AutoStore

Innovation Hub

TESTING FOR THE FUTURE

Product Safety



Think Safe, Work Safe, Be Safe

This booklet is intended for general information purposes only to increase overall safety awareness. The information contained in the booklet should not be considered exhaustive. The user of the AutoStore system has the full and sole responsibility at all times to ensure that the system and all its parts is used safely, in accordance with its intended purpose and in accordance with relevant law, safety protocols and rules.

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Safety has always been paramount at AutoStore. Ensuring the safety and well being of employees, products, and our systems in automated warehouses is absolutely crucial, which is why we've tested every system since our company began. The regimen of tests we perform covers every potential safety risk associated with operating an automated warehouse, including electrical, fire, seismic, cybersecurity, temperature-controlled environments, as well as the impact of natural disasters on stock and operations.

Beyond these comprehensive safety measures, we are also very focused on full compliance with applicable standards, from local to international. This adherence to standards starts from new product development through manufacturing to implementation. AutoStore systems are tested to not only ensure top performance, but also to comply with safety regulations across various governing bodies. For example, AutoStore has an approval process covering various aspects of its product range in 19 different areas. And we don't stop there. Compliance is an essential and core component of our work, which is why we will continue our laser-like focus as new technologies emerge.

Equally important, certifications are another vital component of the work we do at AutoStore. It is imperative that all AutoStore products be tested, approved, and certified by accredited agencies. We don't just expect you to take our word for it, which is why all certifications are done at third-party labs, ensuring that our systems meet the high level of quality that we and our customers expect.

We're passionate about safety and we believe that the best way to ensure a safe working environment for all is to share candid conversation. At AutoStore, we are transparent about the work that we do – the door is always open. Our dedication to the quality of our systems is rivaled only by our emphasis on product safety, and that is something that will not change.

- Mats Hovland Vikse

CEO, AutoStore



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Introduction





Product safety is something no business owner can overlook. At all stages in the product lifecycle – from manufacturing to distribution and selling – it is extremely important to ensure that your products are safe, your employees are safe, your warehouse is safe, and that you and your business are protected against any and all potential hazards and pitfalls.

At AutoStore, our focus is mainly on warehouse automatization. It is of the utmost importance that government regulations are not only fulfilled but that there is constant room for improvement in an industry that is continuously shifting and growing.



A Note on Workplace Safety

While this book does not deal directly with general workplace safety, we feel it's necessary to mention that safety really does start from the ground up. All businesses are responsible for taking a multi-disciplinary approach to encourage safe working practices and maintain the health and well-being of employees.







General Rules to Follow

Think Safe, Work Safe, Be Safe

Safety-related incidents can affect overall productivity, quality of work, and employee morale. They are also a major source of financial upheaval for business owners when regulations aren't properly upheld.

Here are 10 rules for workplace safety that every business should implement today:

- ✓ Preventing workplace incidents is everyone's job.
- ✓ Dress appropriately, from clothing to footwear. Wear and use the prescribed Personal Protective Equipment.
- ✓ Keep work areas neat and tidy. Do not block emergency equipment, aisles, or exits.
- ✓ Follow the rules. Don't cut corners or take unnecessary risks.
- Immediately report workplace accidents or safety incidents.
- Know and follow the correct emergency procedures.
- Lift, bend, and stretch with care to avoid injury.
- ✓ Don't operate tools or machinery that you haven't been trained for.

Avoid drugs and alcohol at work.

The Purpose of This Booklet

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This booklet aims to look at the 5 most crucial aspects of product safety (Electrical Safety, Fire Safety, Earthquake Safety, Cybersecurity, and Storage Safety) and discover how businesses can protect themselves against potential threats and mishaps.

We also take a closer look at how the AutoStore system fits into each of these safety scenarios, helping to keep things running smoothly at all costs.



Electrical Safety

One *Small Fault* = One *Huge Disaster*





Electrical fires cause over \$3 billion worth of damage to business structures in the United States and Europe every year.

Carelessness, insufficient testing of equipment, self-regulation, and a lack of education are to blame.

Every electrical disaster has a story and there's a lesson in each one.



The Case of the **Deadly Arc Flash**

In an unfortunate incident at a shopping mall, defective test equipment (and a lack of training) led to two deaths, one injury, extreme property damage, and some serious lessons.

The Setting

On a stormy day somewhere in the United States, a store in the mall had experienced several short power outages and abnormal behavior of its HVAC system computer. When store personnel noticed smoke coming from an emergency lighting box on the second floor, they called in an electrician to do an inspection.

The Accident

The electrician arrived at the retail store only to find that the fire department was already there, due to the smoke and power outages. He borrowed a multimeter from the maintenance department, did a few routine checks, and then removed the cover from the emergency lighting circuit breaker in the main 480V switchboard. He began checking voltages on the line side lugs. After checking all three phases, he felt that something was not right - and returned to the center lug. As he made this measurement, a fireball erupted from the panel, severely burning him and the two people with him, and causing significant damage to the electrical equipment and surrounding area. The injuries proved fatal for the electrician and the fire official standing next to him.

In the aftermath of the accident, various parties filed lawsuits involving the victims' estates against the electrical contractor, store, meter manufacturer, and insurance companies. It was a huge wave of expensive lawsuits that could have been avoided with proper attention to site and equipment testing.

Failure to Test

Proper and regular testing would have shown damaged wiring in the emergency lighting circuit – as well as problems with the backup generator. Additionally, the multimeter used by the electrician did not have an International Electrotechnical Commission (IEC) safety rating. An engineer from the manufacturer testified that his firm had never tested that model instrument at the IEC test conditions – or even at its maximum working voltage rating.

What Does Electrical Safety Mean?

To keep it simple, "electrical safety" refers to any precautions taken against electrical hazards.







Direct physical contact with live parts that can cause shock and burns.

The Shocking Truth

Why You Should Care About Electrical Safety

Accidental contact with exposed electrical parts can paralyze muscles, burn tissues and organs, and even trigger heart failure. To make matters worse, you don't need to be in direct contact with exposed parts to find yourself in harm's way. An arc flash can be sustained over a gap of up to 20 feet (6 meters) and can heat the air to temperatures as high as 19,400 °C (35,000 °F).

In the US, statistics gathered by the NFPA show that the average, small-scale electrical accident costs \$80,023.

Imagine the millions of dollars in damages that a larger factory or chain of warehouses could sustain.

Damage to Property



Injury



Loss of Life



Better Safe Than Sorry Rules and Regulations

Buildings run on power; miles of wiring and networks of electrical circuits, breakers, panels, switches, meters, controls, and other equipment. All of these networks need care, monitoring and maintenance to minimize danger and prevent expensive incidents.

Various rules and regulations are designed to protect staff against electrical hazards at work. These may differ slightly from one country to the next and tend to range from specific electricity regulations to more general health and safety rules. These regulations state that employers must perform a thorough risk assessment in order to identify any electrical risks and hazards before any activities can begin.

All employees are required to attend safety training to acquaint themselves with new policies and procedures. Training must include risk awareness, recognizing the dangers associated with those risks, and making sure that the implemented safety measures are working.



Always Play it Safe

There Are No Rewards for Risk-Taking

Governments want to protect their communities from needless hazards. Buyers want evidence of the safety, consistency, and reliability of the product or device. Equipment owners and customers like to be able to trust the goods or services they are buying. For this reason, there are certain standards and regulations which must be adhered to when designing and creating electrical and electronic products.

In order to sell electrical and electronic products, it is necessary to prove that they meet the safety standards and regulations of their destination marketplace. Safety standards and regulatory demands may differ from country to country, which can make certification in the global market challenging.

Before we get into the "official" stuff, there are a few key elements to understand.



Regulations

Regulations are laws created by government agencies in order to control the way something is done. Typical uses of regulations include air emission restrictions, child labor or other jobs legislation, minimum wage legislation, regulations requiring true labeling of food and drug products, and food and drug safety regulations setting down minimum levels of safety and consistency on what can be marketed, and zoning and construction permits regulations.

Standardizing Organizations

Standards organizations are organizations who create standards which make it easier to comply with specific regulatory demands. These organizations can be international, such as the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the International Telecommunication Union (ITU). Other organizations may be regional, such as the European Committee for Standardization (CEN) or the Pacific Area Standards Congress (PASC).

Certificates

Certificates are documents issued by a certified body which verify that a product fulfills a specific standard or skill.



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Standards

At the most basic level, standards are an agreed way of doing something. They establish uniform engineering or technical criteria, methods, processes, and practices. Standards fall into a few main categories:



Standards allow technologies to work seamlessly as well as establish confidence so that markets can operate smoothly. They:



What it Looks Like on Paper

Standards are created to make it easier for companies to comply with regulations. Let's look at a simple example:

The regulation states that all doors must be safe for everybody to use. There is no explanation on how to make a door which is safe for everybody to use.

A standardizing organization will lay out a method for creating a safe door. This standard will explain how to make a door that is safe for everyone to use. If you comply with the standard, you comply with the regulatory demand of all countries who have accepted this standard.

You can then certify that your door meets the standard and complies with the regulations.

There are two ways that products can be certified.

Obviously, the most cost-effective way to certify that your product complies with regulations is self-declaration. Unfortunately, self-declaration is not a quality assurance declaration, and is not the best way to do things.

It is for this reason that AutoStore uses an accredited testing lab to conduct the testing and write test reports.

Unfortunately, in many cases, these electrical safety test reports contain a ton of technical information which consumers may not understand, or information which the manufacturer does not want to share. This means that consumers are not able to verify the information, necessitating certificates.

Self-Declaration

Once you have tested the product yourself, you can write a Declaration of Conformity (DoC) which states which regulations your product complies with. Self-declaration is often used in the EU.

Lab Tested

Manufacturers can hire a certified test lab to complete the testing process. The certified body writes the test report verifying that the product has been tested according to a specific standard. If the product fulfills the requirements, the manufacturer completes the DoC and signs it.



The "Official" Stuff

When dealing with electrical safety, you'll come across many acronyms. IECEE. CB. UL and ETL. NRTL. But what do they mean? And why are they important?



What is the IECEE?

The IECEE, or the IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components, is a multilateral certification system based on IEC International Standards. Members of the IECEE make use of reciprocal acceptance and mutual recognition of test results to obtain approval or certification at national levels around the world.

IECEE Schemes address efficiency, quality, safety, and overall performance of equipment, devices, and components for workshops, homes, offices, and health facilities, among others. IECEE covers 22 categories of electrical and electronic equipment and testing services.

What is the CB Scheme?

The CB Scheme, in a nutshell, is an international system for the acceptance of certificates and test reports, dealing with the safety of electronic and electrical components, products and equipment.

Bringing product manufacturers one step closer to the ideal of 'one product, one test, one mark, where applicable', the CB Scheme is an agreement between participating countries and organizations. With the aim of facilitating trade by promoting harmonization between international standards and national standards, as well as cooperation among accepted National Certification Bodies (NCBs) worldwide, the CB Scheme is operated by the IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components (IECEE).

Why is the CB Scheme Important?



Safety

Manufacturers/suppliers must ensure that their products comply with relevant safety standards, while government regulations are generally intended to protect populations from potential risks associated with products.



Quality

Buyers/wholesalers want quality assurance of products purchased and unhindered market access. Interoperability: product manufacturers and end users want to be sure their products work and can interact with other products, services, and installations.



Consistency

Manufacturers/suppliers want to be sure their marketed products comply with the sample assessed.

CB Scheme Process





What is an NRTL?

An NRTL is a Nationally Recognized Testing Laboratory. It is a third-party organization that certifies products for the North American market, recognized by the Occupational Safety & Health Administration (OSHA).

What is the UL/ETL Marking?

Underwriters Laboratories (UL) and Electrical Testing Labs/Intertek (ETL) are both Nationally Recognized Testing Laboratories which offer certifications.

UL offers 40 types of certifications, and manufacturers can apply for testing and receive certifications which include: UL Listed, Classified, or Recognized

Aside from the body that issues the listing, there is no discernible difference between a UL and an ETL listing. Both meet precisely the same criteria.


Prevention is Better Than Cure

The AutoStore Difference

At AutoStore, our primary focus is safety. All AutoStore devices are evaluated and certified by external, independent organizations with strong track records in their respective fields of expertise. As of today, AutoStore has an approval process covering multiple facets of its product portfolio in more than 50 countries.

There are several directives for the European market, such as LVD, EMC, RED, and the EU Machinery Directive. These are an important part of the safety due diligence process and are also grouped together under the auspices of CE mark. As we've discussed, CE marking is a method that depends on self-declaration.

For AutoStore, it is imperative that all of our product approvals be tested, accepted, and certified by accredited organizations such as those mentioned above. On a similar footing in other regions of the world, AutoStore relies on the approval of certified bodies capable of carrying out the requisite safety checks of our products. This helps us to sustain the high degree of service that our consumers want and expect.





Low Voltage Directive

Electrical safety is about more than just shockpotential, it also concerns the possibility of burns from heated surfaces, unsafe practices such as placing a hand or finger in a machine, or why a product develops heat during an error.

The Low Voltage Directive (LVD) is known officially as:

DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.

During electrical safety tests, the modules are exposed to fabricated faults and are stressed. The intention is to ensure heat does not form in the modules, thus creating a fire source or risk to personnel or other infrastructure. Another important aspect of electrical safety testing is that only approved components can be used in the final product. This also includes tests featuring items such as non-flammable plastic, cables, and connectors and demonstrates the housing is certified and fulfills the directive. While the EU does not require third-party testing, leaving it up to the individual manufacturer to perform a self-declaration, the AutoStore system is fully tested by thirdparties to ensure all requirements are met. The outcome from these comprehensive tests is approval for the "CB Certificate". This certificate is valid in more than 50 countries and shows that our products meet all the necessary requirements.



Research Institutes of Sweden

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Inside the EMC test chamber (Awitar) at RISE in Sweden. Photo: RISE.

Electromagnetic compatibility (EMC)

All electronic devices emit some kind of electromagnetic disturbances. Like when you make a phone call near an old TV or radio, and hear interference. In an industrial setting, like a warehouse, it is important that systems can operate as intended, and are not influenced by each other. This has become increasingly important as technology advances, as warehouses often have many different types of technologies installed. It is important these technologies don't affect each other.

The electromagnetic compatibility (EMC) Directive 2014/30/EU ensures that electrical and electronic equipment does not generate, or is not affected by, electromagnetic disturbance.

One route of compliance is the self-declaration route. To ensure that products from AutoStore meets all the requirements, our modules are tested at an accredited test-house which verifies that the products meet the requirements in the EMC Directive by testing according to European standards. There are two defined electromagnetic environments within EU. The first is residential, commercial, and light industry environments. The second is industrial. For residential, commercial, and light industry environments the emission limits are more stringent than for products in industrial environments. For immunity there are more severe test requirements for industrial than for residential, commercial, and light industry environments.

Modules from AutoStore meet the most severe requirements from both the residential and industrial environments which certify our products can be used in both environments.

Fire Safety

Unpreparedness Fuels the Flames





There are about 40,000 fires at industrial or manufacturing facilities each year, resulting in 18 deaths, 279 injuries, and \$1 billion in property damage. That's in the United States alone. And only in a specific niche.

Consider the extent of the damage if we added all the business industries in Europe to the list. The results would seem catastrophic.



Commercial Fires are Mostly Caused by:



Cooking & heating equipment



Electrical and lighting systems



Exposure



Smoking materials



Arson



Office or electronic equipment

The key to keeping your business safe from the flames is thorough testing, meticulous inspection, and intensive fire safety training.



Never Too Old to Make a Plan

Employees at a lift truck attachment plant in the U.S. noticed plumes of smoke coming from a small section of the building. Within minutes the smoke became an uncontrollable blaze that razed the entire building. After 67 years as the largest employer in the county, the business was no more.

The Setting	At 11 am in the morning on the day before Christmas, while they were wrapping up for the holidays, employees at a large lift truck attachment plant noticed smoke coming from one section of the building. Local firefighters were called in as soon as the problem was discovered.
	The firefighters knew they had a problem on their hands before they arrived on the scene and immediately called in backup from six neighboring departments.
	The building was completely engulfed in smoke when the fire fighting teams reached the scene. The fire quickly moved into a paint area which added more fuel to the flames. They began to hear a slew of small explosions once the fire spread, and shortly afterwards the entire building was ablaze.
	The multiple fire departments battled the blaze for four hours before they could bring it under control. Later in the evening, the fire flared up again, bringing the firefighters back into the monumental fight.
The Damage	The building was a metal structure, and fires in metal structures are extremely difficult to fight. The metal tends to collapse in, so firefighters have to dig through it to get to the flames underneath.
	The plant had been in business almost 70 years before this disaster burned it to the ground. Their customers included big brands, like Toyota. The company was the largest employer in the small community.
	According to news reports, the building was a total loss. There was absolutely no chance of salvaging anything.
The Lesson	Even businesses that have been in operation for more than half a century need adequate fire safety measures in place. No one is exempt from the rule. Regular equipment testing and factory inspections are an absolute must.
	Every corner of the business needs to be checked. Complacence is the true enemy of

any business.

What is a Fire, Exactly?

Fire, at its most basic level, comes from a chemical reaction between oxygen in the atmosphere and some sort of fuel.

A fire naturally occurs when certain elements are combined in the right mixture.

- Without sufficient heat, a fire cannot begin, and it cannot continue.
- Without fuel, a fire will stop.
- Without sufficient oxygen, a fire cannot begin, and it cannot continue.



Ignorance is NOT Bliss

Everyone Needs Fire Safety Awareness

In Europe, around 2.0–2.5 million business and domestic fires are reported every year, resulting in 20,000–25,000 fire deaths and 250,000–500,000 fire injuries.

Any type of building could suffer a blaze, including hospitals, education premises, and retail shops. Extreme fire safety precautions should not be limited to industrial sites where the risk is perceived as higher simply because of the nature of the work undertaken.

Fire, heat, and smoke are not the only culprits when it comes to damaging property. The triggering of a sprinkler system can cause significant water damage, increasing repair bills and the size of insurance claims.

Without the right type of fire protection, it can take a business much longer to restart day-today operations.



On the Right Side of the Law Fire Risk Assessment

No business owner is exempt from the long arm of the law. To keep employees safe and premises protected, it is important to:

- Undertake risk assessments to determine fire risks and the appropriate level of fire safety measures.
- Reduce the risk from fire as far as is reasonably practicable by putting appropriate control measures in place.
- Nominate employees to implement these measures, make known their identities, and provide adequate training and equipment for such employees.
- Keep the risk assessment under regular review.
- Support the risk assessment with professional fire safety advice wherever necessary.

Fire Safety Risk Assessment

1

Identify Fire Hazards

Identify:

- sources of ignition;
- sources of fuel; and
- sources of oxygen.

2

Identify People at Risk

Identify:

- people in and around fire premises; and
- people who are especially at risk.

3

Evaluate, Remove or Reduce, and Protect from Risk

- Evaluate the risk of a fire starting.
- Evaluate the risk to people from a fire.
- Remove or reduce fire hazards.
- Remove or reduce the risks to people from a fire.
- Protect people by providing fire precautions.

4

Record, Plan, Inform, Instruct, and Train

- Record any major findings and action you have taken.
- Discuss and work with other responsible people.
- Prepeare an emergency plan.
- Inform and instruct relevant people.
- Provide training.

5

Review

- Review your fire-risk assessment regularly.
- Make changes where necessary.

Remember to review your fire-risk assessment regularly.

The Nitty Gritty Risk Assessment of the AutoStore System

A well-designed fire protection system detects a fire early and then suppresses quickly, minimizing damage, product loss, and downtime. AutoStore's unique design allows a fire protection system to meet the goals of early detection and rapid suppression.

Standard warehouses are covered by standards and regulations in terms of fire protection design.



AutoStore's technology is relatively new to the market. With our pioneering approach, AutoStore goes the extra mile when it comes to validating the fire protection capabilities of the system. All the equipment goes through certification tests, and AutoStore conducts extremely thorough fire tests and material testing. These combined efforts result in recommendations for the fire protection capabilities of the AutoStore system.



How, What, and Why Do We Test?

For over a decade, we have dedicated a large portion of our time to performing ongoing fire safety tests of our entire system. Our step-bystep procedure tackles each part of the system, starting with bin material tests, moving on to each individual module, and carefully working our way up to large-scale fire tests.

Our painstaking testing process involves replicating a warehouse environment, constructing a life-sized version of the setup our clients might use, and replicating the fire's journey to see how it behaves in the AutoStore system.

It's a scary (and expensive) process but it needs to be done. We need to be able to show, beyond a shadow of a doubt, precisely how our system would handle a blaze. We don't believe in guesswork. We need to see the reality of the situation.

In constructing our testing scenarios, we take into consideration various sprinkler configurations, height ratios in relation to overhanging ceilings, and compact storageunit density. We also perform fire-fighting foam tests, robot ignitability tests, fire barrier tests, and low oxygen tests.

We leave no stone unturned.

AutoStore fire test 2017. ESFR (Early Suppression Fast Response) sprinkler test. Sprinkler is operating and suppressing the fire. AutoStore fire test 2017. ESFR (Early Suppression Fast Response) sprinkler test. Sprinkler has operated and suppressed the fire.

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What Have We Discovered?



Even within a high-density storage space with a high volume of combustible materials, the AutoStore system helped to slow the growth of the fire by a significant amount. Due to the lack of available or circulating oxygen, there was no way for the fire to expand or intensify.



It's important to analyze different sprinkler system configurations to make sure they will work as planned. Different materials used and designs of sprinkler systems will have an effect on a fire's behavior.



In fires that are started in the bottom of the grid, the fire spreads vertically. This causes the sprinkler suppression to release very early in fire development, which leads to early suppression with minimized damage.



Testing of the AutoStore system also shows that fire growth is limited in a horizontal direction because of the solid wall bins and the vertical structural grid supports.

What Should Happen After a Fire Has Started?

When it comes to fire safety, you can't rely on a single, solitary plan. You need backups. Fire is no joke and when things go wrong, it's a quick downhill slope to disaster if you're not prepared.

Once a fire has started and is under control by a sprinkler system, there's more work to be done by firefighters. Building and company owners are responsible for establishing a solid plan for these types of emergencies.



We suggest that this plan include:



Early-warning smoke detection

#



Access to the grid



Means of removing bins

Smoke ventilation

 $\frac{1}{2}$



Heat-seeking camera



Availability of medium expansion foam



Bin Removal Process







You Can Never Be Too Prepared Fire Safety for the AutoStore System

The goal of fire safety is to protect not only the building and its occupants, but also the AutoStore system and its contents. A well-designed fire protection system will detect a fire early, before it has a chance to spread. The system should suppress any fire quickly, minimizing any damage or product loss and reducing downtime.

The AutoStore system features a unique design which easily allows fire protection systems to meet these goals. Each component of the AutoStore system undergoes rigorous testing and certification processes to ensure that they meet or exceed all electrical and fire safety requirements. Extensive fire testing also guides the design and certification process, ensuring that fire hazards are minimized.





The AutoStore Difference

AutoStore has performed over 100 small, medium, and large scale fire tests since 2009. From these tests, we have learned that there are several elements in top-load, high-density systems which can have a significant impact on heat release and fire growth during a fire.

These properties are taken into account when new products are created, or specific strategies are recommended for protecting the system.

Through testing and research, we have discovered that the most likely location for a fire to start is outside of the AutoStore bins, as there are no sources of ignition inside the bins. Significant efforts have also been made to limit the probability for a fire starting in the electrical systems and components that are near the grid. All robots and charging systems have been extensively tested and verified by third parties, including IEC/UL and CE certification.

AutoStore test 2019, water distribution from sprinkler during fire sprinkler water collection test.

AutoStore Equipment Certification Process

The greatest risk of fire ignition is electrical components.

All of AutoStore's electrical components meet the requirements for product safety as outlined by different regulations worldwide. Components are tested by an independent third-party Nationally Recognized Testing Laboratory (NRTL) and are marked with UL/ETL or CE to show our product safety certifications. AutoStore is independently audited to ensure conformity to the different approvals.



System Controller

AutoStore systems can be connected to early detection or smoke alarm systems within a facility, which in turn will stop a system's operation.



Robots

AutoStore robots are certified to CE, IEC/ ETL, and other requirements and meet the UL 94 standard for relevant parts. Our batteries have been proven to be safe through 20 years of operational safety and our rigorous certification process. The robots are constructed of metal and fire-retardant material.



Charger

AutoStore chargers are certified to CE, IEC, ETL or UL requirements and meet the UL 94 standard for relevant parts. Our chargers have been in use for over 20 years. Our charger's input is a standard 100V – 240V converted to lower, voltage and have an output, which generate a lower heat load.



Bin

Based on our extensive fire testing, we know that the design and material used in the bins can have a big impact on fire growth and heat-release during a fire. AutoStore doesn't allow openings in the bins, which reduces the amount of oxygen in the cube. Fire tests prove that this limits the ability for fires to grow horizontally.



Grid

An extremely important factor in the grid is the flue spaces that allow water penetration during a fire. Our flue spacing is designed based on test results that maximizes water penetration to the lower levels. Narrow flue spaces reduce the amount of oxygen. Our flue design also allows for rapid vertical heat release, which triggers the facility sprinklers quicker. The cell structure also limits the potential collapse of bins, which maintains the flue spaces and sprinkler water penetration possibilities.

The Heavy Paperwork

Guidelines

CEA 4001

The CEA is the European insurance and reinsurance federation. Standard CEA 4001 specifies requirements and recommendations for the design, installation, and maintenance of fixed fire sprinkler systems in buildings and includes a chapter on pumps.

CEA 4001 is based on EN 12845, with additional requirements and updates. VdS also uses CEA 4001 as the basis for its standards for the installation and planning of sprinkler systems. This is known as VdS CEA 4001, and covers controllers, drives and pumps.

VdS 2098

VdS is owned by the German Insurance Association. VdS 2098 is a guideline for smoke management.

Datasheets

FM Global Property Loss Prevention Data Sheets.

FM Global Property Loss Prevention Data Sheets provide standards designed to help reduce the chance of property loss due to failure of electrical or mechanical equipment, fire or weather conditions. They incorporate consensus standards committees, equipment manufacturers, and others, as well as nearly 200 years of property loss experience, research, and engineering results. FM DS 8-9 Storage of Class 1, 2, 3, 4 and Plastic Commodities

FM DS 8-34 Protection for Automatic Storage and Retrieval Systems

FM DS 5-34 Fire Detection

FM DS 8-1 Commodity Classification

Regulations

International Building Code and International Fire Code.

National building codes vary from country to country.
Standards

EN 12845

EN 12845 is a standard which provides recommendations and specifies requirements for the installation, design, and maintenance of fixed sprinkler-type fire fighting systems in buildings and industrial facilities. It also lays out specific requirements for sprinklertype systems included in personal protection measures.

NFPA 13

NFPA 13 is the industry benchmark for design and installation of automatic fire sprinkler systems, and addresses design approaches, system installation, and component options to prevent property loss and fire death.

DIN 18232-2

DIN 18232-2 is the standard applicable to the design and installation of natural smoke exhaust ventilators and its components.

EN 16750:2017

EN 16750:2017 is a European standard which specifies oxygen reduction systems used as fire prevention systems.

It specifies minimum requirements and defines the specifications which govern the design, installation, and maintenance of fixed oxygen reduction systems with oxygen reduced air in buildings and industrial production plants. It also applies to the extension and modification of existing systems.

EN 16750:2017 applies to oxygen reduction systems using nitrogen which are designed for continual oxygen reduction in enclosed spaces.

Note: Nitrogen is the most suitable gas to be used for oxygen reduction. For other gases, this standard can be used as a basis.

EN 16750:2017 does not apply to oxygen reduction systems that use water mist or combustion gases, or to:

- Explosion suppression systems
- Explosion prevention systems
- Fire extinguishing systems using gaseous extinguishing agents
- Inertization of portable containers
- Systems in which oxygen levels are reduced for reasons other than fire prevention (e.g. steel processing in the presence of inert gas to avoid the formation of oxide film)
- Inerting required during repair work on systems or equipment (e.g. welding) in order to eliminate the risk of fire or explosion

This European standard also covers some structural requirements for the protected area, in addition to the criteria for the actual oxygen reduction system and its individual components. The space covered by an oxygen reduction system is regulated and continuously monitored indoor environment for prolonged occupation. This standard does not extend to unventilated confined spaces that could contain dangerous gases.

EN 15004-1:2019

EN 15004-1:2019 designates specifications and offers guidelines for the design, installation, evaluation, maintenance, and safety of gas extinguishing systems in buildings, plants, or other structures, as well as for the characteristics of the different extinguishers and fire types for which they are an effective extinguishing method.

Oxygen Reduction System



Fire Needs to Breathe

Oxygen Reduction Fire Prevention

Where a conventional fire suppression system suppresses or limits the spread of a fire after ignition, an Oxygen Reduction System (ORS) is designed to prevent a fire starting by creating an oxygen reduced (hypoxic) environment. By maintaining the oxygen levels in the protected space at non combustible levels and at the same time ensuring that the environment is safe for humans, an Oxygen Reduction System is able to successfully prevent ignition.

How It Works:

- Air with a reduced oxygen content is injected into the room to lower the normal oxygen.
- Lower oxygen content can't support combustion, though the oxygen content needed to protect a system from fire would depend on the material's ignition threshold.
- Most flammable solid materials and liquids cannot ignite in environments with an oxygen level lower than 14%.

Going Up in Smoke and **Fire Detection**

Smoke detection systems are designed to provide an early warning for possible fire by detecting the presence of smoke, sounding a warning or issuing a signal to a building's alarm system. A good fire detection system should notify the occupants of the building with a warning, report the event to emergency services, and activate any automated systems in place designed to control the spread of fire and smoke.

While there are many types of detection systems, care should be taken to select the appropriate type for the premises to be protected. Choosing the right type of detection system will also reduce the chance of false alarms, which can cause costly interruptions to business activities.







Smoke Detectors

The most common types of smoke detectors fall into two categories: ionization and photoelectric. The ways in which these types of smoke detectors respond to the presence of fire differs greatly. Ionization smoke detectors are generally more responsive to flaming fires, while photoelectric smoke detectors are more responsive to smoldering fires.

Ionization smoke detectors

The smoke detector is made up of a small amount of radioactive material stored between two electrically charged plates. This causes an ionized flow between the two plates, and when smoke enters the chamber, the flow is reduced and the alarm is activated.

Photoelectric smoke detectors

A photoelectric smoke detector is made up of a small light-emitting diode and a lightsensitive sensor housed inside a chamber. When smoke particles enter the chamber, they scatter the beam and cause the scattered light to reflect onto the light sensor. This then triggers the alarm.

Aspirating Smoke Detection

Aspirating Smoke Detectors (ASD) are more advanced and highly sensitive, providing an earlier warning than normal smoke detectors, making them useful as part of active fire prevention.

Drawing air in from each room through small, flexible tubes, ASD systems analyze the air for minute smoke particles as part of a continuous process.

As these systems are not reliant on air flow in the room, they can often detect smoke before it is visible. These systems are the preferred smoke detection method for challenging areas, such as areas of high airflow, or when condensation is present. They are also widely used when very early detection is required, such as computer rooms and communications setups.

These types of systems are also beneficial in high-ceilinged buildings such as warehouses, as the detectors can be located at easily accessible levels for maintenance purposes.



Smother the Flames & Keep an Eye on Progress

Fire Protection



Pendant sprinkler head



Upright sprinkler head





Automatic Sprinklers

When handling fires, dealing with them when they are small is the best way to prevent damage to property, injury, and loss of life. Automatic sprinklers are one of the most effective ways to fight fires and stop their spread in the early stages. According to the National Fire Protection Association (NFPA), the presence of automatic sprinklers reduces the average property loss per fire by one half to two thirds, and reduces the chances of dying in a fire by one-half to three-fourths.

Automatic sprinklers are heat-activated, and operate automatically when the air temperature rises to or above the device's specified temperature rating. When this happens, the sprinklers discharge water over a specified area.



Water Mist

Water mist systems make use of fine water sprays to suppress, control, and extinguish fires by:

- Cooling flames and surrounding gases by evaporation
- Displacing oxygen
- Attenuating radiant heat by the small droplets themselves

The spray characteristics of a water mist system are what determine its effectiveness for fire suppressions. These characteristics include spray dynamics, flux density, and droplet size distribution. Ventilation conditions, fire size, and the shielding of the fuel also play a role.

When compared to the use of gaseous agents and traditional sprinkler systems, water mist fire suppression has revealed advantages such as:

- Immediate activation
- High efficiency in the suppression of a wide variety of fires
- Minimized water damage
- Environmentally sound characteristics
- No toxic problems





Foam (Medium and High Density)

Foam has been used for years as a fireextinguishing medium for flammable and combustible liquids. Through the combined mechanisms of cooling, separating the flame/ ignition source from the product surface, suppressing vapors and smothering, stable aqueous foam can extinguish a flammable or combustible liquid fire – unlike other extinguishing agents such as water, dry chemical, CO2, etc.

It can also secure against re-flash or reignition for long periods of time. Water is heavier than any of these liquids when used on a typical hydrocarbon fuel, and if added directly to the fuel surface, it can sink to the bottom with little or no effect on extinguishment or vapor suppression. If the liquid fuel heats above 100 °C (212 °F), the water will boil out of the enclosed area below the fuel surface, throwing the fuel out and spreading the fire. For this purpose, foam is the primary fireextinguishing agent for all possible hazards or areas of transport, manufacturing, storage, or use of flammable liquids as an energy source. As part of our environmental focus, AutoStore encourages the use of environmentally friendly foam, when possible.

Inert Gas (Inergen®/ Argonite® / Argon / Nitrogen)

Inert gas clean agents include nitrogen and argon and blends of these. INERGEN® (IG541) differs from the other inert gases as this contains 8% carbon dioxide. Inergen® is a natural fire extinguishing gas blend, consisting of Nitrogen (52%), Argon (40%), and Carbon dioxide (8%). It is harmless to people, machines, and equipment. It has no impact on the environment. Inergen® reduces the oxygen level in a room, to a level that will extinguish a fire.

Some additional common attributes for inert gases are: inert gases do not produce more decomposition products and do not contribute to global warming or ozone depletion. All inert gases need to be evaluated with respect to health and safety concerns.

When inert gases are discharged, the oxygen concentration of the location is lowered, which will quench the fire. Inert gases remove oxygen from the fire tetrahedron, ensuring that the fire does not have a sufficient supply of oxygen to continue burning.









Smoke and Heat Ventilation

There are two methods used for smoke ventilation, mechanical ventilation and natural ventilation. The basic principle of smoke ventilation is to remove the smoke from the room. By removing the smoke one can limit the accumulation of heat and smoke within the room. Mechanical ventilation uses fans to extract smoke from a room, while natural ventilation uses the thermal buoyancy and passive forces of wind to extract the smoke.

Small Hose Streams

Small hose streams are connection stations for fire services. They are used during firefighting efforts, similar to fire hydrants, but could also be connection points inside a building at floor level or higher on mezzanines for firefighting efforts from above.

Cameras & Water Monitors

Cameras will provide an overview of the building and structures. In case of an unwanted event such as a fire, cameras can be used to determine the location of smoke development or flames.

Water monitor nozzles are often used for manual firefighting or as automatic fire protection. This can be aimed in various directions and is a controllable high-capacity water jet. This can help with targeted firefighting in confined spaces. It is used to apply water or foam to the specific area of risk.

Stop Flames in Their Tracks Fire Barriers

Fire barriers significantly protect human life, property interiors as well as your equipment & infrastructure. Depending on your needs and requirements, different types of fire barriers will best suit your building or equipment configuration. We will help you find the best one that satisfies your needs.

Modular Fire Barriers Modular Fire Barriers are typically installed in outdoor setups and can be configured and placed in any custom configuration depending on how your setup is arranged. Typically these are used to separate transformers in substations from one another so if a transformer blows, it does not cause any collateral damage. This is essential in maintaining the protection and continuation of critical infrastructure like power grids. **Firewalls** A firewall helps in resisting fire on the exterior of the building. It holds fire within the source boundaries. The duration that the fire is enclosed within the source depends on the firewall rating. The enclosure time usually ranges from 3 to 4 hours, allowing optimal protection by continued extension from the bottom to the roof of the building - also it has incredible structural integrity and resists extreme environments. Notably, firewalls remain standing even after the entire structure collapses. **Fire Partitions** Another type of fire barrier is a fire partition. Fire partitions are walls contained on the inside of the building. These walls subdivide specific areas of the floor. The walls extend from the ceiling to the floor surface, taking the form of a vertical Assembly. Partitions can be fastened to the floor and ceiling for extra support. Fire partitions offer fire protection for a period of 1 to 2 hours. **Smoke Barriers** The smoke barrier is another common type of fire prevention measure by preventing the spread and circulation of smoke. A smoke barrier consists of a continuous membrane which can either be horizontal or vertical.

Fire partition AutoStore system





Fire Protection Best Practices

Having a fire plan in the workplace that focuses on Fire Safety Best Practices is a priority in any business. This involves the procedures once a fire occurs, fighting the fire, and evacuating the area.



Pre-Planning with Local Fire Services

Pre-incident preparation, particularly at industrial and manufacturing facilities, is essential for safe and efficient firefighting operations.

A Pre-Incident Plan is defined by The National Fire Protection Association (NFPA) as "a document developed by gathering general and detailed data that is used by responding personnel in effectively managing emergencies for the protection of occupants, responding personnel, property, and the environment." (NFPA 1620- 2010 Ed)

Pre-incident coordination through the local fire department makes it easier for first responders to transfer vital information that can direct their response to a fire incident and strengthen their response capability, which can eventually save lives and decrease property loss and business interruption.



Pre-incident Plan

Creating an efficient pre-incident plan includes collecting and supplying the local fire department with information, including the following:

Basic Details

- Company name
- Property Address
- Driving directions
- Access barriers such as narrow bridges, steep or narrow roads, RR crossings
- Access Code for gates/doors
- Electronic Access Card
- □ Knox Box location
- Aerial Photo of the site
- Number of stories (above grade, below grade)
- Building length & width
- Building construction (non-Combustible, fire resistive, ordinary, masonry non combustible, modified fire resistive, frame)

Having a pre-incident plan in place helps to facilitate an effective response by the local fire department. It also minimizes risk to building occupants and first-responders, as well as the risk of damage to property or assets. It can also aid in reducing business interruption. **Floor Plans**

- Major partitions and doors (locations of firewalls and fire doors)
- Location of stairs and stairwells
- Location of elevators
- Location of sprinkler control valves and the areas controlled by each valve
- □ Location of fire pump(s)
- Location of standpipes, hose stations, and hose outlets
- Exit door locations and interior stairwells
- Access to rooftop venting devices
- Location of roof access ladders

The direct understanding of a building's characteristics, risks, and layout by firefighters is often the most critical factor in encouraging an efficient response and attack in a fire situation. Having a Pre-Incident Plan in place for the responding fire department will make a difference in selecting offensive or defensive fire attack pathways in their approach, which will eventually decide the magnitude of the loss of fire.

Site Plan

- □ Significant buildings
- Separation between buildings
- Hydrant locations and other available water sources
- Fences and gates
- Low-hanging power lines
- Electrical transformers
- Location of shut-offs for water, LP gas, electrical, solar panels, HVAC, & emergency power

Others

- Hazardous materials present & their quantity, container type/size, and location in the building or on the property
- ☐ Water supply information (city water, city water with booster pump, or pump and tank, pond/lake, elevated tank)
- Roof shape (flat, pitched, arched, hip, dome, shed, etc.)
- Roof type & covering
- Roof penetration including skylights or smoke vents
- Location of attic access doors, hatches, or ladders
- Indicate which areas and buildings have sprinkler protection
- Confirm defensible space around the building including turn around capability, and access to all sides of the building
- □ Location of buried tanks on-site
- □ Typical # of occupants (day/night)
- Any occupants requiring special assistance with evacuation and their location in the building
- Emergency evacuation plan (tested annually) with designated assembly area
- Occupancy (special hazards, warehousing)
- Square footage (total, basement, 1st floor, 2nd floor etc.)
- Protection (sprinklers, gaseous suppression, dry chemical, foam systems, etc. & location)
- Fire alarm system information, detection, manual pull stations, and notifications appliances, location of fire alarm control panels and annunciators

Earthquake Safety

Being Seismically Secure is Not Optional





Throughout history, earthquakes have always been one of Mother Nature's most destructive forces. Seismic activity can take lives, destroy buildings, and cause tremendous amounts of damage, costing hundreds of thousands of dollars to repair.

According to the National Earthquake Information Center, of the 20,000 average earthquakes a year, around 18 of them are major disasters. While these major earthquakes happen infrequently, when they do they can cause major damage.



Shaking Businesses to the Ground

For businesses, this can be ruinous. When buildings collapse, owners or lessees are left with no operating business or huge business interruptions, along with little to no cash flow, employees possibly out of work, and executives questioning why there was no emergency plan in place. Add to this the need to pay for repairs, or build an entirely new facility, and you can see why earthquake safety is vital for businesses. According to the Federal Emergency Management Agency (FEMA), around 40% of businesses that are forced to close their doors because of disaster never recover.

This hardship can be further compounded by legal action, as building owners can be held legally liable for any injury, death, or property loss, as well as millions of dollars in damages for negligence for not making seismic retrofit upgrades. Following the 2003 earthquake in Paso Robles, a precedent-setting case found the owner of a building negligent for neglecting to make his building safer. Survivors were awarded \$1 million for each person killed in the building's collapse.



Twin Earthquake Has Car Manufacturers Quaking in Their Boots

In a devastating blow that reached well beyond the danger zone, the aftereffects of a twin earthquake forced a major car manufacturer to suspend production at most of its factories, sending shock waves throughout international supply chains and stock markets.
The Setting	A strong earthquake struck a city of more than 500,000 residents and affected areas more than 130 kilometers (80 miles) away. A day later, an even higher-magnitude tremor followed suit. While the area is no stranger to earthquakes and most buildings are subject to strict building codes, quakes of this size (especially in succession) are uncommon.
	The earthquakes were shallow and the fault line long. The ground surface may have moved about 4-5 meters (13-16 feet), leading to intense, terrifying shaking throughout the city.
The Damage	Several buildings in the region were severely damaged after the quake – many collapsed. Roads buckled, power supplies were disrupted, and lives were lost. Throngs of citizens were evacuated, gathering in open public spaces, and left fearing for their lives and livelihoods.
	The damage to a nearby motorcycle factory belonging to a major car manufacturer was immense. The ripple effect caused by the seismic damage reached far beyond this single building, forcing the company to suspend production in plants across the country. These factories were responsible for providing small machine parts to bigger suppliers, who in turn supplied their components to even bigger suppliers.
	In the end, production was halted across multiple well-known brands on three continents. The financial repercussions as a result of the pause in production were astronomical. At least three of the world's leading vehicle brands took a tumble on the stock market.
	Two earthquakes, thousands of lives affected.
The Lesson	When it comes to earthquakes and natural disasters, overprepared is always better than underprepared. Even if a building is up to code, there is immense danger in becoming too complacent.
	Large earthquakes may be infrequent, but nature is unpredictable. To protect the lives of employees and to safeguard against major financial setbacks, seismic safety needs to become more of a priority.

How Does the Earth Move During an Earthquake?

When two plates of the earth suddenly slip past one another, they have the potential to cause an earthquake. The point where these blocks meet and slip is called the "fault".

During an earthquake, energy is released in seismic waves that travel from the "focus", which is the place where the earthquake starts. These waves pass through the ground. As the waves pass near or underneath a structure, it can move up and down or from side to side. The intensity of the shaking depends on how far a structure is from the fault as well as the type of soil around or under it.

Seismic waves travel more slowly through soil, sand, and soft rock than they do through hard rock. But, while they may travel more slowly through these softer sediments, the strength of the tremor increases as well, so the physical shaking is more intense in these areas.

It's important to consider the ground around a structure when planning for seismic safety – as this can be a make or break situations in the event of a natural disaster.

What is PGA?

Peak ground acceleration (PGA) is basically how hard the earth shakes at a given geographic point. PGA is equal to the maximum ground acceleration that occurred during earthquake shaking at a location.

PGA is an important parameter (also known as an intensity measure) for earthquake engineering. The local engineering authority looks up the PGA value or equivalent design ground acceleration value, and it must be used in every design for an AutoStore restraint system.





The "Bones and Muscles" of a Building Structural Engineering

The Institution of Structural Engineers has said, "if a structure was a human body, then the architect would be concerned with the body shape and appearance, and the structural engineer would be concerned with the skeleton and sinews."

Structural engineering is a speciality within the field of civil engineering and focuses on the framework of structures, as well as designing these structures to remain secure, stable, and safe throughout their use despite the pressures and stresses of their environment.

Dating back to the first time tree branches were lashed together to make a shelter, structural engineering has been important throughout history. From the first primitive huts, down to the International Space Station, people have used structural engineering to build progressively bigger and more sophisticated structures in a safe and secure manner.

In the simplest of terms, structural engineering is all about making sure that buildings don't fall down. The "Bones" of the Structural System

And How AutoStore Fits In

There are four elements an engineer needs to consider when designing a structual system. Here is how an AutoStore system fits into these elements.

Structural Element Sizing	This is the sizing of the bottom and top tracks and columns. This size must be large enough to withstand the gravitational and dynamic loads from fully loaded robots moving about the grid.
Connection Details	This is the design and sizing of the clips, pressed fit top track, screws, etc. to allow the gravitational load to be fully transferred through the structural elements and into the floor.
Load Analysis	This is required to ensure the element sizing and connection details will withstand all the loads the system will see. The defining loads for AutoStore are dynamic loads from the robots moving and gravity loads from the robots and service vehicle.
Mother Nature Input	This is where seismic loads and indoor wind

loads are considered.

What is "Mother Nature" input?

Mother Nature Input has three sub-elements to consinder:

1 Risk Category

This defines how functionable the building/equipment must be after exposure to an earthquake.









Life Safety

Collapse Prevention

Operational

Immediate Occupacy

2 Mapped Acceleration Parameters (Address/Location)

This is provided through various agencies throughout the world. The structural engineer will collect "seismic input" for the installation location of the AutoStore system. This is a requirement for all locations around the world. Much of the world uses PGA and the United States uses S_{DS} values. However, some sites are in a low seismic zone, and therefore the operational loads will be greater than the seismic input.

3 Site Class (Soil Conditions)

An AutoStore is installed in a building and will usually be considered the default of Site Class D.

How Loads Move Through a Structure

There are a few characteristics which influence the structural integrity of a building, and which are considered when designing earthquakeresistant buildings: stiffness and strength, foundations, and load paths.

Stiffness and Strength

Foundations

When designing earthquake-resistant buildings, adequate lateral and vertical stiffness and strength are required. Lateral strength and stiffness are especially important, because structures tend to handle vertical movement more easily than lateral movement. Even without taking seismic safety into account, many professionals still focus on a building's vertical stiffness and strength – it has to support itself somehow! Unfortunately, earthquakes bring with them new directional forces, and these are not always prepared for. If not built correctly, buildings will quickly destabilize during the horizontal movement.

Stable foundations are vital for creating large structures, regardless of any natural disaster risks. A characteristic that is critical for any building's long-term survival, strong foundations are a necessity for buildings that hope to resist seismic forces.

A building's foundational requirements will vary depending on the area in which it is built, and professionals need to closely observe the way the ground reacts and moves. Deep foundations and driven piles are just one characteristic of buildings designed to withstand violent earthquakes. Foundations are often connected, allowing them to move as one unit, in order to stabilize these measures.

Continuous Load Path

The continuous load path is the journey an earthquake takes through a building, both vertically and laterally. This path needs to remain intact, or the building will not be able to adequately dissipate the earthquake's movement.

Similarly to stable foundations, other structural and nonstructural building components may also need to be interconnected to allow inertial forces to dissipate without compromising the structure. With multiple strength and redundancy points sharing the force, seismic activity has a lower chance of damaging the foundations. Safety professionals, engineers, and architects must remain wary of this continuous load path characteristic.

If a structure is not adequately tied together, components will be able to move independently, compromising the stability of the structure.





Design Loads Keep Your Structure Standing

There are many load types that could act upon a structure, and the nature of these will vary according to the use, location, design, and materials being used. The loads are usually classified as either dead or live: dead loads (DL) and live loads (LL).

Dead Loads (DL)

Live Loads (LL)

Dead loads are also known as static, or permanent loads. These are primarily associated with the weight of the structure itself. These loads remain relatively constant, and remain stationary. Dead loads could also include the weight of structural elements, immovable fixtures like built-in cupboards, or permanent non-structural partitions.

Live loads are also known as imposed loads. These are, most often, dynamic, temporary, and changeable. Live loads could include furniture, occupants, vehicle traffic, and other equipment. The intensity of live loads often varies by time of day. For instance, office buildings often have increased live loads during weekday work hours, with smaller loads at night and over the weekend.

Live loads could be either distributed or concentrated, and could involve acceleration, vibration, or impact. How the AutoStore System Fares in Terms of Seismic Testing

(LAT

Seismic testing shows the AutoStore system is not very rigid but able to withstand large movement.

AutoStore Seismic Testing at UC Berkeley in 2019.

Cybersecurity

Be Aware of Invisible Threats





When you think about the security of your warehouse, you're probably thinking about the physical aspects of security – access control, video surveillance, and proper inventory management, for instance. But what about your cybersecurity? Supplychain hacking is a growing threat, and is making its way into warehouses across the globe. This is especially true for companies and buildings which depend on technology, such as the IoT, or the Internet of Things.

While having a strong security system in place is good for protecting your physical assets, protecting your data is also of vital importance. Cyber attacks can bring operations to a grinding halt, and can affect companies of any size.

To make matters worse, cyber attacks are becoming more sophisticated, and as such are becoming harder to spot.



Malware Attack Makes Business Owners Wanna Cry

The Setting

In May of 2017, the WannaCry ransomware cryptoworm crippled hundreds of thousands of computers in more than 150 countries, spreading like wildfire in just a matter of hours. In what seemed to be a coordinated cyberattack, government systems, hospitals, railway networks, and private companies were knocked offline.

More than 300,000 computers were encrypted, and businesses affected ranged from FedEx, China National Petroleum, Britain's National Health Service, Sberbank of Russia, Yancheng police department in China, Deutsche Bahn, Hitachi, and the Russian Interior Ministry.

This attack was the first time that ransomware, a type of malware that encrypts a user's files and demands cryptocurrency as ransom to unlock them, had spread across the world.



The Damage	WannaCry caused billions of dollars worth of damages in just a few short hours. Many businesses paid to get their files back – though often this proved to be in vain. Later, NotPetya, another ransomware which used the same DoublePulsar and EternalBlue exploits, went on to further ravish advertising agencies, supermarkets, and shipping giants.
	Even now, years later, around 1.7 million internet-connected endpoints are still vulnerable to the exploits – not counting the potentially millions more devices connected to infected servers.
	Though the ransom amount was relatively insignificant, Cyence estimates the potential costs of the attack at around \$4 billion. Companies suffered heavy monetary setbacks in the form of productivity loss, investigation costs, and data restoration.
	According to the Cost of Data Breach Study 2017 by IBM and Ponemon Institute, the average cost of data breaches globally was around \$3.62 million.

The Lesson

There are many lessons that can be taken from both the WannaCry and NotPetya incidents. Some are obvious, like the critical importance of having backups and frequent patching, but there are other, not so obvious lessons too for organizations of all sizes.

According to Kevin Epstein, Vice President of Threat Research at Proofpoint, "Bottom line, companies should make it a priority to improve their defenses against increasingly targeted and sophisticated attacks across email, mobile devices, and social media, in addition to ongoing widespread malware and phishing campaigns."

Organizations must now begin to prioritize their cybersecurity, with shorter patch windows, implementing network segmentation and implementing zero trust frameworks, like Google's BeyondCorp, which requires everything to be trusted in order for communication to occur.

What is Cybersecurity?

Cybersecurity is a discipline that is designed to protect devices, networks, and programs from digital attacks. Typically, these cyberattacks are aimed at obtaining, manipulating, or damaging confidential information, extorting users' money, or disrupting normal business processes.

It is especially difficult today to enforce successful cybersecurity measures because there are more devices than individuals, and attackers are becoming more creative.



Elements of Cybersecurity

Efforts need to be coordinated throughout an organization's entire information system in order for cybersecurity to be effective. Cybersecurity can encompass the following elements:

- Network Security: Protecting the network from attacks, intrusions, and unwanted users
- Application Security: Keeping programs up to date and protecting them from attacks through testing.
- Endpoint Security: Protecting remote access to the system, as these remote access points can be areas of vulnerability.
- Data Security: Protecting customer and company information.
- Identity Management: Understanding the access each individual has within the organization.
- Database and Infrastructure Security: Protecting the hardware and databases of the network.
- Cloud Security: Protecting the data which is store in a 100% online environment.
- Mobile Security:

Keeping tablets and cellphones safe, and making sure they pose no threat to general network security.

• Business Continuity Planning/Disaster Recovery:

Making sure that data can be restored, and business can continue as usual in the event of a breach or natural disaster. End User Education: Ensuring an individual with system access has acceptable security habits, such as two-factor authentication, frequent password changes, etc.

The ever-evolving nature of the risks is one of the most challenging aspects of cybersecurity. Organizations have often focused most of their security on the perimeter, protecting their crucial systems against known threats. Nowadays, this approach is insufficient.

Threats now advance and change too quickly – more quickly than many organizations can keep up with. Because of this, adaptive and proactive approaches to cyber security are recommended by most advisory organizations. The National Institute of Standards and Technology (NIST), for instance, has issued guidelines in their risk assessment framework which recommend a shift to real-time assessments and continuous monitoring.



Know Your Enemy Threat Modeling

In today's IT world, cybersecurity remains a key concern, with the number of hacking events ever increasing. Too many facets of our lives have moved online, and both the commercial and private worlds have much to lose from security breaches.

In response, cybersecurity experts are deploying an array of protections and counter-measures to keep transactional data and sensitive information secure. Considering the sheer number and variety of attacks available today, this is a massive undertaking.

That's why threat modeling is making a major contribution to this field.





What is Threat Modeling?

Allowing IT professionals to identify any potential vulnerabilities and security threats, as well as quantify their seriousness, and prioritize methods for mitigating attacks and protecting resources, threat modeling may sound like the job description of any cybersecurity professional, but it's actually a structured and systematic process.

Threat modeling walks through well-defined steps in order to understand the environment in need of protection, identify potential attackers, and vulnerabilities.

Threat modeling can be conducted at any point, though it is best practice to conduct it at the beginning of the project. This way, threats can be identified early, and can be dealt with before they become a serious problem. It's also important to ask questions such as:

• What type of threat model do you need to build?

Answering this question will require studying architecture diagrams, data flow transitions and data classifications, to give you a virtual model of the network in need of protection.

• What pitfalls are there?

This requires research into the main threats faced by the applications and network.

 What action needs to be taken to recover from a potential attack?
 Once you've identified the problems, actionable solutions need to be ironed out.

• Did it work?

Follow up to the previous question, retrospective needs to be conducted to allow you to monitor quality, feasibility, planning, and progress.



The Threat Modeling Process

Threat modeling consists of defining the assets of an enterprise, determining, in the grand scheme of things, what purpose each application plays, and assembling a security profile for each application. The process proceeds to identify possible threats and prioritize them, then to record both the adverse incidents and the steps to be taken to address them.

Or, to put this in practical terminology, threat modeling is the process of taking a step back, analyzing the digital and network assets of your company, finding weak points, assessing what risks exist, and making strategies to defend or recover. It might sound like a no-brainer, but in some industries, you'd be shocked by how little attention security gets. We're talking about a world where certain people use the term PASSWORD as their password, or leave their mobile devices unattended. In that light, it's not shocking that the concept of threat modeling has not even been contemplated by many organizations and companies.





Threat Modeling - Revealing Attack Routs to Business Assets





Cybersecurity

Through the Software Development Life Cycle

The Software Development Life Cycle (SDLC) is a structure for the method of creating an application from initiation to decommissioning. Multiple SDLC models have evolved over the years, from waterfall and iterative to, more recently, agile and CI/CD¹, which increase the deployment speed and frequency.

More often than not, SDLCs include the following phases:



In the past, at the end of the SDLC, organizations typically conducted securityrelated practices. As a result of this latein-game strategy, bugs, glitches, and other vulnerabilities would not be discovered until they became much more costly and timeconsuming to repair. Worse still, there will be no security vulnerabilities found at all.

It's much easier, not to mention quicker and cheaper, to incorporate security testing through the SDLC, not just at the end, to help uncover and reduce vulnerabilities early, effectively building security. Security assurance tasks include design architecture research, code review during coding and construction, and pre-release penetration testing. Here are some of the key advantages of a safe SDLC approach:

- Your software is more protected, as security is a constant concern.
- All stakeholders are aware of safety issues.
- You detect design vulnerabilities early, before they have been programmed into existence.
- Thanks to early detection and troubleshooting, you reduce the costs.
- You reduce the total inherent business risks for your company.

¹ C/CD stands for Continuous integration (CI) and continuous delivery (CD)



This diagram illustrates the Microsoft Security Development Life Cycle model.

Secure by Default Principles

Secure by Default isn't an assurance scheme, or even a set of requirements, and there is no compliance badge for meeting the requirements. Secure by Default is mainly a philosophy. Though, product developers who do adopt some Secure by Default principles will definitely have an easier time making sure their products are safe when new threats arise. Additionally, users will have confidence that the products they are purchasing are designed to be secure, and will deal better with future threats.

The Secure by Default principles are:

- Security can't be added in later it should be built in from the beginning.
- Security needs to treat the root cause of the problem, not the symptoms.
- Security is a process, not a goal. It must continue throughout the life of the product.
- Security shouldn't compromise usability. Products should be secure, and usability should then be maximized.
- Security should work reliably without extensive configuration.
- Security needs to constantly evolve to counter the latest threats.
- Security features should take longer to defeat than they do to build.
- Security through obscurity should be avoided.
- Security should not require nonobvious behavior or specific technical understanding from the end user.

What is Secure DevOps?

Relying on different functional groups working together to improve business delivery, DevOps is a philosophy which combines the traditional roles of IT and development to accelerate the delivery of value. Essentially, when development and IT handle work smoothly, new features can be shipped more frequently, and businesses can become more adaptive and competitive.

One of the central concepts of Secure DevOps is enhanced integration of IT, security, and development. Adding security to the original mix allows security changes to be accelerated as well. This way, there are reduced opportunities for vulnerabilities, and the organization will be able to more quickly mitigate any risks which remain.

How Can You Build a Secure DevOps Program?

It is important that the company focuses on a personalized implementation for their customized climate and objectives. Companies should discuss tangible actions related to IT, growth, and security in the transition to Secure DevOps capabilities. As a result, current culture, processes, and technology will be strengthened. The requisite changes in group cultures are similar across the three groups. Owing to huge changes in different systems, the people involved must be ready to introduce new initiatives and processes and to take various conventional approaches.



Temperature Controlled Storage

Protecting More Than Just Your Bread and Butter





Businesses in industries around the globe make use of warehouses to store millions of different types of products. A vital link between producer and retailer, warehouses are governed by stringent regulations that must be adhered to at all times.

Medicines, cigars, wood, clothing, electronics, food... the list of items requiring temperature-controlled storage is seemingly endless. Warehouses need to undergo rigorous evaluations regularly to ensure that nothing slips through the cracks.



The Station for the Gravy Train

Food-Grade Warehouses

Food-grade warehouses are governed by arguably the strictest regulations of all. These warehouses are often enormous and can be required to store large amounts of food products for long or short periods of time.

The most common types of foodgrade warehouses include dry storage, refrigerated or chilled storage, and frozen or cold storage. Each of these warehouses is required to maintain exemplary health and sanitation standards at all times to prevent the spread of food-borne diseases and illnesses and to prevent monetary losses for food channel members.




Safeguarding All Treasures General Warehouses

Industries the world over required safe storage for temperature-sensitive products. Often, these products require a temperature range above or below room temperature, which necessitates warehousing solutions that keep a consistent temperature throughout the year.

Temperature-controlled warehouses utilize cooling (and/or heating) units to keep the temperature within a set range.

To keep the temperature stable, these warehouse buildings cannot have:

- Leaks in the roof, walls, or edges of the foundation
- Holes in the windows or the window frames
- Damage to the exterior of the building such as cracks, holes, open pipes, etc.

The Real "Mystery Meat" Listeriosis Outbreak

At the beginning of January 2017, a deadly listeriosis outbreak raged through South Africa. The serious foodborne disease led to a 27% fatality rate among those infected, and hospitalization of the rest. No one really knew what caused the outbreak at the time but within a few months, the origin would wreak havoc on several large businesses around the country.

LISTERIOSIS TEST

Trahalose

10115

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Sucrose

LISTERIOSIS TEST

3 mL

3 mL

D-Mannitol

The Setting	In January 2017, 9 children were rushed to a hospital in Johannesburg, South Africa. A pediatrician suspected that a foodborne illness, listeriosis, was to blame. From then on, the numbers steadily grew to nearly 1000. There was no real evidence of what caused the outbreak or why it was spreading so quickly.
	Scientists undertook a nationwide investigation to discover the origins of the outbreak. After several months, and many additional infections, they were able to trace it back to a ready-to-eat processed meat product called "polony". Further investigation showed that the deadly bacteria causing listeriosis was found in a single factory but that it had spread to several others in the production line.
The Damage	As soon as the origin of the outbreak was discovered, retailers across the country began pulling products from their shelves. All polony products associated with the responsible brand were removed, along with several others that may have come into close contact during production.
	The South African government issued a total recall of all products from the facilities in question. When it was discovered that the company knew of the presence of bacteria in their products 18 days before the total recall, the high court granted a certification order opening up the process for a class-action lawsuit against the brand in question. Over 1000 claimants would each be eligible to see between 100,000 to 2,000,000 Rand in compensation for their losses due to the outbreak
	Following the disaster, Botswana, Namibia, Mauritius, Mozambique, Malawi, Kenya, and Zambia suspended all imports of processed meat from South Africa. Additionally, the brand's stock price plummeted by 7%, accounting for a 5.7 million Rand reduction in value.
The Lesson	Scientists are still unsure what caused the presence of the listeria bacteria in the first place, but it has been speculated that improper storage and refrigeration are to blame.
	Without proper storage safety protocols in place, outbreaks of this magnitude can happen, leading to loss of life, serious illness, and millions of dollars in losses for the businesses involved as well.

Keeping it Cool

Temperature is the Cornerstone of Safe Storage

When it isn't stored properly, food can grow bacteria that doubles in growth every 20 minutes. The more bacteria there is, the higher the chances of consumers getting foodborne illnesses. Bacterial infections such as E. coli affect almost 40,000 people per year. If food has been left out for too long, or the freezer malfunctions for any reason, food can become a veritable breeding ground for microscopic nasties.

Thermometers are of the utmost importance in a warehouse. They need to be checked frequently to make sure they aren't malfunctioning. Checks should be done daily at a bare minimum though it's best to conduct checks every few hours.



Use Your Noodle Following Regulations

Refrigerated Foods	In the EU, regulation (EC) 852/2004 establishes that: "Raw materials and all ingredients stored in a food business are to be kept in appropriate conditions designed to prevent harmful deterioration and protect them from contamination."
	In the EU, most products of non-animal origin need to be stored at a maximum temperature of 8 °C (46.4 °F). In the US, refrigerated foods should be stored at a temperature not higher than 7.2 °C (44.96 °F).
Dried Foods	Because dried foods have such a low moisture content, microorganisms have low activity. When kept in dry storage areas with good ventilation, the shelf life of these foods becomes longer. According to industry guidelines, dried foods should be stored between 10 °C (50 °F) and 21 °C (69.8 °F).
Bread and Pastry	Baked goods, in general, have a short shelf life. It is common practice for bakeries to freeze bread and cakes to -30 °C (-22 °F)before they are transported further along the chain. Generally, frozen breads and pastries can be kept at -18 °C (-0.4 °F) for up to 12 months.
Canned Foods	Canned foods often have a shelf life of one year or longer. Because the food is cooked and then sealed in airtight containers, manufacturers are able to effectively stop any microbial spoilage.
	Semi-preserved foods, like caviar and pickled herring, are subjected to a much milder heat treatment and must therefore be stored in a chilled environment.

Dairy Products	Dairy products such as milk, cheese, and yogurt must always be stored at well below 8 °C (46.4 °F). While the pasteurization process kills most of the bacteria in milk, some bacteria still survive. These types of bacteria generally can't flourish in cooler temperatures, so it's often suggested that milk should be stored at below 6 °C (42.8 °F).
Fruits and Vegetables	Fruit and vegetables are commonly stored in a controlled atmosphere to delay the ripening process. In this type of storage, the oxygen content is kept below 8% and the carbon dioxide content above 1%. This also helps to increase the shelf life of the produce.
Meat and Meat Products	Foods of animal origin carry the highest risk

Foods of animal origin carry the highest risk of microbial contamination. Temperature requirements for storage of foods of animal origin are addressed in regulation (EC) 853/2004 in the EU legislation.

Product	Max Storage Temperature °C (°F)
Fresh fish and fishery products	0-2 (32-35.6)
Cuts of meat	7 (44.6)
Meat preparations	4 (39.2)
Minced meat	2 (35.6)
Offal	3 (37.4)
Poultry	4 (39.2)
Egg (liquid)	4 (39.2)

Other Critical Safety Factors

Particular challenges for food safety include organic regulation, HACCP compliance, food defense and vulnerability, and employee training and awareness programs.

The following safety factors should be considered:

- 1. Training and Education
- 2. Allergen Awareness
- 3. Cross Contamination
- 4. Food Defense







Temperature Controlled Storage Compatibility

AutoStore System

The AutoStore system is compatible with both food and non-food items. Stored items may be held in ambient conditions or refrigerated conditions. When items need to be moved, AutoStore robots select the appropriate bin, delivering it to the port. Thereafter, the robot picks up the bin and moves it back to the correct temperature zone.

It is important to now that AutoStore does not provide refrigeration. However, the system can run in a chilled environment and maintains the ambient temperature within the storage facility to keep products safe and prevent food from spoiling.

Ongoing testing of the AutoStore system in chilled and various environments for real world application. .

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