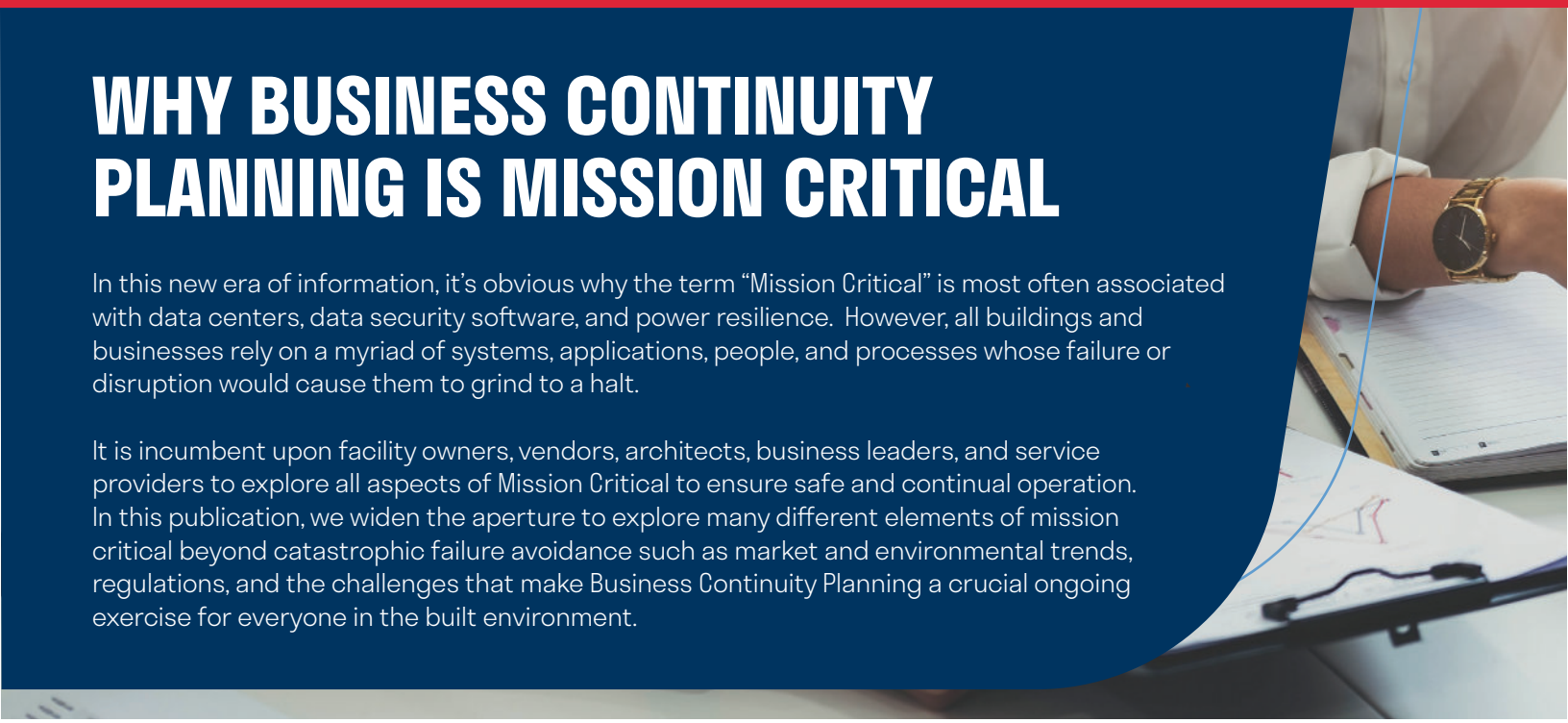
WHY BUSINESS CONTINUITY PLANNING IS MISSION CRITICAL



In this new era of information, it's obvious why the term "Mission Critical" is most often associated with data centers, data security software, and power resilience. However, all buildings and businesses rely on a myriad of systems, applications, people, and processes whose failure or disruption would cause them to grind to a halt.

It is incumbent upon facility owners, vendors, architects, business leaders, and service providers to explore all aspects of Mission Critical to ensure safe and continual operation. In this publication, we widen the aperture to explore many different elements of mission critical beyond catastrophic failure avoidance such as market and environmental trends, regulations, and the challenges that make Business Continuity Planning a crucial ongoing exercise for everyone in the built environment.

INTRODUCTION

There are many variations to the definition of Mission Critical, but most describe it as being a component of business operations whose failure or malfunction poses a direct and immediate threat to the achievement of an organization's objectives and could result in financial losses, damaged reputation, and even the loss of life.

And yes, it's impossible for Data Centers to not steal the spotlight when it comes to the topic of Mission Critical. Data centers are projected to account for 8%-9% of US power consumption by 2030, up from 3% in 2022. Some aggressive estimates are much higher. That explosive growth absolutely merits exploration, along with changes being driven by AI, sustainability, and cooling technology which will also be examined.

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Equally important in providing an expansive view of Mission Critical are matters such as: HVAC and Electrical infrastructure, Safe Work Practices, preventative maintenance, code compliance, regulation and availability of resources, and proficiencies that all stakeholders must employ to keep everyone safe, protect their brand name, and maintain business continuity.

OVERVIEW

In addition to catastrophic failure prevention, it is important first to highlight the external factors businesses must continually research and use to maintain an agile business model. They are experiencing more pressure than ever before due to an ever-changing mix of economic, environmental, and regulatory factors. Market and real estate competition, inflation, rising utility rates, supply chain issues, consumer habits, energy and environmental mandates, exponential advances in technology, more frequent and intense natural disasters, and shortages in skilled labor and resources like power and water are just a few. A properly managed business that is aligned from top to bottom will create and follow a road map to navigate this labyrinth of change. But with all the moving pieces, continual learning requirements, distractions, and fierce competition for funding, the risk of something being overlooked can easily lead to gaps in business continuity.

Data Centers – The Poster Child for Competition and Technology Advancement

To illustrate the impact that rapid change and complexity can have on mission critical facilities, let's look at the 20-gigawatt elephant in the room… data centers. This is one of the fastest growing markets in the world due to cloud adoption, artificial intelligence, and social media. Revenue in the data center market size is projected to be $99 billion in 2024 and reach $124 Billion by 2028, a CAGR of 5.88%.

A Statista report from March 2024[1] states the US has more than 5,300 data centers, more than any country worldwide (followed by Germany with 521). The average data center is 100k square feet and runs 100k servers. The largest in the U.S. is the Meta Platforms (Facebook) at 4.6 million square feet in Oregon (Meta has 14 total, spanning 34.2 million square feet).

According to a Data Center Frontier article[2], 120–130 hyperscale data centers are expected to come online in the United States each year. Synergy Research also reports[3] that 440 hyperscale data centers are in various stages of development.

Geography can have a great impact on data center location selection due to the cooling needs of the equipment. In some parts of the country, the ambient air temperature can be utilized to provide free cooling and is available for a large portion of the year, reducing the energy required from cooling equipment. A great example is happening in the city of Hillsboro, Oregon. Often referred to as the "Silicon Forest", it is a major technology hub with inventory growth of 334% between 2020 and the second half of 2023 partially due to the possibility of 10 months of free cooling via water-side economization.

This growth in data center quantity is only part of the story. A single data center can use as much energy as 50,000 homes, and the power intensity of data center racks is increasing exponentially due to the demand for more robust computing analysis, AI, and adoption of graphics processing units (GPUs). As stated by AFCOM[4], average rack densities have climbed from 7 kW in 2021 to 12 kW today, with some reaching over 100 kW per rack due to the rigorous demands of AI model training. For example, the IEA's "Electricity 2024" report[5] states that a simple Google search would require 0.3 watt-hours compared to 2.9 watt-hours for ChatGPT to respond to a user prompt. Considering 9 billion searches daily, this would require almost 10 TWh of additional electricity in a year.

The transformation and expansion of the data center market is driving increased focus and evaluation of Mission Critical design and maintenance. It is forcing the evaluation of new cooling technologies, power and water use and scarcity, sustainability, and unplanned downtime elimination.

Power / Water / Sustainability / Technology

This increase in rack density creates an enormous cooling demand as well. In most commercial buildings, the Energy Use Intensity (EUI) is a main efficiency benchmarking term, listed in kBtu/sf. In data centers, Power Usage Effectiveness (PUE) is used to determine what portion of total energy is used by the IT equipment itself (PUE: (IT kWh +Total Cooling kWh) / IT kWh). A perfect score would be 1.0, meaning no other energy is needed outside of the IT equipment itself.

Some of the largest players such as Google, Yahoo, Microsoft, and Facebook have reported PUE's in the range of 1.07 to 1.2, which is very efficient. A 2023 survey[6] from the Uptime Institute lists the average as 1.58. The National Renewable Energy Laboratory (NREL)[7] estimates the overall average to be around 1.8.

Regarding regulatory changes, the government's Data Center Optimization Initiative (DCOI) requires all existing federal tiered data centers to maintain a PUE less than 1.5, with all new sites mandated to maintain a PUE less than 1.4. There will likely be more scrutiny and mandates rolled out in future years as the energy footprint of data centers continues to expand.

In addition to using about 10 times as much electricity per square foot as most commercial buildings, the average data center also uses around 300,000 gallons of water per day (equivalent to 1,000 homes) for humidification and cooling to prevent equipment from overheating. That introduces another common metric, Water Usage Effectiveness (WUE), the ratio between the use of water in data center systems and the energy consumption of IT equipment. A lower score represents an efficient use of water resources.

The WUE average is 1.8L per kWh (roughly ½ gallon). A 1MW data center can use the equivalent of 100 Olympic-size swimming pools of water per year. In 2022, Google's data centers consumed 5.6 billion gallons of water, up 20% from 2021.

Because data centers utilize so much power and water (with about 43% of electricity used for cooling), the HVAC industry must continue to innovate and push the boundaries of efficiency to stay competitive and guarantee uptime. The transformation of IT infrastructure and power requirements are forcing the development of disruptive technologies as well. Forced-air applications may no longer be practical for the steep escalation of data center thermal power levels, and some estimates state up to 38% of enterprises expect to use some form of liquid cooling and immersion cooling, which according to Data Center Frontier[8] can reduce data center OPEX by over 90% and reduce CAPEX costs by more than 50%.

And while cooling technologies may reduce PUE and carbon, they can have a negative impact on WUE. The advancement of cooling technology will bring many challenges. Where hesitancy exists in bringing water to the rack, power density limitations will arise.

Balancing the intertwined factors of energy and water usage effectiveness will increase in significance, and additional system complexity will also necessitate continuous education of facility and vendor technicians.

Technology advancement and sustainability are unquestionably critical in supporting our country's energy path. With the push for electrification of HVAC and vehicles, the growth of data centers and computing power consumption, aging grid infrastructure, and rising utility costs, the topics of power availability and water scarcity are becoming increasingly important and relevant. Areas that experience water and power shortages may not be able to support demand, impacting ongoing operation and long-term survival of some businesses. This can also impact real estate pricing, zoning, regulations, and the cost of conducting business.

As of July 2, 2024, 18.67% of the lower 48 states are in drought, according to the U.S. Drought Monitor. These unpredictable trends can have a major impact on data centers that are large consumers of water. In an article by the Lawrence Berkeley National Laboratory[9], it is estimated that 20% of data centers are served by moderately to highly water stressed watersheds.

Water scarcity has a direct impact on electricity generation capacity as well, since power plants consume an average of 11,857 gallons of water per megawatt-hour of electricity produced. Responsible water consumption must become a focus as the upward trajectory of power generation needs continues to climb. While power demand growth has averaged 0% over the past decade, a report published by Goldman Sachs[10] projects 2.4% CAGR in US power demand through 2030 (with data centers contributing 90 bps) and estimates that utilities will need to invest $50 billion in new power generation capacity to support that growth.

Not only do generation projects take years to complete, of material concern are also the lengthy interconnection queues that delay new projects from connecting to the grid. Additionally, natural gas transmission infrastructure construction and permitting is seeing an average lag of 4 years, meaning any additions announced today would not be in service until 2028. This creates bottlenecks in grid expansion and can be exacerbated in some locations.

For example, Eastern Loudoun County in Northern Virginia is known as "data center alley" and has more data centers than the next five biggest markets in the US combined. The local utility, Dominion Energy, had paused connections for new data centers until it could resolve concerns about transmission constraints. As power requirements increase with the growth of AI, generation and transmission will likely become a common bottleneck issue for utilities and data center owners across the country, putting pressure on facilities to implement on-site generation, renewables, and participate in demand response programs, something not traditionally common to data centers.

The voracious utilization of power and water is causing sustainability to quickly become a mandatory component of conducting and expanding business, and that is especially true for data centers. Since Scope 1 and 2 emissions of a datacenter facility are the Scope 3 emissions of its clients, sustainability has become a lever to attract and retain clients. And with financial institutions as both clients and capital providers looking for "green" investments, data centers that are not focused on sustainability could lose clients, pay higher rates, carbon taxes, or in extreme instances be forced to shut down operation.

Proof of this can be seen in the U.N.'s Principles for Responsible Investment, launched to influence investors to incorporate ESG into their decision-making process. There are over 3,800 voluntary signatories with over $121 trillion assets under management.

According to the AFCOM State of the Data Center 2024[11] survey, more than 50% of all data centers plan to implement solar and more than 25% are adding wind. Others are looking at nuclear, hydrogen, geothermal, and battery energy storage systems (BESS). There are data center projects being developed with on-site modular reactors and hydrogen generation, and other campuses are being collocated with existing nuclear power plants. And developments like the passing of the ADVANCE Act in June 2024 will only serve to expedite growth in new energy solutions. This Act focuses on streamlining the regulatory process at the Nuclear Regulatory Commission (NRC), supporting the development and deployment of new nuclear technologies, and strengthening the domestic nuclear supply chain.

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Downtime, Utility Failure, and Resilience

Uptime Institute's Tier Standards are the globally recognized standard for data center availability and overall performance. It allows for various performance levels that consider both the built environment, as well as the approach and performance of the operations team.

- **Tier 1:** 99.671% Uptime (28.8 hours/year downtime)
- **Tier 2:** 99.741% Uptime (22 hours/year downtime)
- **Tier 3:** 99.982% Uptime (1.6 hours/year downtime)
- **Tier 4:** 99.995% Uptime (26.3 minutes/year of downtime)

Downtime metrics like Recovery Time Objective (RTO) and Recovery Point Objective (RPO) are critical in assessing the impact of downtime on operations.

While not 100% applicable to all facilities and systems, a similar approach should be taken by every business continuity team to determine the allowable duration and impact of downtime. For some facilities, it may be based on available battery storage, for others it may be in terms of lost units of production, revenue, etc.

With data centers in particular, the staggering cost downtime helps illustrate why performance standards have been formalized. According to a report[12] by the Uptime Institute about their 2023 data center survey, more than half (54%) of the respondents to the 2023 Uptime Institute say their most recent significant, serious or severe outage cost more than $100,000, with 16% saying that their most recent outage cost more than $1 million. Other articles estimate that Amazon lost $1,100 per second in net sales during a 2013 outage, or $66,000 per minute. Current calculations estimate a 1-minute outage would cost Amazon as much as $220,318.

For data centers that rely on water-cooled chiller plants or evaporative coolers, city water typically supplies water to the "critical" make-up water systems. Most of these sites have provisions for the potential loss of city water by installing make-up water storage tanks, tanker truck connections, or wells (or a combination of all the above). These provisions can facilitate long-term continuous operations of the chiller plant without reliance on city water.

Backup power can come in the form of fuel-powered generators, which is the most common resilience method deployed among most facilities. However, the BESS market is expected to see a CAGR of nearly 20% through the end of the decade. Speaking of batteries, due to the sensitivity of IT infrastructure to power quality, data centers have a large uninterruptible power supply (UPS) system, that consists of many batteries, some over 1 million batteries, in fact. These systems provide redundancies, and along with proper equipment maintenance are paramount to avoiding downtime.

Disaster Recovery

Any commentary about business continuity would be incomplete without the mention of disaster recovery planning, because not all events are preventable. And none are more important to plan for than natural disasters. Changing weather patterns are driving an increase in the frequency and intensity of natural disasters. All critical departments and functions should engage in disaster recovery planning and know what to do when natural disasters or other extreme events such as fires, broken pipes, and severe injuries occur. Emergency operating procedures (EOPs) should be in place to allow safe isolation of faults and restoration of service. Incident management plans should outline a process for maintaining contact information and status communication, creating remote working plans, evacuation and mustering plans, and include training and emergency drills.

The goal is for everyone to know what steps to take to minimize the impact. This could include knowing how to locate and operate shutoffs and specialty suppression equipment and contacting local authorities. And since many businesses rely on critical IT infrastructure and data, a plan detailing data recovery and application restoration is crucial for restoring operations.

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Common Systems and Failure Modes

As Benjamin Franklin once said, "An ounce of prevention is worth a pound of cure." Regarding the complex systems in today's facilities, the challenge is to know exactly how to measure the proverbial "ounce" and exactly what a "pound" would cost. Below are some common systems that should be evaluated and maintained with vigilance to protect business continuity and some strategies that should carry more "weight" in the decision-making process.

Electrical

Electrical infrastructure arguably poses the greatest threat to human life of any facility system, but nearly all risks are preventable. Yet 30,000 non-fatal shock incidents and 1,000 deaths occur annually in the U.S. due to electrical injuries. Even non-fatal electrical injuries typically involve three days away from work, with the potential for more downtime if an investigation is required. This has led to more strict regulations from the National Fire Protection Association (NFPA), including standardized maintenance, testing, and potential fines as defined by its National Energy Code® (NEC®), NFPA 70®.

For example, NFPA 70B® was changed in January 2023 to provide enforceability for what must be done for electrical equipment maintenance. Non-compliance can lead to downtime, OSHA® involvement and hefty fines ($16k per violation and $161k for repeat violations), and possible loss of life where lawsuits and settlements can reach $5M - $10M or more.

Many people think electrical infrastructure is "set it and forget it". While it may continue humming along for many years, that humming is caused by the alternating flow of electrons that causes vibration and leads to heat, harmonics, and loose connections.

To prevent catastrophic events and costly downtime, safe work practices must be implemented, and electrical equipment maintenance and arc flash studies must be carried out properly and in a timely manner. A proactive approach would also include digitization of switchgear and circuit protection, providing real-time condition trending and alerting while reducing unnecessary exposure to energized systems.

Downtime due to electrical equipment failure can extremely expensive. Beyond the potential it carries to result in crippling fines, equipment lead time in the electrical industry is often the most extreme. Lead times can exceed 1 year switchgear 2 years for transformers, and 4 years for utility-scale equipment. Due to the demand and projected deficit of copper due to disruptions in mining and the green energy transition, some projections on the price of copper are as high as 75% by 2025. And with more than 60 countries backing a plan to triple global renewable energy capacity by 2030 at the COP28 climate change conference, the pressure on copper will continue to escalate, causing extended lead times and higher cost. It appears that Ben Franklin, known as "The Newton of Electricity", was spot on with his "ounce of prevention" aphorism.

HVAC

HVAC is a vital component of business operation in most cases. While some buildings and spaces can continue operations for extended periods of time, many have equipment that is sensitive to heat and humidity, and others are occupied and require minimum indoor air quality.

While electrical equipment maintenance may be an unknown need to some, nearly everyone whose occupation is related to the built environment is aware that mechanical equipment and moving parts have a useful life that deteriorates quickly without proper maintenance. And some operational strategies such as free cooling rely heavily on effective heat exchange and will be hindered by poor maintenance practices.

Yet HVAC maintenance is often one of the first budgets to be cut. Not only does HVAC normally consume 40% of a facility's energy and efficiency suffers with deferred maintenance, it's estimated that every $1 of deferred maintenance will result in $4 of future capital cost. Additionally, failure can result in a cascading chain reaction that impacts electrical, IT, and other systems.

As with specialty electrical equipment, some commercial HVAC can take a year or more to acquire and install. Without redundant backup equipment, businesses may have to bring in rental boilers chillers, etc. that require utility connections for power and water, resulting in financial impacts and additional downtime.

And while preventative maintenance is a cornerstone of business continuity planning, many faults and signs of impending failure may not be uncovered in deteriorating equipment through routine inspection tasks. For equipment with high operational significance, regular or continuous vibration monitoring, infrared thermography, and data analysis should be utilized, and intelligent IoT field sensors that can detect changes in vibration, amperage, temperature, and other parameters should be deployed as part of a proactive and predictive strategy to detect and prevent potential failure.

Fire / Life Safety

In addition to sprinkler systems and fire alarm systems, whose testing and inspection are governed by NFPA 25® and NFPA 72®, respectively, many facilities have specialized equipment whose failure could be detrimental to business continuity if not properly designed and maintained.

Data centers are a hot topic in the fire industry due to their need for UPS Systems. These power backup systems can be sized to provide ample power supply to allow systems to properly shut down without damaging components or result in the loss of data. They can also protect against power surges, blackouts, brownouts, and other interference. Or they can get sized to provide longer-term operation.

As energy intensity increases in data centers, technology will be needed to provide new levels of capacity and reliability. One technology that is the center of much debate is the lithium ion (Li-ion) battery. It is estimated that Li-ion batteries will account for 30% to 40% of data center UPSs by 2025, and potentially higher in hyperscale operations. Though Li-ion batteries have impressive performance, longevity and a smaller footprint than other battery types, they also come with a serious risk of fire. In an article published by the Uptime Institute titled "Ignore Li-ion Fire Risks at your Peril[13]", one common issue for operators is a mismatch between a fire suppression agent and the type of fire. Many UPS vendors admit that a fire suppression system tailored to the specific installation is left solely to the customer, and the Uptime Intelligence claims to be aware of multiple battery room fire suppression systems that are inadequate for tackling a Li-ion fire, on non-existent. As competition for battery solutions grows and prices fall, it is important for businesses to fully understand the risks that cost-cutting by manufacturers may present. That is because manufacturing faults are one of the causes of Li-ion battery fires. The UL 9540 standard, originally designed for energy storage systems (ESS) used in grid balancing, is now being cited in relation to the UPS systems used in data centers. It places requirements on equipment spacing to prevent the spread of any fire, which may negate the space-saving benefits of Li-ion batterie and pose a problem for businesses that need to expand to stay competitive or retrofit spaces to handle the increased energy intensity of new IT infrastructure.

It could also drive data center designs to utilize alternative backup systems such as flywheel energy storage systems (FESS) that do not require a temperature-controlled environment, reduce fire risk, can require 50% less space, and further improve energy efficiency due to more sustained efficiency at lower load conditions. For example, a study by Silicon Valley Leadership Group (SLVG) showed that moving to a 97% efficient flywheel system at Yahoo! sites would reduce UPS energy costs by more than $822k annually, an 80% reduction in compared to batter-based systems. However, all systems present safety challenges and FESSs are no exception.

Becoming Mission Ready

In addition to keeping up with current events, technology advances, and possible changes that can impact business, there are many areas where experts stand ready to support business continuity planning. Here are a few ways your business can remain proactive and vigilant, mitigate risks and gain confidence around all things Mission Critical in your facilities.

Emergency Preparedness Planning: Consult with experts and authorities to build a disaster recovery plan and deploy proper training. What do you do in the case of a fire? What if there's a large leak? Do you know where water and fuel shutoffs are located and who to call?

Application Recovery Planning: Know what redundancy systems and processes are implemented by vendors of online applications. Current studies show inadequate testing of full site failover and failback capability. Establish and regularly test applications used in daily operation to avoid data loss.

Facility Condition Assessment: As facilities age, the blind spot grows and too often projects are placed on the back burner that can have real consequences. Conducting a thorough assessment of all systems and equipment will document and bring to light the age, remaining life, and condition of mission critical assets while identifying manual changes, like running VFDs in hand mode, that are preventing operating sequences from working properly.

Maintenance and Inspection: Stay compliant and prevent degradation, failure, and life-threatening events through a proactive equipment maintenance and monitoring program by scheduling and verifying maintenance tasking, deploying sensors, and monitoring trends where applicable. Make sure all systems are tested and inspected per code. It is the business's responsibility to ensure compliance or verify the building owner is meeting code.

Equipment Redundancy and Inventory: Identify specific equipment and components that may have long lead times on replacement parts so inventory purchases can be prioritized. Ensure backup power is tested for functionality and avoid reactive processes for backup heating/cooling via temporary rental planning or redundant unit installation.

Cross-Train the Team: This can include financial education for Plant / Facility Managers and technical training for Finance Managers / Decision Makers. This is a widespread issue in businesses across the country that often results in risks not being weighted properly and resolved. Key stakeholders must be able to speak a common language so nothing is lost in translation and Facility Managers' efforts aren't dismissed. Fully understanding how to define, assess, and communicate risks associated with mission critical systems is the only way to expose and eliminate hazards and effectively leverage the team's technical expertise. Once that connection is solidly made, they can often find a champion within the executive or financial ranks. This is a fundamental change that needs to occur as a standard part of any capital or project approval and maintenance proposal review process to make sure "first cost" is not the main driver, but business continuity.

Mission Possible

The world is rapidly changing, not only with technology and regulations, but with the workforce. Facility and business teams must keep their eyes fixed on business continuity by bulletproofing existing systems for constant uptime. Simultaneously, they must monitor developments across all aspects of the built environment to future proof their business and strategies. A major benefit of this being the age of information is the availability of abundant studies, research papers, and experts in every field they will encounter in their mission critical journey. Regardless of your business model, the activities you conduct, or the facilities and systems you operate, it is entirely possible to build a solid team of internal and industry experts to reach your mission critical goals.

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