

NFPA 75 AND FIRE PROTECTION AND SUPPRESSION IN DATA CENTERS



Data centers are critical components of today's modern technology and communications infrastructure, and are expected to grow significantly in number and importance as more users shift to cloud-based applications and services.¹ With an average total cost of nearly \$700,000 (USD) per downtime incident,² protecting data centers from downtime and service outages is an essential requirement for both businesses and consumers.

Fires are perhaps the least predictable cause of data center outages, as well as the cause that poses the greatest potential hazard to the health and safety of workers. As such, local building and fire codes generally require data centers to install and maintain fire protection and suppression systems that meet the requirements of accepted standards to reduce that risk. Recent changes in the technical requirements of the standards for data center fire protection will ultimately result in stronger code requirements and potentially more rigorous enforcement over data center construction and operation by local authorities having jurisdiction (AHJs).

This UL white paper provides an overview of generally-accepted fire protection and suppression system requirements for data centers. Beginning with information on the current size and projected future growth of data centers, the paper continues with a discussion of the direct and indirect costs of data center outages. The white paper then summarizes the key requirements of NFPA 75 and the prescribed methods to be employed in data centers to prevent fires and to mitigate their impact. The paper concludes with recommendations for data center developers and operators.

The Growth of Data Centers

Modern society's dependence on advanced computing technology has spurred dramatic growth in the construction and deployment of data centers, dedicated locations where information technology (IT) and communications equipment and infrastructure assets can be efficiently monitored and operated. According to a 2014 forecast by International Data Corporation (IDC), the total number of data centers of all types will reach 8.6 million worldwide by 2017. During the same period, space dedicated to data centers globally will reach nearly 2 billion square feet by 2018, up from just over 1.8 billion square feet in 2013.³ And construction spending on data centers is expected to grow at a compound annual growth rate of more than 10 percent between 2015 and 2019.⁴

The projected growth in the number and size of data centers worldwide is being driven by several factors. For one, more enterprises are opting to outsource essential IT services to third-party service providers in order to fully leverage current technologies and to reduce the need for future infrastructure investments. Larger data centers expressly designed to handle significant volumes of traffic with minimal downtime are also essential to support cloud-based services, including IT processing and storage capabilities. And the emerging Internet of Things (IoT) is expected to lead to nearly 20 billion connected devices by 2020,⁵ further driving the demand for IT infrastructures that can support data collection and exchange activities.



The Cost and Consequences of Data Center Outages

The increased dependence on IT capacity will drive the growth of data centers also highlights the cost and consequences that result from data center outages. In a 2013 survey of nearly 600 data center operators in the U.S.,⁶ 91 percent of respondents reported having experienced an unplanned outage within the prior 24 months, ranging in duration from 15 minutes to nearly seven hours. Industry segments with the highest average number of data center outages included organizations in healthcare and the public sector, with an average of 2.70 and 2.53 outages respectively during the survey's two year period.

Data center service outages have significant consequences for those directly and indirectly affected by them. In the above cited survey, the overall average cost for each unplanned outage was \$690,000 per incident, with actual costs ranging from \$74,000 to more than \$1.7 million. This estimate includes direct costs related to the detection and containment of an outage as well as the cost of recovery including equipment, etc. It also includes lost revenues and other consequences from business interruptions (lost business opportunities and brand and reputational damage) for an affected data center.

However, these estimates do not include the impact on those whose activities are dependent upon uninterrupted access to information maintained on servers in data centers affected by an outage. The following examples of recent data center fires serve to illustrate the scope of that impact:

- A fire reportedly sparked by an overheated computer server at a University of California Berkeley data center shut down operations in September 2015. The University's CalNet website server and WiFi service were reportedly down for more than 12 hours.⁷
- A major data center in Milan, Italy operated by Colt Technology went offline for about nine hours in July 2015, reportedly as a result of a fire attributed to the overheating of the building's power infrastructure. The company's data centers across Europe primarily serve financial service firms.⁸
- A June 2015 fire at a British Telecom data center in Belfast, Northern Ireland disrupted the data center's power supply, shutting down Internet service for a number of major government and state offices as well as many businesses and consumers for the better part of a day.⁹
- Operations at Office of Motor Vehicles locations throughout Louisiana were suspended for nearly 24 hours in May 2015 when a fire at the State Police data center in Baton Rouge that was reportedly triggered by an electrical panel short shut down all automated computer systems at the State's Department of Public Safety.¹⁰
- A transient voltage surge suppressor device in the state of Iowa's primary data center failed in February 2014, resulting in sufficient heat and

smoke that triggered the center's fire suppression system. The 16 hour blackout shut down state government's websites, email and communications services.¹¹

As these and other cases illustrate, data center outages attributable to fire and smoke can have significant consequences, even during outages of relatively short duration. While some may be merely inconvenienced as a result of an outage, others may be placed at significant risk, especially when the outage involves IT systems that support vital health and safety operations. In such cases, even a brief outage can have potentially devastating consequences.

NFPA 75 and Fire Protection, Detection and Mitigation in Data Centers

The design and construction requirements for data centers are unlike those applicable to many other commercial and industrial structures. Data centers require access to energy sources sufficient enough to power extensive arrays of computers and other electronic devices, as well as heating and cooling equipment required to maintain suitable environmental conditions. Adequate backup energy generating capacity is also required to provide uninterrupted power during outages. Fire protection and suppression technology is critical to minimize the potential loss of both IT equipment and data under fire conditions.

Originally developed in the 1960s, NFPA® 75, the Standard for the Fire Protection of Information Technology Equipment, establishes the minimum requirements for the protection of IT equipment and areas holding IT equipment from damage by fire and its associated effects, such as smoke, heat and water. The scope of the standard is comprehensive, detailing requirements regarding data center construction techniques, requisite fire detection and protection equipment, utilities and emergency and recovery procedures. The current edition of NFPA 75 (2013) also stipulates that IT equipment located in data centers be certified for compliance with the requirements of ANSI/UL 60950-1, the Standard for Safety of Information Technology Equipment.

NFPA 75 has been regularly updated since its original publication, with the latest edition released in 2013. Of particular note in the 2013 edition of the standard is the development of a fire risk assessment "that addresses the fire scenario or fire scenarios of concern, their probability, and their potential consequences." As such, the intent is that a documented fire risk assessment is an acceptable approach for determining the specific minimum construction, fire protection and fire detection requirements applicable to a given data center implementation. The fire risk assessment also serves as the basis for determining equivalent or additional requirements that may be applicable given the specific degree of risk.

Compliance of data centers with the requirements of NFPA 75 is generally mandated by reference in state and local building and fire codes. In most cases, this makes local building and fire code officials the authorities having jurisdiction (AHJ) in determining whether a given data center installation meets the requirements of the standard. In government installations, a government agency or department official may assume primary approval authority. In other circumstances, an insurance inspection department or related insurance company representative may be the responsible authority.

Failure to account for the requirements of NFPA 75 in the design and construction of a new data center can result in delays in the issuance of building or occupancy permits and facility insurance coverage, as well as potentially costly overruns in subsequent efforts to bring a non-conforming project into compliance. Failing to maintain ongoing compliance can lead to citations and other sanctions by AHJs.

An Overview of NFPA 75 Requirements

The 2013 edition of NFPA 75 consists of 11 chapters and five informative annexes. Chapters 4 through 11 of the standard detail the key requirements as follows:

- Risk Considerations (Chapter 4)—The 2013 edition of NFPA 75 permits the development and use of a documented fire risk analysis to determine the requirements applicable to a data center. Considerations regarding acceptable fire risk include:
 - Life safety aspects
 - Fire threat to occupants or exposed property
 - Economic impact from loss of function or records
 - Economic impact from loss of equipment

- Regulatory impact
- Reputational impact
- Redundant off-site processing systems

Section 4.2 of the standard applies similar fire risk criteria to telecommunications equipment used in support of private communications networks. (Requirements applicable to telecommunications equipment used in support of public communications networks are presented in NFPA 76, the Standard for the Fire Protection of Telecommunications Facilities.)

- Construction Requirements (Chapter
 5)—Chapter 5 of NFPA 75 details requirements related to the construction of data centers, including:
 - Building construction (5.1)—Specifies the use of fire-resistant-rated construction materials to separate the IT equipment area from other areas within a building, with a minimum fire resistance rating of not less than one hour. The fire resistant area must extend from the structured floor to the structured floor above, or to the roof. Openings must be protected to prevent the spread of fire and the movement of smoke, and doors must have a minimum resistance rating of 45 minutes.
 - Location of the IT equipment area (5.2)—Requires that IT equipment areas be positioned away from areas where hazardous processes are conducted. Also requires that access to IT equipment areas be restricted to authorized persons.

- Equipment area interior construction materials (5.3)—Specifies the minimum acceptable class ratings for interior wall, ceiling and floor finishes in both fully sprinklered and non-sprinklered IT equipment areas, as defined in NFPA 101, Life Safety Code.
- Raised floors (5.4)—Requires
 that both decking and structural
 supporting materials for raised floors
 be made of noncombustible material.
 In addition, floor decking must
 consist of pressure-impregnated,
 fire-retardant-treated material
 with a maximum flame spread
 index of 25, per ANSI/UL 723, the
 Standard for Test for Surface Burning
 Characteristics of Building Materials.
- Openings and penetrations (5.5)— Windows or pass-throughs located in fire resistant walls must be equipped with an automatic shutter, service counter fire door or fire-rated window that deploys automatically when exposed to fire or smoke. Such shutters, doors and windows must have a fire-resistance rating at least equal to that of the wall in which they are located. Cable and other penetrations must be firestopped with a material that has a fire-resistance rating at least equal to that of the barrier in which the penetrations are located. Finally, air ducts and air transfer openings must be equipped with automatic fire and smoke dampers.
- Aisle containment and hot air collar systems (5.6)—Specifies material requirements for both factory-

packaged and field-constructed systems, and requires that detection and suppression components within such systems be rated for the intended temperature of hot aisles at that location. In addition, existing fire detection and suppression systems must be evaluated and tested as necessary to maintain compliance with applicable codes and standards.

- Materials and Equipment Permitted in the IT Equipment Area (Chapter
 6)—States that IT equipment areas are expressly intended for IT equipment, and that storage of additional items, such as records and other potentially combustible materials, be kept to a minimum. Small work areas may be installed within the IT equipment area, provided that they are constructed of non-combustible materials and are not intended for full-time use.
- Construction of IT Equipment (Chapter 7)—Specifies that IT equipment

and replacement parts meet the requirements of ANSI/UL 60950-1, and be listed for the purpose. This section also specifies requirements for filters, liquids and acoustical materials associated with IT equipment constructions.

- Fire Protection and Detection Equipment (Chapter 8)—Addresses the requirements for fire protection and detection equipment, as follows:
 - Automatic fire protection systems

 (8.1) Requires that IT equipment
 areas and rooms be equipped with
 an automatic sprinkler system, a
 gaseous clean agent extinguishing
 system, or both. In certain cases,
 an automatic sprinkler system or a
 gaseous fire extinguishing system
 must also be installed below a raised
 floor. Sprinkler systems used in IT
 equipment areas and rooms must
 be valved separately from other
 sprinkler systems.



- Automatic detection systems

 (8.2)—Requires the installation of automatic fire detection equipment at both the ceiling level of the IT equipment area and below a raised floor housing cables. Smoke detection systems must also be installed to operate smoke dampers.
- Portable extinguishers and hose lines (8.3)—Requires the deployment of listed portable fire extinguishers, either carbon dioxide or halogen-based, to protect IT equipment. Signage must clearly indicate the type of fire for which each type of extinguisher is intended. Dry chemical extinguishers are not permitted.
- Gaseous agent and total flooding extinguishing systems (8.4)— Addresses requirements for gaseous agent and total flooding extinguishing systems in cases where such systems are deemed essential for protecting data, minimizing equipment damage and facilitating a prompt return to service.
- Water mist fire protection systems (8.8)—Details requirements for water mist fire protection systems where installed.

Additionally, Chapter 8 includes requirements for training IT equipment area personnel on the desired response to alarm conditions, the functioning of the alarm system, and the location of all emergency equipment, tools and extinguishers.

• *Records Kept or Stored in IT Equipment Rooms* (Chapter 9)—Chapter 9 addresses the protection and storage of vital or important records within the IT equipment room, as well as the offsite storage of duplicate copies of those records.

- Utilities (Chapter 10)—Chapter 10 stipulates requirements related to utilities, many of which are extracted from Article 645, Information Technology Equipment, of ANSI/NFPA 70, also known as the National Electric Code[®] (NEC). Specific requirements include:
 - Heating, ventilating and air conditioning (10.1)—Specifies the maximum permissible flame spread and smoke developed indexes for duct insulation and linings, including vapor barriers and coatings. Also requires that HVAC system dampers operate upon the activation of smoke detectors.
 - Coolant systems (10.2)—If required for the operation of IT equipment, coolant systems must be equipped with an alarm to indicate a loss of fluid.
 - Electrical service (10.3)—All electrical service wiring must comply with the requirements of NFPA 70, National Electrical Code. This section also specifies requirements for premise transformers, systems that protect against lighting surges, electrical junction boxes, emergency lighting, electrical wiring and optical fiber cabling installed in the air space above suspended ceilings, signal wiring and cabling, and electric power supply cords.

- Supply circuits and interconnecting cables (10.4)—Permits the interconnection of separate IT equipment with listed cables and cable assemblies. Requires the provision of a method to disconnect power to all electronic equipment in the IT equipment area or room, as well as separate method to disconnect power to all dedicated HVAC systems and equipment. This section also includes provisions for remote power disconnect controls.
- Emergency and Recovery Procedures (Chapter 11)—Requires the development of a managementapproved emergency fire plan, a damage control plan and a recovery procedures plan for continued operations. Each plan must be tested annually. In addition, data center operators must be able to provide the local fire department with information about the IT equipment in the data center, a current floorplan showing equipment placement, and strategies and tactics that are in place to address the risk of a fire incident.

The informative annexes included in NFPA 75 provide additional explanatory information about the standard's requirements and a list of suggested reference documents. The annexes also include a guide on how to address damaged equipment and magnetic media in the 24 hours immediately following an incident involving fire or smoke, and a separate guidance on the use of gaseous agent systems in IT equipment areas and rooms.

Anticipated Changes

NFPA standards are revised periodically, many on a three year schedule. NFPA 75 is no exception to this revision cycle, and work is currently underway on a revised version of the standard, expected to be published in 2017.

While details of the final standard are subject to modification, significant changes from the 2013 edition of NFPA 75 are anticipated. Most notable is the expected modification to the risk based approach that is currently outlined in Chapter 4. The 2017 edition of the standard is expected to provide users with the option of applying the specific requirements detailed in the standard (the so-called "prescriptive based approach") or conducting an independent risk assessment and developing a performance based design that will provide fire safety performance equivalent to that achieved with the prescriptive based approach.

Adopting the performance based approach is expected to require the use of a "licensed design professional with experience in fire protection" to develop a performance-based design that is "acceptable to the AHJ." This requirement is intended to set a minimum threshold of experience and skills for those individuals charged with the development of an effective fire risk assessment. The 2017 edition is also expected to give the AHJ the right to request a review of the design by an independent third party.

While these changes ostensibly provide greater flexibility in meeting the requirements of the standard, it is expected that most data center operators will opt to follow the prescriptive based approach, since it is likely to be a more efficient and cost-effective method for achieving compliance in most scenarios.

Finally, it is important to note that, once published, the 2017 edition of NFPA 75 must be incorporated by reference into existing state and local codes, or adopted by government agencies or insurance companies for its specific provisions to take effect. Therefore, the effective transition to the requirements of the 2017 edition of the standard may take several years or more, depending on the speed with which it is adopted in a given jurisdiction.

Recommended Methods for Improved Fire Protection in Data Centers

NFPA 75 provides an effective blueprint for the design and construction of data centers to minimize the risk of fire and its associated effects. Nonetheless, there are a number of additional actions that data center developers and operators can take to reduce the risk of data center outages attributable to fire. These actions include:

- Identify specific fire risks and evaluate their potential impact—A fire risk assessment should be an integral part of the data center design process. A thorough assessment conducted in advance can help to minimize delays and increased expenses incurred as a result of efforts to address non-compliant designs or unanticipated risks during the construction process
- Review equipment and systems for compliance—Assess data center systems and equipment for compliance with the requirements of the standard as part of procurement process. Even

more effective, stipulate compliance with NFPA 75-referenced standards as a condition of procurement.

- Consider modular designs Whether constructing a new data center or remodeling or expanding an existing center, using pre-approved modular systems and components can speed up the construction process significantly while providing the required level of fire protection. This approach using a pre-approved modular system already is an option permitted in NEC Article 646, Modular Data Centers.
- Perform periodic audits—Compliance with basic fire safety requirements can slip over time, particularly in connection with workstation furnishings and storage of non-essential media and records. Periodic safety compliance audits help to maintain prescribed levels of safety, and serve as a reminder to data center employees.
- Seek expert guidance An experienced, independent third party can provide valuable guidance in assessing the potential effectiveness of current fire protection efforts, and make recommendations for further improvements.

Summary and Conclusion

Data centers are an essential element in today's data driven economy, and data center outages can have major consequences for both data center operators and those who depend on continuous access to their information. NFPA 75 establishes requirements for the protection of data centers from fire, and compliance with the standard's requirements is mandated in most jurisdictions in the U.S. In addition to meeting the requirements of NFPA 75, data center developers and operators can also take other steps to help prevent data center fires from occurring and to minimize their risk.

UL has extensive expertise in the evaluation of products, equipment and materials used in data centers to protect against the risk of fire and its associated effects. UL has also published UL 2755, the world's first comprehensive certification document for modular data centers, helping to support the demand for flexible data infrastructure systems and equipment. For additional information about UL's services for data centers, systems and equipment, please visit UL.com.

References

- [1] According to one source, global data center IP traffic is expected to more than double by 2018, from just under 4000 exabytes of data per year to over 8000 exabytes per year. See "Global data center IP traffic from 2012 to 2018," Statista, 2015. Web. 8 July 2015. http://www.statista.com/ statistics/227268/global-data-center-ip-traffic-growth-by-data-center-type/.
- [2] "2013 Cost of Data Center Outages," Ponemon Institute, December

2013. Web. 8 July 2015. http:// www.ponemon.org/local/upload/ file/2013%20Cost%20of%20Data%20 Center%20Outages%20FINAL%2012. pdf.

- [3] "Worldwide Datacenter Census and Construction 2014-2018 Forecast: Aging Enterprise Datacenters and the Accelerating Service Provider Buildout," International Data Corporation, October 2014. Web. 12 October 2015. http://www.idc.com/ getdoc.jsp?containerId=251830.
- [4] "Global Data Center Construction Market 2015-2019," Technavio, March 2015. Web. 12 October 2015. http://www.technavio.com/ report/data-center-constructionmarket-global-report-analysisand-forecast-2015-2019?utm_ source=T4&utm_medium=BW&utm_ campaign=Media.
- [5] "Gartner Says 4.9 Billion Connected 'Things' Will Be in Use in 2015," press release from Gartner, Inc., November 11, 2014. Web. 12 October 2015. http://www.gartner.com/newsroom/ id/2905717.
- [6] "2013 Cost of Data Center Outages,"Ponemon Institute, December 2013.See Note #2 above.
- [7] "Small fire knocks out UC Berkeley's computers, WiFi," Berkelyside, September 19, 2015. Web. 15 October

2015. http://www.berkeleyside. com/2015/09/19/small-datacenterfire-knocks-out-cals-computers-wifi/.

- "Colt Data Centre Suffers Fire and Power Outage in Milan," TechWeek
 Europe, July 7, 2015. Web. 15 October
 2015. http://www.techweekeurope.
 co.uk/cloud/datacenter/colt-data centre-cloud-outage-171974.
- [9] "Fire in BT data centre leads to internet disruption," Belfast
 Telegraph, 25 June 2015. Web.
 15 October 2015. http://www.
 belfasttelegraph.co.uk/news/
 northern-ireland/fire-in-btdata-centre-leads-to-internetdisruption-31328504.html.
- [10] "Louisiana motor vehicle offices expected to be back on line by Friday after data center fire shut down transactions," The Advocate, May 21, 2015. Web. 15 October 2015. http:// theadvocate.com/news/12433402-123/all-louisiana-motor-vehiclesoffices.
- [11] "Most state computer systems back online after fire at data center," The Des Moines Register, February 19, 2014. Web. 15 October 2015. http:// blogs.desmoinesregister.com/dmr/ index.php/2014/02/19/most-statecomputer-systems-back-online-afterfire-at-state-data-center#.

©2015 UL LLC. All rights reserved. This white paper not be copied or distributed without permission. It is provided for general information purposes only and is not intended to convey legal or other professional advice. 12/15 NG 5101