilization, which can further exacerbate heat issues if not properly managed with airflow and cooling strategies.

Power Supply Concerns:
The high-power draw of GPUs puts additional strain on power supplies and cabling, increasing the risk of electrical issues that could spark a fire.

Mitigating Fire Risk in GPU-heavy Data Centers:

Monitoring and Alerting:
Robust monitoring systems to detect abnormal temperatures and trigger alerts to prevent overheating situations.

Detection: Mitigating risks with early warning systems

Advanced fire detection systems ensure that data center staff have as much time as possible to decide how to address the issue and mitigate risk.

1. Air sampling systems

Air sampling systems, also known as aspirating smoke detection (ASD) systems or high sensitivity smoke detection (HSSD®) systems, continuously draw air samples from the environment through a network of pipes to a central detection unit. Within the detection unit, highly sensitive laser-based technology analyzes air samples for the presence of smoke particles. These systems can detect smoke at very early stages, often before it is visible, providing advanced warning of potential fire incidents.

Relative Sensitivity air sampling smoke detection systems, adapt to virtually any environment in which they are installed, providing alarm thresholds which are 'relative' to the background particle levels in the protected area, instead of placing the alarm threshold at a fixed level relative to ambient conditions. At any time, the detector's performance remains constant, regardless of fluctuations in the normal background particle level and only responds to particle levels significantly above the expected background level, such as from a genuine fire situation. Once smoke is detected, the system signals the alarm control panel, which takes actions on the next steps in the suppression routine.

Fixed Sensitivity air sampling smoke detection systems feature fixed alarm thresholds that are programmable depending on the sensitivity of smoke detection required. Once smoke is detected, the system sends signals to the alarm control panel, which takes actions on the next steps in the suppression routine.

Kidde Fire Systems makes available both the Relative Sensitivity and Fixed Sensitivity ASD products.

2. **Optical Smoke, Heat detection and Combination systems**

   The Kidde Fire Systems KC2 Optical Smoke and Heat Combination Detector offers advanced smoke detection combined with heat detection.

   - The advanced photoelectric sensing chamber detects smoke from a fire versus nuisance smoke from non-fire sources.
   - The rate-of-rise heat sensor quickly detects a fast, flaming fire.
   - The fixed-temperature heat sensor detects fire when the air temperature near the detector exceeds the alarm point of 135 °F (nominal).

3. **Flame detection systems**

   Flame detection systems utilize optical sensors to detect the presence flames, or the specific wavelengths of light emitted by fires. They operate in the ultraviolet (UV), infrared (IR), or both spectrums.

   - UV detectors are sensitive to the ultraviolet light emitted by flames.
   - IR detectors detect the heat radiation produced by fires.
   - Dual-spectrum detectors combine both UV and IR sensors for enhanced flame detection accuracy.

4. **Heat detection systems**

   Heat detection systems monitor temperature changes within a specific area. There are two categories.

   - **Fixed temperature detectors:** Activate when the ambient temperature reaches a predetermined threshold, indicating a potential fire. Basic fixed temperature detectors activate only when completely heated to alarm temperature and therefore a lag in response time may occur with a fast rate fire.
   - **Rate-of-rise detectors:** Trigger alarms if the temperature rises rapidly within a short period, suggesting the presence of a fire.

   Rate compensation detectors such as the Fenwal Controls DETECT-A-FIRE® Heat Detectors (D-A-F) accurately sense the surrounding air temperature regardless of the fire growth rate and are activated at precisely the pre-determined temperature – thereby acting as the "heart" of many fire protection systems, used for signaling overheating or fire conditions. The D-A-F often provides the initial heat sensing that is used to activate suppression systems using clean agent, CO2, inert gases, wet or dry chemicals. D-A-F detectors are designed with rate compensation, providing a unique advantage over both fixed temperature and rate-of-rise detectors because they accurately sense the surrounding air temperature regardless of the fire growth rate, activating the suppression system at a pre-determined set point.

5. **Lithium-Ion Battery Anomaly detection**

   Many Data Centers are now using Lithium-Ion batteries as a means of emergency power instead of diesel-engine driven generator sets. See our WP-106 BESS and LI Guide for risks involved with Lithium-Ion Batteries. To mitigate the risk of thermal runaway events, a crucial approach involves the utilization of sensors capable of detecting several different external abuses (Stage 1 events), while also detecting off-gases or initial venting occurrences (Stage 2 events).

   Kidde Fire Systems REL-iON™ Battery Monitoring System is a modular sensor platform with the ability to detect both Stage1 and 2 anomalies.

Stage 1 prevention involves continuous monitoring of various factors, including environmental conditions, mechanical stress, power fluctuations, and thermal conditions. This monitoring is crucial to proactively prevent potential thermal runaway. Several different sensors can be deployed for preventive monitoring, such as Water Leak, Temperature and Humidity, Solid Contaminants, Real-Time Corrosion, Air Flow, Vibration, etc.

Stage 2 detection begins just before a complete thermal runaway occurs. Malfunctioning lithium-ion batteries will vent gases due to internal pressure build-up, leading to the rupture of the battery's enclosure. The optimal sensor for this task is one that can identify volatile organic compounds (VOCs). However, when employing liquid-cooled batteries, it is imperative to include Hydrogen (H2) sensors as well. In such cases, battery failures can occur at typical operating temperatures, releasing H2 gas before any other gas. The REL-iON™ Battery Monitoring System extends off-gas detection beyond just volatile organic compounds (VOCs) electrolyte vapors, seamlessly incorporating the analysis of other dangerous vented gases like CO2 and H2.

			LOCATION			
Stage	**Sensor Type**	**Model Number**	**In-Cabinet**	**Room / Sub-Floor**	**HVAC System**	**Cable Trays**
1	Water Ingress Detection	31-ENV-LEAK		X		
1	Temperature	31-ENV-TEMP	X	X		
1	Temperature + Humidity	31-ENV-THUM		X	X	
1	Corrosion	31-ENV-CORROSION		X		
1	Air Particulate	31-ENV-PARTICLE		X		
1	Thermal Imaging	31-ENV-THIMG-x		X		X
1	Linear Heat Detection	31-ENV-LHD		X		X
1	Air Flow	31-ENV-AIRFLOW		X	X	
1	Door Opening	31-SEC-DOOR	X	X		
1	Differential Pressure	31-ENV-AIRPRESSURE		X	X	
2	VOC	31-GAS-VOC	X			
2	VOC + H2	31-GAS-H2-VOC	X	X		

Detection & Suppression Control

The sensors and detection devices described earlier operate in conjunction with a Kidde Fire Systems Fire Alarm-Suppression Control Unit (FACP) or fire panel.

- The conventional AEGIS™-PHX fire panel is suitable for small applications with 1 -2 suppression zones:
- The ARIES®-SLX manages fire response events from detection and alarm to suppression system release. In stand-alone or non-networked mode, the ARIES-SLX is ideal for medium-sized applications with up to 10 suppression zones, providing pre-planned, sequential system response or immediate system actuation, depending on the requirements of the application. The system capabilities can be expanded by networking up to 31 additional control units.
- The ARIES™-MLX is a fully featured, multi-loop, intelligent, addressable and networkable Fire Suppression Control Unit and is designed for large commercial, industrial and high-tech facilities. In stand-alone or non-networked mode, the ARIES-MLX is ideal for applications requiring 10 or more suppression zones. Like the ARIES-SLX, the system capabilities can be expanded by networking up to 63 additional control units.
- Two detection circuits per zone
- Each circuit less than 20 conventional smoke detectors
- One of each manual operator circuit, such as manual releases and abort stations
- One of each notification circuit, first alarm, cross-zone confirmation and agent release
- One Agent Release Circuit

Suppression: Minimizing damage and spread.

Kidde Fire Systems fire suppression line is available in a range of options, designed to address the unique needs of modern data center facilities. Our systems will suppress fires without leaving a messy residue behind or damaging expensive equipment.

Data Center Fire Suppression Types:

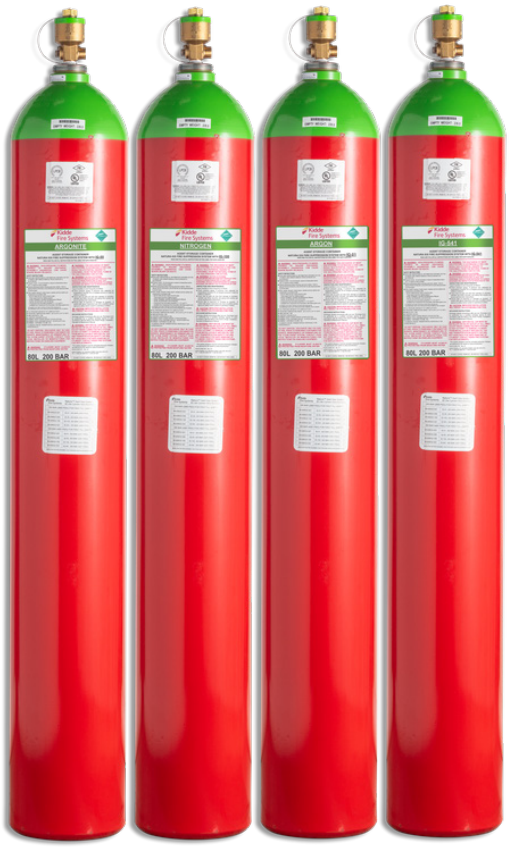
Clean agent fire suppression systems are designed to discharge and suppress fires before heat or flame levels trigger the buildings sprinkler systems to activate. After the clean agent suppresses the fire, a building's ventilation system easily removes the agent. Clean agents do not leave messy residue or cause equipment damage and are typically deployed in the main hall housing the key business assets viz. the data racks and servers.

Fires are caused by a combination of fuel, oxygen, and heat – often referred to as the "fire triangle". Clean Agents absorb heat from the surface of the burning material and effectively lower its temperature below the ignition point – thereby disrupting the fire triangle and suppressing the fire without harming equipment or personnel in the protected room. Clean Agents offer fast extinguishment, suppressing fires within seconds of the agent being discharged into the protected area. Clean Agents are non-toxic when used in compliance with NFPA Standard 2001. They do not impair breathing or obscure vision in an emergency, providing an added measure of safety for personnel.

The Kidde Fire Systems clean agent fire suppression line is available in a range of options.

Kidde Fire Systems offers Fluoro-K™ (FK-5-1-12) and HFC-227ea 'chemical' fire suppression clean agents in versatile total flood type delivery system platforms including ECS™, ECS-500™ and ADS™. The ECS platform is standard and delivers either a small amount of agent at a moderate distance or a large amount of agent at a short distance. ECS-500™ offers design flexibility for small to medium volume hazards by enabling smaller diameter pipes for longer distances. ADS™ offers significant enhancement in distance traveled for systems with large agent volumes. All systems discharge clean agent within 10 seconds.

The Kidde Fire Systems NATURA™ Inert Gas System is an alternative to 'chemical' clean agents. Inert gases suppress fire by lowering the oxygen content in the room to a level where the process of combustion is no longer supported – which means that the fire won't continue to burn. These gases are environmentally responsible, having an ozone depletion potential (ODP) of zero and a global warming potential (GWP) of zero. At room temperature, inert gases are odorless and colorless.



Inert gases are safe for human exposure under limited conditions and criteria. According to NFPA 2001 in occupied areas, people can breathe Inert gas blends at extinguishing concentrations below 52% for very brief periods of time thereby aiding egress. There are no toxicological factors associated with the use of Inert gases as they will not decompose or produce any by-products when exposed to a flame.

The NATURA™ system offers a choice of 4 different inert gases - two are pure gases present naturally in the environment and two are blends of those gases. All four are listed in NFPA 2001 and are approved by the ISO committee. The selection of which one to use should be made based on regional availability approved agents to suit re-charge conditions and any unique specification requirements. Inert Gas systems are allowed to be discharged within 120 seconds into the protected space.

Delivery System Comparison Chart

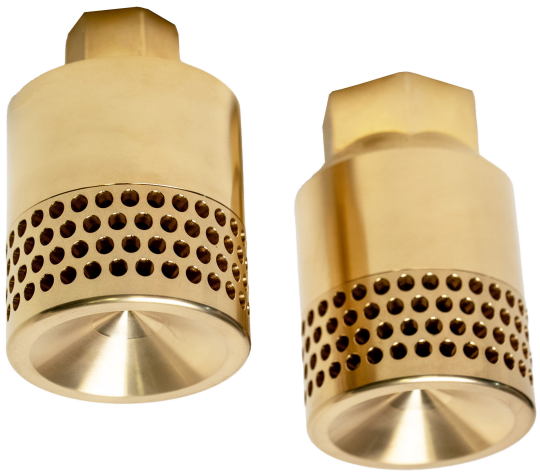
Delivery System	ECS™	ECS™-500	ADS™	NATURA™	NATURA™
Storage Pressure[1] psi (Bar)	360 PSI (25 Bar)	500 PSI (35 Bar)	1,800 psi[2] (124 Bar)	2900 psi (200 Bar)	4350 psi (300 Bar)
Distance[3] feet (meters)	120' (36.5 m)	140' (42.7 m)	245' (74.7 m)	500' (152.4 m)	500' (152.4 m)
Storage Footprint[4] ft x ft (m x m)	13.5' x 2.5' (4.1m x 0.77m)	13.5' x 2.5' (4.1m x 0.77m)	26' x 3.5' (8m x 1.1m)	80 Liter: 34' x 3.5' (10.4m x 1.1m) 140 Liter: 27' x 4' (8.2m x 1.21m)	80 Liter: 25' x 3.5' (7.6m x 1.1m) 140 Liter: 18.5' x 4' (5.6m x 1.21m)
Nozzle Height[5] Feet (meters)	16' (4.9 m)	16' (4.9 m)	16' – 18.5'[6] (4.8 m – 5.6 m)	16' (4.8 m)	16' (4.8 m)

[1] Nominal system storage pressure at 70° F (21° C)
[2] Pressure indicated is that of the separate Nitrogen driver. Agent cylinder pressure depends on the agent 44 psi for HFC-227ea and 360 psi for Fluoro-K™
[3] Distance is defined as the distance measured from the agent storage location to the asset room being protected.
[4] Storage footprint is the space required to house the armed agent cylinders. In this example of a 10,000 square foot Data Center with 12-foot height, the storage footprint is calculated assuming Fluoro-K™ in 6 x 900 lb. cylinders each with 819 lb. (4,914 lb. total) for the ECS and ADS™ platforms and IG-100 in an 80 Liter cylinder at 300 Bar for the Natura™ platform.
[5] Maximum nozzle mounting height from the floor or the vertical interval between levels of nozzles for rooms with high ceilings.
[6] The maximum mounting height of the ADS™ nozzle depends on the agent used – it is 16 ft for HFC-227ea and 18.5 ft for Fluoro-K™

NATURA™ Acoustic Nozzles

For use in applications requiring a system discharge generating a lower sound output than a standard suppression nozzle

- Quieter, reduces sound levels to below 110dB (between 500 Hz and 10 kHz when measured at 1 m)
- Aesthetically pleasing alternative to bulky nozzle-silencer combinations
- Can replace existing discharge nozzles without major pipe modifications



Fuel Storage Fire Suppression Types:

Kidde Fire Systems High Pressure Carbon Dioxide (HPCO2) fire suppression system is the ideal fire suppression solution for heavy and light industrial applications where unoccupied spaces or assets need protection, where CO2 is an acceptable agent and other agents would be cost prohibitive, and where in addition to the primary total flooding design, a local application system may be required.

CO2 agent can penetrate and spread to all parts of the protected area. As a gas or as a finely divided solid called 'snow' or 'dry ice', CO2 will not conduct electricity and therefore can be used on energized electrical equipment. It leaves no residue, thus eliminating cleanup of the agent itself and is the only clean agent system that can be used for deep seated fires. HPCO2 systems may be configured for total flooding, local application, or combination of both.

HPCO2 Total Flooding System:

In a total flooding system, a predetermined amount of CO2 is discharged into an enclosed space or enclosure around the hazard. Total flooding is applicable when the hazard is totally enclosed and when all openings surrounding the hazard can be closed automatically prior to or at the start of system discharge

HPCO2 Local Application:

Local application systems differ from total flooding in that the nozzles are arranged to discharge directly onto the fire. This technique can be generalized to protect three-dimensional hazards.

Gaseous clean agent systems have become the go-to fire protection solution for data centers.

For decades, Kidde Fire Systems has been an industry leader in fire prevention, detection & control, and suppression. Our name is backed by a strong commitment to product quality, innovation, and expertise in system design, installation, and service. We operate globally through a network of trained and authorized Engineered Systems Integrators/Distributors that excel in initial hazard analysis, system design, installation, testing and commissioning as well as aftermarket service including parts, refills and code-mandated periodic testing and maintenance.

System Design: Crafting fire protection plans that account for a facility's specific layout and requirements.

Installation: Expert implementation of fire suppression systems with minimal disruption to operations.

Ongoing Maintenance: Regular inspections and servicing to ensure systems remain in peak condition.

Upgrades and Retrofits: Adapting existing systems to meet evolving needs or comply with new regulations.

Whether you're building a new data center or upgrading an existing facility investing in a fire suppression system is an essential step in safeguarding your organization's future. Kidde Fire Systems offers tailored solutions that help data centers operate with confidence knowing that their critical assets are protected by the most advanced and effective fire systems available.

Kidde Fire Systems are not just an insurance policy, they're a fundamental component of business continuity and risk management. Contact us at www.kiddefiresystems.com to learn more about Kidde Fire Systems tailored solutions.

About KiddeFenwal:

For decades, KiddeFenwal has been a global leader in fire prevention, detection, and suppression. Our reputation is built on a deep commitment to product innovation and specialized expertise in system design. We operate through an elite worldwide network of Authorized Engineered Systems Integrators. These partners excel in every phase of protection—from initial hazard analysis and custom system design to installation, commissioning, and code-mandated maintenance.

Closing Thoughts

Whether you are securing a critical power infrastructure or protecting a priceless archive, investing in a KiddeFenwal solution—combining early warning detection, anomaly sensing, and multi-tiered suppression—is an essential step in safeguarding your future. We offer tailored Kidde Fire Systems solutions that allow organizations to operate with total confidence, knowing their most critical assets are shielded by the most advanced technology available.

These comprehensive systems are more than just an insurance policy; they are a fundamental component of business continuity and risk management. By stopping a threat at the source, this technology moves your facility from reactive firefighting to proactive resilience, ensuring that your infrastructure and the physical records of our history remain perfectly intact and undisturbed.

NOTES:

Kidde-Fenwal, LLC
400 Main St
Ashland, MA 01721, USA

KFI U.K. Limited
Station Road,
Bentham,
Lancaster, LA2 7NA

Kiddel Technologies
India Private Limited.
Survey No. 28/2,44/2 and 45,
Rasyani,Dandapta Road
Raigad Maharashtra-410207

www.kiddefenwal.com | 508.881-2000