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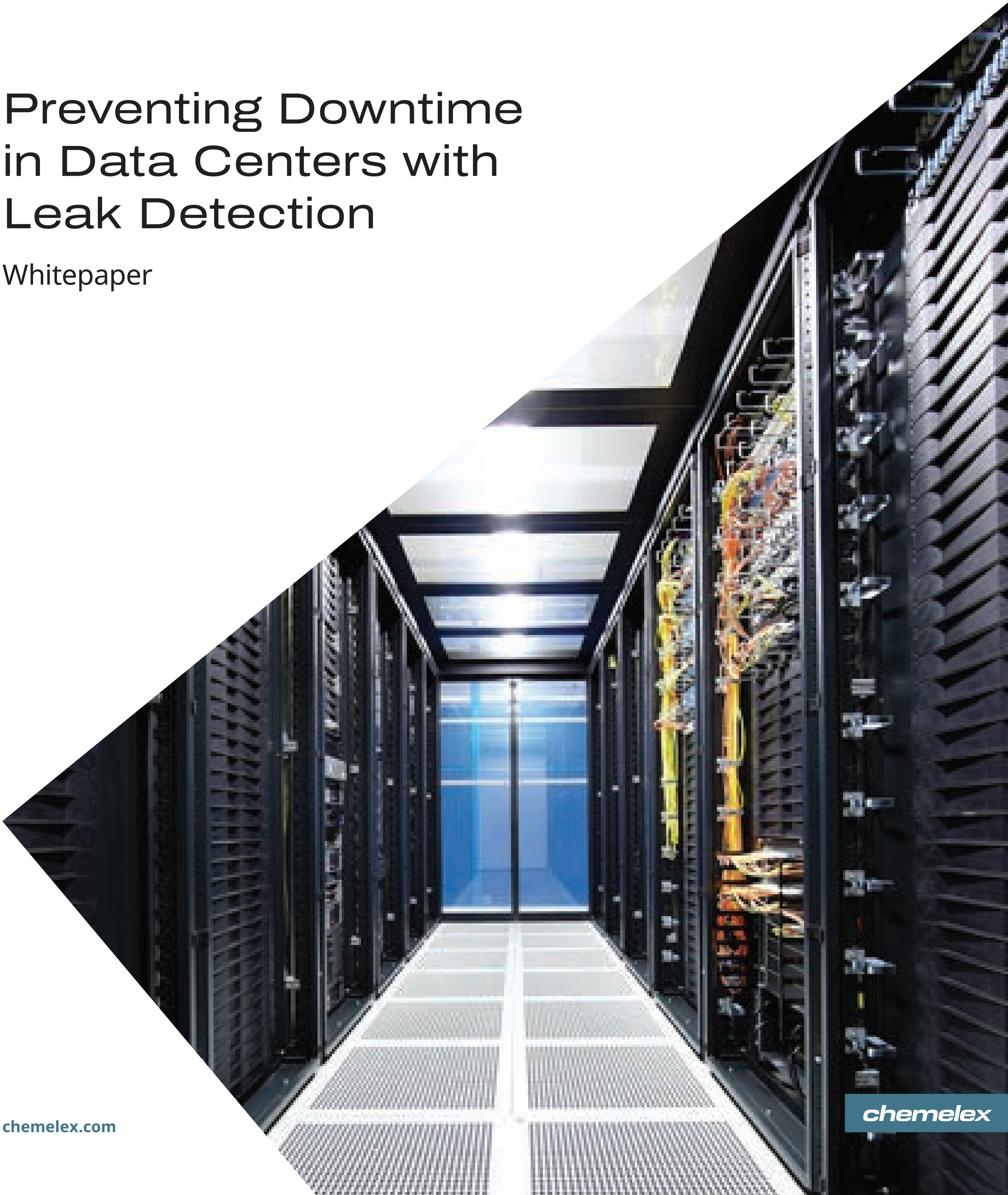
Preventing Downtime in Data Centers with Leak Detection

Whitepaper



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Abstract

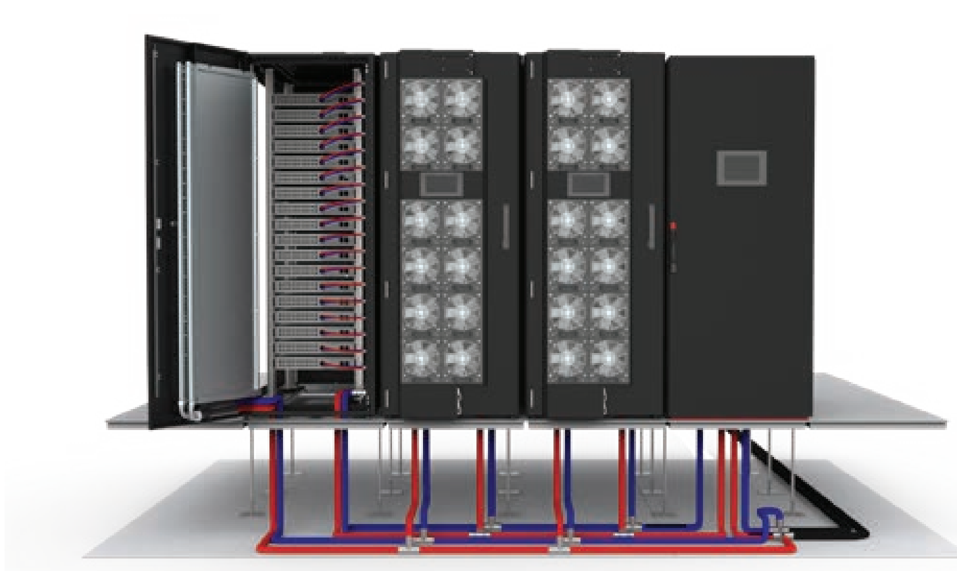
Data centers are designed to provide continuous uptime for mission-critical applications in nearly every aspect of business, commerce, and communications. Based on a 2021 survey of IT decision makers, is estimated that it costs roughly $84,650 per hour when an outage occurs and there is downtime. This is a 25% increase from the estimated cost of downtime at $67,651 in 2020. **1.** While most outages are due to on-site electrical issues; approximately 14% include computer room air conditioning (CRAC)/ cooling failures. **2.** Additional failures and outages from in rack and chip level cooling leaks is growing in significance as these technologies are becoming increasingly implemented.

Water damages in the U.S. alone cost insurance companies over $2.5 billion a year in claims. **3.** As data center sizes and computing power density have grown, the dependence on liquid cooled CRAC has likewise grown along with their added risk of liquid leaks. Fortunately, leaks can be easily identified before they cause serious problems or outages. Leak detection technologies include systems for water, chemicals and fuels all of which may be needed for data centers. This paper describes various methods of timely detecting, locating and communicating leak information so as to either prevent or minimize outages.

Index Terms

Leak Detection, Data Centers, Raychem TraceTek

Coolant Distribution Unit (CDU)



Cold Plate (Chip Level Cooling)

I. INTRODUCTION

Although they are rarely seen or thought of by the average individual, data centers are critical to nearly every aspect of our day to day existence.

Figure 1. Typical Data Center

Businesses rely on data centers for banking, manufacturing, selling and promoting products and services. Our communication systems use them for transmitting voice, data, and video. The world wide web and "the cloud" are vast interconnected collections of data centers used for countless transactions and uses. Apple's 1.3 million square foot Mesa data center is but one example of a massive fortress filled with seemingly endless stretches of servers and computer equipment. Similar data centers are used by Google, Amazon, IBM, and numerous other web dependent companies. These purpose-built facilities are specifically designed with security and leak detection and prevention in mind. However, many data centers are located in standard commercial buildings or retrofitted warehouses where their mission critical requirements may be challenged by unknown or less understood leak sources. In those cases, careful leak detection and prevention designs are that much more important.

Since data centers have a critical need to operate reliably 24/7 they depend on many forms of monitoring and backup systems. These systems generate significant amounts of heat, which in turn makes keeping them cool an important aspect of their operation. Multiple market research firms report that after 2020, the expected compound annual growth rate (CAGR) for data centers will exceed 10% for at least the next 5-6 years and that the market for cooling within data centers will grow even more strongly. The North American market for data center cooling alone is predicted to almost double over the next five years and currently represents approximately 40% of the global market as depicted in Figure 2.[4]

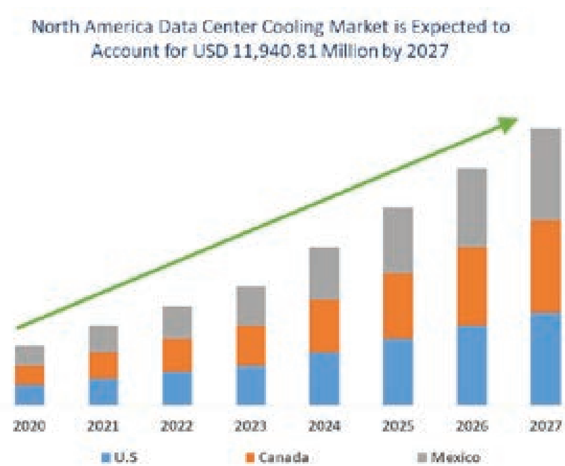


Figure 2. North America Data Center Cooling Market

The number of data centers is a major contributor to cooling growth. However, the demand for more and faster data using the same rack space is driving towards increased processor densities and speeds which further increase the resulting heat generation and cooling needs. Even with more energy efficient processors, cooling systems that previously relied on air have been shifting to liquid cooling technologies. Ironically, many of the old liquid cooling techniques used by mainframe computers decades ago are now being used for servers. Google, for example, uses a complex combination of air handling and chilled-water cooling coils to keep their data centers operating at the optimal temperature and humidity. As liquid leaks can play havoc with electronics, leak detection is critical for such systems.

II. LEAK DETECTION

A. Typical Leak Detection Systems

Besides data centers, leak detection systems have been used for a wide variety of uses in buildings for decades. Figure 3 identifies the wide use of leak detection systems used in commercial buildings.

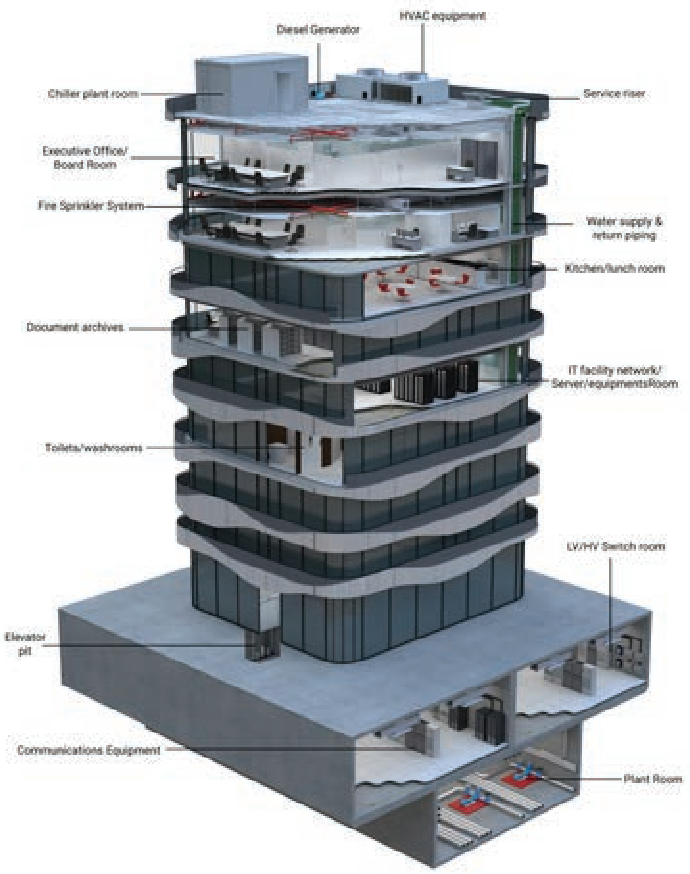


Figure 3. Typical Leak Detection in Buildings

In most cases, systems used to detect potential water leaks are located at or near possible sources such as HVAC equipment, lavatories, below ground foundations or basements, or water supplies. Additionally, leak detection may be used in critical parts of data center operations including server racks or rows of servers. Liquid chemicals or diesel fuel leaks in backup generator rooms may also be monitored for leaks. All of these systems are often integrated into the building management systems for coordinated alarm, location and maintenance services. Data rooms and data centers pose a wide variety of possible leaks such as:

- A/C cooling units
- Chilled water/refrigerant piping
- Server racks and rows of racks with liquid cooling
- Plumbing and condensate lines
- Drains
- Sprinkler systems and other overhead piping
- Roof and window leaks
- Seepage from foundations in below ground spaces
- Remote communication rooms or closets
- Backup battery acid leaks
- Diesel fuel leaks near backup generators

Most data centers cover a huge amount of floor space, operate 24/7, and are staffed with a small number of operating personnel. As such, timely location of a leak is just as critical as getting an alarm.

B. Point Sensors

Leak sensors are available in a wide variety of shapes and sizes. The simplest type include probe or point sensors. When used to detect conductive fluids such as water, acid, or caustic, the probes consist of two-point contacts which send a signal when the conductive fluid touches both points at the same time.

Figure 4. Example Point Contact Probes

Emergency generators are currently used in the majority of data centers for backup power. Leaks from generators or their fuel tanks are not only a significant fire safety hazard but a significant threat to business continuity. Many of these generators are located in basements or below ground where water or moisture may be present. A specialty probe for quickly identifying a fuel leak is shown in Figure 5. This probe is designed to ignore water but identify fuel leaks including films floating on top of water. Such detectors comply with performance standards outlined in Factory Mutual Standard FM 7745.

Figure 5. Example Fast Fuel Sensor

C. Cable Sensors

Although probes and point sensors are reliable and effective at detecting fluids, a big issue is identifying where to put them. In drainage areas, drip pans or small confined spaces, they can be very cost effective. However, when the leak source is less well defined or difficult to predict such as along pipes, drains, or under raised floors, cable sensors are more effective.

Again, cable sensors come in a variety of types for different applications such as detecting water, acids, caustic, and other aqueous chemicals. Figure 6 includes examples of cable sensors.

Figure 6. Example Cable Sensors

A unique feature of some cable sensors is the ability of not only identifying that a leak occurred, but to accurately determine where along the cable the leak occurred. For example, when used under a raised floor or within a server rack as illustrated in Figure 7, a leak touching one portion of the cable would trigger the monitoring electronics to identify which specific floor tile or rack position to investigate.

Figure 7. Example Leak Detection Cable Under Raised Floor

D. Leak Detection Monitoring Units

Leak detection sensors can be connected to numerous types of monitoring devices. The simplest monitor connects to a single probe or cable and provides an alarm as soon as it detects a leak. These types of modules do not locate the leak but usually include a switching relay for on/off control of a pump or valve to stop the leak.

Figure 8. Non-locating Single Alarm Module

Other module types include modules that connect multiple cables, probes and other sensors and include detection and full location capabilities. A wide variety of user interfaces are also available. In most cases, these modules are connected to Building Management Systems (BMS) or similar instrumentation or security monitoring systems. Many of these modules can be programmed to take immediate action such as shutting off power or turning off a liquid flow valve to minimize damage and safety hazards.

Figure 9. Locating Alarm Modules

III. DATA CENTER LEAK DETECTION GUIDELINES

Data center designers and facility managers are often faced with decisions on where and how to protect against leaks. A few key guidelines can be followed:

- Assess where and how leaks can occur.
- Identify types of leaks
- Decide if point or cable sensing is needed
- Decide type of action needed when leak is detected

A. Where and How Leaks Occur

Predicting where and how leaks occur requires a thorough examination of the data center facility. The most obvious sources are those at, near or for the servers and computer equipment such as the server specific cooling equipment, HVAC, cooling fluid distribution piping, and under raised floors. However, less obvious sources may be weather related or due to faulty piping such as sprinklers, roofs, windows, lavatories, drains, or electric generators. Leak sources should be protected from the most likely sources with special emphasis on protecting sensitive area.

B. Types of Leaks

Leaks from water, caustic chemicals, and hydrocarbons are easily detectable but may require special sensors. Assess the types of leaks and the likelihood of threats.

C. Point or Cable

Designers often assume that they know exactly where the leak will occur or how it will flow. With proper designs of drip pans and drainage, point sensors can prove to be inexpensive and effective. However, as their name implies, they can only detect leaks at a single point. On flat surfaces, for example, fluids leaks may go around the point sensor without detection. Again, careful assessment of leak source and likelihood of occurrence may lead to cable type detection especially along pipes, under raised floors or areas where the source is less well defined.

D. Type of Action

Most leaks require some form of alarms. Where and how to alarm, acknowledge, and act must be considered for each type of leak. In many cases, a simple localized alarm is sufficient. In others, sending alarms along with location information needs to be sent to a centralized BMS or control room. At the same time a local user interface may be required. For example, if there is a leak under a raised floor, the leak alarm would usually be sent to a central point for local dispatch of someone to investigate and repair. In the data room, a graphical interface which displays precisely where the leak was detected and which floor panel to check under would greatly simplify the investigation. For some leaks, immediate action such as cutting off the source can be automated such as using a solenoid valve to turn off a water leak in a lavatory. In others, turning off the source may not be possible or provide other dangers such as cooling systems or sprinklers and should instead have an escalated alarm priority. In all cases, a carefully designed response plan must be created for each type of leak so that the response team can react timely and properly.

IV. CONCLUSIONS

The rapid deployment and reliance on data centers has resulted in the need for multiple safeguards and levels of redundancy to monitor, protect and maintain their integrity. Unplanned outages can still occur. Water, heat, cooling system failures, air conditioning failures, backup generator failures and weather are significant sources of unplanned outages. Liquid leaks from these types of events are often the cause. Fortunately, leaks can be easily identified before they cause serious problems or outages. Leak detection technologies include systems for water, chemicals and fuels all of which may be needed for data centers. A comprehensive solution that can detect and locate all types of leaks in all types of locations is necessary. With proper assessment of the potential sources and types of leaks, designers and facility managers can design leak detection and action plans to minimize the risk of occurrence and downtime for repair.

[1] Data Protection Trends Report, Veeam, 2021. [2] Data Center Industry Survey Results, Uptime Institute, 2021. [3] On Water Damage in the US: Statistics, Categories, and Prevention Tips, United States Adjusters, 2017. [4] North America Data Center Cooling Market – Industry Trends and Forecast to 2027, Data Bridge, 2020.

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