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Fire protection in archives and storage vaults

Protection of people and cultural assets

Archives and storage vaults, in which documents, manuscripts, books or paintings are stored, are risk areas that need to be especially well protected. The historical and cultural value of the objects stored in such facilities can often be considered priceless, since most of the items will be unique. This means that a tailored fire protection concept is required. The first priority is obviously the prevention of fire occurring at all, although even when all structural measures have been implemented and all organizational measures strictly enforced, there will always remain a small possibility of fire. However, the high value of the contents means that the fire risk will still be high.

To limit any fire damage to the absolute minimum, it is essential that an incipient fire is detected at the earliest possible stage and dealt with quickly and efficiently. Aspirating Smoke Detection (ASD) systems are able to detect even the smallest aerosol concentrations and offer the ideal solution for fire detection in archives.

A quick response to the detection of a fire is also an essential requirement, which can only be met by an automated extinguishing system. In this case we not only need to extinguish the fire and prevent any danger of re-ignition, we also need to ensure that the extinguishing agent used will not cause any damage to the stored objects. The Sinorix H₂O Gas system fulfills all these requirements and is a perfect solution for applications in closed rooms where damage to cultural assets is not acceptable.

Archives are generally dedicated rooms in buildings such as libraries and museums. In many cases these rooms are not visited on a daily basis, so early detection and suppression of incipient fires in these rooms also ensures that smoke and fire cannot spread throughout the building and become a life-threatening danger.

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Introduction

Archives are places where public records, manuscripts and historical documents (including film and other media) are stored. In general the stored objects are unique and consequently extremely valuable. Their purpose is to collect and catalog information and make it available for both present and future generations.

Art storage vaults provide a similar function for works of art (which are not currently on public display): these are generally temperature-controlled, darkened, and meticulously organized storage facilities. Museums may also have similar vaults to store and protect a variety of valuable collections (e.g. archaeological finds, coins, etc.).

In both cases the stored objects are concentrated in a small space and it is not only important that the environment is carefully controlled, but also that they are well protected from the consequences of fire.

All objects are subject to an aging process which, depending on how they were stored, can lead to damage or eventually even to destruction over a period from as short as a few years to millennia. To ensure that these objects remain in as good a condition as possible and for as long as possible, they need to be stored under ideal conditions.

The following points can help to slow down the aging process:

- Constant environmental conditions, with a temperature of approx. 18°C and a relative humidity in the region of 50%. Rapid changes must be avoided as these could cause some materials to expand or contract, which could lead to permanent damage.
- As some materials are sensitive to sunlight, they must be kept in darkened archives. These rooms (either without windows or with covered windows) should only be lit with artificial light and then only when absolutely necessary. It is important that any light source used has no UV-content, as this can damage the objects.
- Dust or air pollutants can also damage the stored objects. The air supply to the archive must therefore be designed to prevent any air pollutants from entering.

To prevent damage, destruction or loss of valuable objects, the following points must be observed:

- The objects should be kept in such a way that neither the storage nor the handling of the objects can lead to mechanical damage. Care should be taken to ensure ease of access, to prevent pressure marks and to provide suitable packaging (where this is necessary).
- Rodents or insects can also cause damage. This must be prevented by appropriate counter measures (e.g. effective sealing of all entry points, air filters and regular cleaning).
- Theft or vandalism must be prevented by appropriate technical and organizational measures (e.g. a locked area that is only accessible to authorized persons).
- To prevent the danger of water damage, no water pipes should pass through the archive. If this cannot be avoided then a water leak detector should be installed to monitor the floor of the archive.
- Fire in an archive must be prevented as far as possible. However, if a fire should occur the resulting damage must be kept to the absolute minimum.

Long-term conservation requires careful storage under stable environmental conditions, together with the appropriate structural, technical and organizational measures.

Archive fires often result in enormous damage, which is not only caused by the fire itself, but also by smoke and the extinguishing agent used in suppressing the fire. Irreplaceable objects may be damaged beyond repair. This document focuses on minimizing the most common threat to cultural assets: FIRE.

Highlights

- Sensitive and irreplaceable objects must be provided with protection that is appropriate to their value
- Irreplaceable objects automatically imply a high fire risk, even when the probability of fire occurring is very low
- Typical fire hazards include short-circuits and overloading of electrical installations
- Fires must be detected at the earliest possible stage and dealt with quickly and effectively

Basic conditions

Objectives

- Recognition of an abnormal aerosol concentration and transmission of this information to a technician so that the situation can be evaluated and the appropriate counter measures can be taken (e.g. disconnecting an overheated air conditioning unit or closing the air intake to prevent contaminated air from entering the room).
- A substantial increase in the aerosol concentration will indicate the presence of an incipient fire. In this case the damage must be minimized by activating an automated extinguishing system installed in the archive (or storage vault). However, the extinguishing agent used should not have any detrimental effect of the stored objects.
- When a fire is detected in an archive, smoke and fire must not be allowed to spread to neighboring areas. This is particularly important when the archive consists of a number of adjacent rooms.
- Timely alerting and evacuation of all endangered persons.

Typical fire hazards

- Overload or short-circuit of electrical installations (e.g. cables, switches, etc.).
- Defective electrical equipment (e.g. air conditioning, heating, lighting).
- Danger created by human activity (e.g. maintenance work, vandalism).

Typical development of a fire

Fires started by an electrical source exhibit a very typical fire development pattern:

- When electrical equipment overheats small quantities of an aerosol are generated. If during this phase the power to the device is removed then no fire will occur and any damage will be minimal.
- If the electrical power is not interrupted then a smoldering fire can develop, which produces increasing amounts of visible smoke. If such a fire can be detected during the early stages, it can be dealt with easily and the damage can be limited to a small area.
- If appropriate counter measures are not taken at this stage, then the smoldering fire can develop into an open fire, which can cause immense damage.

If the fire has been caused by carelessness during maintenance work (e.g. welding) or even deliberately (arson) then we will be confronted with an open fire from the outset.

Critical points

- Air contaminated by smoke, fire gases and other particles can cause damage to sensitive objects. It is therefore essential that even slightly increased aerosol concentrations are detected quickly and reliably.
- Tall storage units (e.g. shelving) which nearly touch the ceiling can hinder the spread of the fire-related aerosols throughout the room.
- An open fire can spread very rapidly indeed, due to the large number of flammable objects made of paper, celluloid film, wood or fabric.
- The extinguishing agent must be selected that is most appropriate to the type of object being protected.
- The extinguishing agent used should not cause any additional damage to the stored objects.
- Any damage must be limited to a single room by ensuring that fire cannot spread to neighboring areas.

Solution

When all technical equipment has been correctly installed and regularly maintained, and all organizational measures are being strictly enforced, then the probability of a fire occurring should be very low. However, the fire risk in an archive is still very high as the stored items are usually extremely valuable. An effective fire protection solution must be capable of detecting even the smallest incipient fire at the earliest possible stage and be able to deal with it quickly using appropriate counter measures. Only in this way can possible fire damage be limited to the absolute minimum.

Since even a slightly raised aerosol concentration in an archive must be detected quickly, a highly sensitive Aspiration Smoke Detector (ASD) system offers the best solution. Modern ASD systems are now capable of distinguishing between fire aerosols and dust or dirt particles. Depending on the level of danger recognized, they can then trigger the appropriate warning (or alarm) signals and the controls that activate the alarming devices and subsequently the automated extinguishing system.

If local regulations stipulate a multiple zone dependency (simultaneous alarm signals across two zones in the same area) then the room must be equipped with at least two ASD systems. In addition to the automatic smoke detectors a manual call point should also be installed in the room.

In an archive an extinguishing system must be installed which not only guarantees rapid, effective suppression of a fire, but also ensures that the stored items are not damaged in any way by the extinguishing agent itself.

Extensive tests have shown that an extinguishing agent consisting of a mixture of nitrogen and water mist is able to fulfill these requirements admirably. This is particularly true for smoldering fires and deep-seated fires, for example in archives, where the water mist provides additional protection. (It is important to note that deep-seated fires in documents cannot be extinguished by nitrogen or clean agents alone.) The highly efficient extinguishing effect of the nitrogen is supported by the cooling effect of the fine water mist, which cools all objects and surfaces below the flash point and prevents re-ignition. A further feature of the water mist is that it provides a smoke-scrubbing effect, thereby reducing the toxic fumes in the air and providing additional protection for people's health while reducing smoke damage.

Due to the very low volume of water required (30 to 80 liters per 100 m³ of room volume) this technique does not cause any irreversible damage to documents, books, paintings and other items.

When defining the size of an archive a compromise must be made between storage space and the associated fire risk. As previously stated the fire risk is largely determined by the total value of items stored in the archive: the larger the room, the more items and consequently the higher the fire risk. A smaller room will be able to house fewer items, but the fire risk will also be lower.

Fire protection considerations determine that very large rooms must be subdivided into multiple fire compartments. NFPA 232 recommends that the storage volume should not exceed 3540 m³. The construction of the walls, doors etc. should also be designed to prevent fire from spreading to a neighboring area for at least 2 hours.

The following example describes the elements and provisions required to ensure early fire detection and effective fire suppression in an archive with a floor area of 240 m² (20 x 12 m) and a ceiling height of 4 m.

Details	Comments/Notes
Automatic fire detectors: Aspirating Smoke Detection system	ASD systems ensure early detection of incipient fires and activation of the automated extinguishing system. They also provide information on air pollution in the archive. <ul style="list-style-type: none"> • Connected to the fire detection panel directly via the detection line • High sensitivity: for alarming in the case of fire • Medium sensitivity: for activating the extinguishing system • Recognition of air pollution (e.g. dust) The quantity and size of the sampling holes can be determined with the aid of the calculation software provided.
Manual call points: MCPs	Manual activation of a fire alarm (via the fire detection panel) <ul style="list-style-type: none"> • Single or double action (depending on local regulations)
Alarming devices: Sounder-beacons	Sounders with supplementary optical indication to alert any persons in the room so they have time to react.
Automated extinguishing system:	For rapid and reliable extinguishing: <ul style="list-style-type: none"> • Based on a combination of nitrogen and water mist technology • Highly efficient extinguishing process and prevention of re-ignition • The small quantities of water involved cause no damage to historical documents and other items • The quantity of extinguishing agent required and the number of extinguishing nozzles can be determined using the calculation software provided • Non-toxic extinguishing agents – safe for people and the environment
Manual release button:	For immediate manual activation of the extinguishing system.
Pressure compensation: Overpressure flap	To prevent structural damage to the room, all gaseous extinguishing systems need pressure relief openings, which reduce the overpressure created by the release of the extinguishing agent. The size can be determined using the calculation software.
Manual suppression: Hand-held fire extinguisher	Hand-held foam fire extinguisher; for the manual suppression of minor fires.
Positioning of the system elements: (see Figure. 1)	ASD System <ul style="list-style-type: none"> • ASD evaluation unit outside the archive • 1 sampling pipe above the manual mobile storage units • 1 sampling pipe above the corridor between the rows of shelves • Air recirculation to the archive room Manual call point <ul style="list-style-type: none"> • Next to the door (inside the archive) • At a height of 1.4 m ± 0.2 m Sounder-beacon <ul style="list-style-type: none"> • In a clearly visible location: e.g. above the door (inside the archive) Gas extinguishing system <ul style="list-style-type: none"> • Extinguishing control panel • Gas cylinders in technical room adjoining the archive • Piping network and extinguishing nozzles must be so arranged that the extinguishing agent can spread out unhindered • Extinguishing warning display Manual release button <ul style="list-style-type: none"> • Next to the door: inside or outside the archive (depending on local regulations) • At a height of 1.4 m ± 0.2 m Overpressure flap <ul style="list-style-type: none"> • Mounted in an outside wall, as the excess air must be able to escape into the atmosphere. If there is no outside wall, then a pressure release duct must be provided to ensure that the excess air can escape. Hand-held fire extinguisher <ul style="list-style-type: none"> • Next to the door (inside the archive)

Further Comments/Notes

Positioning of the ASD system, extinguishing control panel and gas cylinders

These elements should always be housed in a neighboring room. In cases where there is no suitable room in the immediate vicinity of the archive, however, the following positioning can be selected.

- The evaluation unit of the ASD system should always be installed outside the archive (e.g. in the corridor and next to the archive door). This enables any maintenance to be carried out without needing to enter the archive itself, which reduces the danger of accidental damage or theft. It also means one less electrical installation in the archive and therefore one possible ignition source fewer.
- To prevent any willful damage or malicious activation of the extinguishing system, the gas cylinders should be stored in a secure area which is not freely accessible. The cylinders may also be situated on another floor if the piping network permits this. In general, the gas cylinders should only be installed within the archive itself when no other feasible solution can be found and where local regulations permit.

Furthermore

- When local regulations require multiple zone dependency (independent alarm signals across two zones in the same room) before the extinguishing system can be activated, the room must be monitored with a second ASD system.

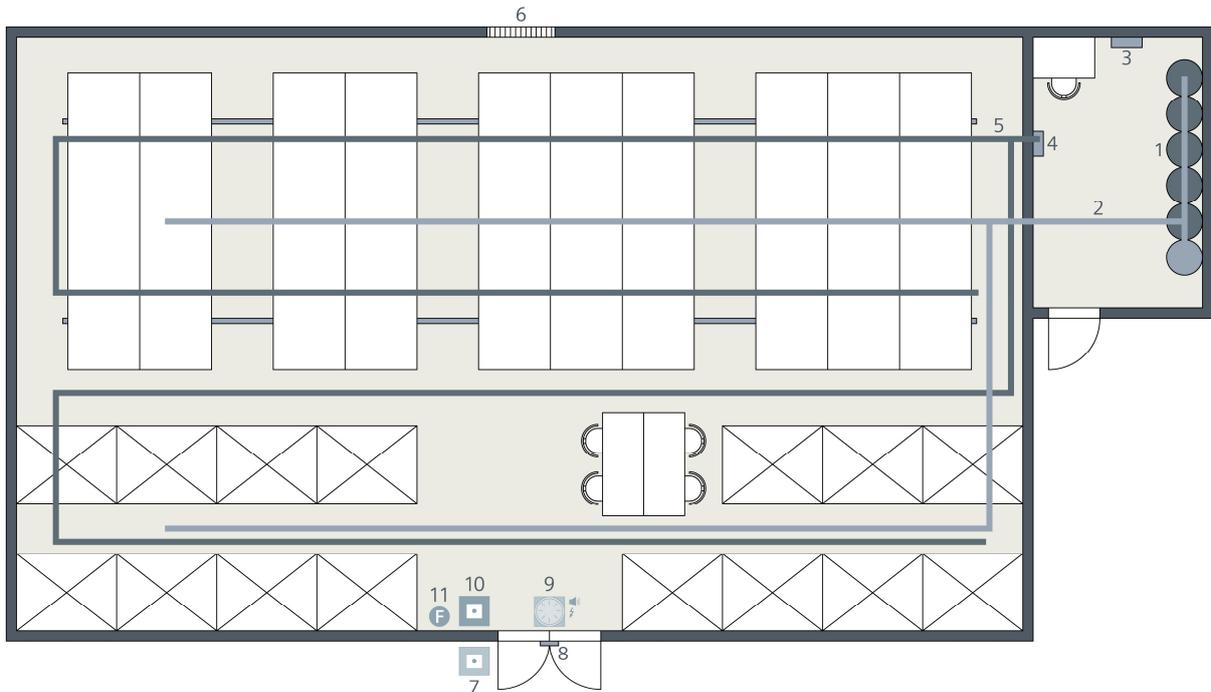


Figure 1 Positioning of the system elements

Key:

- | | |
|---------------------------------|------------------------------------|
| 1. Gas cylinders | 7. Manual call point (red) |
| 2. Extinguishing piping network | 8. Extinguishing warning display |
| 3. Extinguishing control panel | 9. Sounder-beacon |
| 4. ASD evaluation unit | 10. Manual release button (yellow) |
| 5. ASD sampling pipes | 11. Hand-held fire extinguisher |
| 6. Overpressure flap | |

Practical experience

Due to the high concentration of valuable cultural assets stored in archives and storage vaults, these facilities present a number of exacting requirements relating to early detection and fire suppression. Even a fire starting in a partially enclosed area (e.g. manual mobile shelving) must be detected early. This is also true for fire suppression; the extinguishing system must be designed in such a way that even a fire in the furthest corner of the room will be extinguished quickly and reliably. In addition to the high reliability of the individual functions such as detection, alarming, control activation and effective extinguishing, they must all be coordinated to work with one another in an optimal manner. Only in this way can fire damage be kept to an absolute minimum.

Fire detection

The earliest possible detection of an incipient fire is a major factor in the protection of archives and storage vaults, as even the smallest smoldering fire must be detected quickly. As the fire detection system is programmed to automatically activate the extinguishing process, we must be sure that this only occurs when there is a genuine fire. It must not be activated when an increased aerosol concentration is detected that has been generated by some other source. To provide the earliest possible detection, but still ensure reliable alarming, the ASD system must fulfill the following criteria:

- The detector sensitivity must be Class A (in accordance with EN54-20).
- The system must be capable of distinguishing between fire aerosols and other particles such as dust.
- It must be possible to set the threshold which serves to activate the alarming devices and the threshold which serves to activate the extinguishing system independently from one another.

The closer the air sampling holes are to the seat of the fire, the more sensitive the system will be and the faster it will react. Consequently, when designing the layout of the piping network we should also consider installing pipes within the shelving systems and not just below the ceiling.

Technicians with considerable experience are able to define the suitable thresholds for each application. However, to be sure of making the optimal settings, an appropriate series of tests must be carried out. This requires an analysis of the air quality (air pollution) and observing how the system reacts to a defined test fire.

Extinguishing system

When selecting, planning and installing an extinguishing system, in addition to high quality components experience plays a major role.

- Selection of an unsuitable extinguishing system (e.g. sprinkler) can lead to cultural assets being damaged.
- When planning the piping network and the positions of the extinguishing nozzles, care must be taken to ensure that the extinguishing agent will be able to spread out evenly throughout the entire room.
- If the planning and installation of the extinguishing system are not carried out correctly, then it is possible that a fire might not be completely extinguished or that it may reignite.

An extinguishing system can only perform its function reliably if the system is correctly designed. Siemens provides specifically developed calculation software to assist in this design process.

Extensive tests in real-world applications have demonstrated that the highly efficient combination of the extinguishing effect of nitrogen, together with the cooling effect of the water mist reliably extinguishes the fire and effectively prevents re-ignition. The water mist also reduces the toxic fumes in the air, providing additional protection for people's health and minimizing smoke damage to the stored objects.

Aspirating Smoke Detection - Early fire detection with excellent reliability and genuine alarm guarantee

Aspirating Smoke Detection (ASD) systems from Siemens ensure reliable fire detection in demanding application areas, where very early fire detection is required and business continuity is paramount. Aspirating smoke detectors continually draw samples of air from the areas requiring protection and evaluate these samples for the presence of smoke. The high detection reliability and immunity to deceptive phenomena provided by these systems are backed up by our genuine alarm guarantee.

Learn more about [ASD](#) from Siemens.

Sinorix H₂O Gas - Automated extinguishing system based on highly efficient nitrogen and water mist technology

This innovative gas/water-combined extinguishing system uses nitrogen and water as extinguishing agents. During a fire, Sinorix H₂O Gas floods an area simultaneously with both nitrogen and water mist for ideal protection from combustion, smoke, and heat damage. Both extinguishing agents are carried by the same piping network and are distributed by the same nozzles. As it is discharged, this mixture fans out through the room, extinguishes the fire and cools hot surfaces quickly and reliably. Nitrogen is used as the extinguishing agent and as the propellant for the water. The water component ensures that re-ignition is prevented. As part of the nitrogen is used to propel the water, the initial burst of gas is softened, which results in smaller overpressure flap openings and lower costs.

Learn more about [Sinorix H₂O Gas](#) extinguishing systems.

Everything you need for comprehensive fire protection

Incorporated in a concept tailored to your customers' requirements, Siemens and its Solution Partner network provide:

- Early and reliable fire detection solutions, offering an unrivalled financially backed "Genuine Alarm Guarantee".
- Fully forwards and backwards compatible systems, to ensure any system provided is equipped to integrate the latest technology Siemens has to offer.
- Clear and fast alerting and evacuation processes.
- Innovative and fast extinguishing systems.

All these aspects are at the core of comprehensive fire protection. Only when these are fulfilled can you be assured that people in your buildings are safe and assets and business operations are protected.

In order to offer your customers peace of mind, Siemens and its Solution Partner network have a variety of service and solution offerings that can be tailored to an individual client's needs. To find out more about this, please visit our Web site at www.siemens.com/firesafety-markets or contact your local Siemens organization through [the online contact form](#).

Advantage Engineering - share the experience

With our dedicated program for consulting engineers, you can benefit from our extensive application know-how and complete portfolio.

With Siemens, you can offer your customers comprehensive fire safety for any application and environmental condition. Your customers will appreciate this as it enables them to reliably protect people, assets and business processes from fire.

Backed by more than 160 years of experience in the field, our offerings for early detection, reliable alarming, orderly evacuation and safe extinguishing are based on innovative and unique technologies. They provide you with convincing arguments like maximized life safety or environmental friendliness, and open the door to strong, long-term customer relationships. And with Siemens, you gain a reliable partner at your side and benefit from our smart tools, in-depth trainings and personal support – wherever you are, wherever you go. For more information please visit www.siemens.com/advantage-engineering.

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Our world is undergoing changes that force us to think in new ways: demographic change, urbanization, global warming and resource shortages. Maximum efficiency has top priority – and not only where energy is concerned. In addition, we need to increase comfort for the well-being of users. Also, our need for safety and security is constantly growing. For our customers, success is defined by how well they manage these challenges. Siemens has the answers.

“We are the trusted technology partner for energy-efficient, safe and secure buildings and infrastructure.”