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Fire protection in event venues

Protection of people, assets and reputation

University event venues are used for many diverse functions with large numbers of participants. In such buildings it is therefore not surprising that the safety of those participants is of particular importance. This is especially true for the greatest single threat – FIRE.

The probability of a fire can be significantly reduced if the appropriate organizational measures are strictly enforced. However all fires cannot be prevented and the structural measures must be designed in such a way that all visitors would be able to escape from the building safely if a fire did occur.

Ensuring early and reliable fire detection in an environment with extreme deceptive phenomena, such as those present at a rock concert with pyrotechnic effects, is a particularly difficult challenge. In such an environment fire detectors must be installed which allow their response characteristics to be adapted to fit the current risk and environmental conditions.

Special attention must be given to the safe evacuation of large numbers of people. To prevent panic there must be an adequate number of escape routes that are safe and well signposted. Additionally the visitors should be informed about the developing situation with clear announcements over a public address system. Designing the fire protection concept for an event venue must take all the various uses into account, with the worst case scenario constantly in mind.

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Introduction

Highlights

- The fire risk in an event venue varies considerably depending on the function.
- The fire protection concept should be designed for the worst case scenario.
- An orderly evacuation of large numbers of people requires an adequate number of escape routes and clear instructions.
- The installed fire protection systems must adapt automatically to different demands.

An event venue can be used for many different purposes. It normally consists of a large hall with a number of smaller areas, such as the foyer, cloakrooms, storerooms and rest rooms.

Many universities have an event hall with a floor area of between 600 m² and 3000 m² with a room height of between 8 m and 12 m. Some of the larger universities even have event halls with a floor area considerably larger than 3000 m² and a room height of over 12 m. Such large halls are mainly designed for sporting events and often have spectator seating.

The focus of this document is on the technical elements of fire protection for halls of up to 3000 m². Such halls may be used for the following purposes:

- Seminars or lectures where the audience attentively follows the presented topics while seated
- Festive occasions such as graduation ceremonies
- Banquets where the participants enjoy their gala dinners seated at tables
- Theatre and film evenings where the audience follows the performance while seated
- Rock concerts and dances where a party atmosphere is created with laser light effects and fog machines, and large numbers of people celebrate exuberantly
- Exhibitions where people move around freely

As the above list shows, the number of people in the room can vary greatly depending on the current usage. These differences also apply to the fire risk and to the environmental conditions that can affect reliable fire detection. The fire risk during a seminar or lecture is relatively low and there are no environmental conditions that could make fire detection difficult. The situation during a rock concert, however, is quite different, where many people may be celebrating excitedly and fog machines or even pyrotechnic effects are being used to create a party atmosphere. During such an event there is a considerable fire risk and the environmental conditions make reliable fire detection much more difficult.

When designing the fire protection concept for an event venue all the different usages must be taken into consideration. The structural measures must be designed to handle the worst case scenario, whereas the

organizational and technical measures must provide flexibility, so they can be easily adapted to any particular situation.

Basic conditions

Objectives

- Fire protection that can be adapted to meet the different fire risks
- Timely alerting and orderly evacuation of all endangered persons, enabling them to leave the danger area safely
- Prevention of unnecessary fire alarm and evacuation scenarios and needless fire brigade calls

Typical fire hazards

- Overload or short-circuit of electrical or electronic equipment and electrical installations
- Structures or decorations made of flammable materials that are in close proximity to hot items such as spotlights
- Careless handling of open flames (candles, flaming torches, pyrotechnics) or smoking materials (in spite of no-smoking and other fire regulations)

Typical development of a fire

In an event venue we cannot talk about a typical fire development. A fire may develop from a smoldering fire or can just as easily start directly as an open fire.

- An overload or short-circuit of electrical equipment can lead to a fire that begins with a smoldering phase which generates increasing quantities of visible smoke. If such a fire can be detected in the early stages, it can be dealt with easily (e.g. by removing power from the device).
- If flammable materials come into contact with a powerful heat source or with an open flame, this can easily lead to an open fire. If such a fire can be detected early enough it can frequently be extinguished with water, a fire blanket or an appropriate hand-held fire extinguisher.

Critical Points

- Varying fire risks and changing environmental conditions
- Reliable fire detection even under difficult conditions – prevention of false alarms caused by aerosols from fog machines or intense heat development from pyrotechnics (although these should be prohibited)
- Safe and orderly evacuation of large numbers of people – preventing panic situations arising

Solution

The primary aim is to reduce the risk of fire occurring. In addition to the technical fire protection measures described below, there are also organizational and educational issues.

Depending on the size of the room and the current function, the number of people present in the room can vary from a few individuals to a thousand or more. Frequently the number of people is very large and it is not surprising that life safety is clearly the highest priority in event venues. The risk of personal injury in the event of fire, however, can be considerably reduced by well-coordinated structural, organizational and technical measures.

Structural measures

Structural measures must be based on the worst case scenario. In the event of fire, it must be ensured that large numbers of people can escape from the building safely and quickly, and that fire is not allowed to spread to other parts of the building. To achieve these objectives, the following requirements must be fulfilled:

- The building must be subdivided into a number of fire compartments
- Storage rooms, technical rooms and staircases must be fitted with fire doors and all relevant doors must be self-closing
- At least two escape routes with unrestricted access must always be available
- The building must have sufficient openings to allow smoke and heat to vent to the atmosphere
- A suitable access route must be provided for the fire brigade and auxiliary services

Organizational measures

The most important organizational measure is strict enforcement of the fire safety guidelines which focus on the following issues:

- **Prevention of fire occurring** Enforce smoking bans; store flammable material in secure places; use waste containers made of non-flammable materials (with lids); check electrical equipment regularly; only use decorations made of fire retardant materials.
- **Keeping escape and rescue routes clear** Do not use escape routes for any type of storage; prevent smoke from spreading to neighboring fire compartments (close fire doors); ensure that emergency exits are neither locked nor obstructed in any way.
- **Actions to be taken in the event of fire** Report the fire; pay attention to the alarm signals and give appropriate instructions; assist any disabled and/or injured persons to get to a place of safety; do not use elevators.
- **Autonomous extinguishing of small fires** Remove power from the electrical equipment concerned; use a fire blanket or hand-held extinguisher.

In addition staff must be trained at least once annually in the fire safety regulations and in the operation of the fire protection and extinguishing equipment.

For functions with large numbers of people, additional trained security staff may be required to supplement those measures specified in the fire safety policy.

Regular testing and maintenance of all safety related systems, however, is also an important part of the organizational measures.

Technical measures

The relevant technical measures include the fire protection and warning system, the smoke extraction system, the emergency lighting and the extinguishing system.

The fire protection system must be able to detect a fire reliably and at an early stage. Since the fire risk and the environmental conditions in an event venue can vary considerably, depending on the function concerned (rock concert or seminar) the fire protection system must be able to adapt easily to the particular conditions. In addition to detecting the fire, the fire protection system is also responsible for activating the warning devices and the smoke control system.

Successful self-rescue can be assisted by a voice alarm system, which informs the endangered persons of the situation and tells them what to do.

In the event of fire, smoke must be extracted from the event hall and escape routes to enable the people to escape from the building safely. For rooms with a floor area of over 1,000 m² an automated smoke extraction system should be installed; in smaller rooms the smoke may be vented through openings in the roof or through windows and doors.

The emergency lighting must ensure that if the normal lighting fails, all persons are still able to find their way out of the building. As many people may be present who are not conversant with the building layout, appropriate emergency exit directional signs should be installed at regular intervals along the escape routes. In addition, all exits should be indicated by illuminated emergency exit signs.

Event venues must be equipped with appropriate extinguishing equipment. In the various areas such as the foyer, meeting rooms, stage and corridors, an adequate number of hand-held fire extinguishers must be provided in clearly visible and easily accessible locations. Additionally, halls in excess of 1,000 m² should be provided with wall-hydrants. In some countries it is also a legal requirement that automatic extinguishing systems (sprinklers) must be installed in event venues; these are primarily intended to protect the building itself.

Every event venue must be equipped with an emergency power generator, which is able to provide sufficient power for all safety related systems for a pre-defined period of time. In the event of fire this includes the alarm system, the automated smoke control system, the emergency lighting and the pumps for any automatic extinguishing system.

Coordinating the individual measures

Fundamentally, fire protection in a building must always be based on the greatest possible fire risk. If a rock concert with several thousand fans is held at an event venue, the fire risk is obviously considerably higher than is the case for a seminar or lecture with an audience of several hundred. Consequently the fire protection measures must be designed to handle the more demanding scenario.

For a rock concert the following factors must be given due consideration:

- The building will contain a large number of people who are celebrating excitedly.
- The danger of fire will be significantly increased by the additional numbers and the threat posed by the various ignition sources (additional electronics, hot light sources, or even pyrotechnics).
- Fog machines with laser light shows and pyrotechnic effects, which are often used to create a more exuberant atmosphere, generate deceptive phenomena which make fire detection at an early stage considerably more difficult.
- The loud music will make it more difficult for people to hear fire alarm.
- Ensuring an orderly evacuation of large numbers of people can be a major challenge.

Since the structural measures cannot be adapted, or can only be adapted in a very limited manner, they must be designed for the worst case scenario. Consequently the escape routes must be designed to ensure that the maximum imaginable number of visitors can be evacuated safely.

With regard to the technical measures, systems should be selected which can be adapted to the requirements of any specific event. For example, during an exhibition the fire protection system must be able to detect a smoldering fire; during a rock concert the system must be so robustly set-up that the deceptive phenomena present will not cause any false alarms.

It is the organizational measures that demand the greatest flexibility. For example during an exhibition or seminar, alarm warnings can be given via the voice alarm system. In the case of a rock concert or disco, however, such a solution on its own would be inadequate, as people would not take any notice of the announcements. During such functions the security staff must ensure that the music is stopped and the lighting returned to normal levels. Only in this way can the people be made aware of the danger and be alert to the announcements made via a microphone.

Typical events may include discos or rock concerts ...



Example: Event venue for up to 3,000 persons

The fire protection solution described below is based on a single-story event venue with a hall, a stage and several side rooms (see Figure 1).

The hall has a floor area of 1,000 m² (40 x 25 m) and a ceiling height of 9 m. The stage has a floor area of 200 m² and a ceiling height of 7.5 m. The room height of the remaining areas is a maximum of 4 m. The hall is intended to be used for seminars, banquets, exhibitions, theatrical performances, concerts, discos and various other functions. With seating, events for up to a thousand visitors can be held: without seating (rock concert, disco) the number of visitors is limited to 3,000 persons on security grounds.

The proposed solution focuses primarily on those aspects relating to technical measures. It is assumed that structural measures are appropriate for the intended use and the necessary organizational measures are specified in the fire safety regulations – which are strictly complied with and reinforced by regular training.

Fire protection system

A fire protection system is installed which is able to automatically adapt its behavior according to the various types of function. In particular this applies to:

The response behavior of the installed fire detectors

During an exhibition the detectors in the main hall and stage area will react very sensitively, however, during a rock concert with a laser light show they will react very robustly. During events where pyrotechnic elements (open flames, profuse smoke generation) are employed and consequently individual detectors in the stage area may need to be isolated for limited periods of time, the reduction of technical supervision must be compensated for by a corresponding increase on the organizational side (with security staff providing supervision of the stage area).

Control of the subsequent systems

Depending on the event, and where and how the alarm was triggered (manual call point or automatic detector), the subsequent systems may be controlled in different ways. A fire alarm will automatically activate a voice alarm announcement and close all fire doors. If the alarm was initiated by an automatic detector in the hall or stage area, the smoke extraction system will also be activated. Should this occur during an event with large numbers of visitors, then the security staff will be warned via pager (or similar mobile devices).

If the situation is considered by the security staff to be critical, they will activate a manual call point. The hall lighting will then automatically be returned to full brightness and the power to the music systems cut. Subsequently a manual announcement will be made via microphone.

The automatic fire detectors must guarantee early and reliable fire detection. To achieve this, smoke detectors, multi-criteria fire detectors and/or flame detectors should be installed in the relevant areas. The fire protection system can also modify the behavior of the fire detectors according to the risk (e.g. source of the fire, number of visitors) and the deceptive phenomena expected (e.g. fog machines, pyrotechnic effects). This may be a fully automated process which depends, for example, on the time of day: normal mode during the day, but disco mode between 20:00 and 03:00. Alternatively, the mode may be selected manually via a multi-position control switch:

- Pos. 1 = Seminar;
- Pos. 2 = Exhibition;
- Pos. 3 = Theatrical performance;
- Pos. 4 = Rock concert.

Based on this selection, the fire protection system will then automatically modify the behavior of the fire detectors using the predetermined settings that were optimized for the selected event.

Voice alarm system

Where event venues have an audience capacity of over 300, a voice alarm system approved to EN54-16 should be used. Such a system ensures that all endangered persons can be informed about the severity of an emergency situation via distortion-free announcements.

In addition to the automated transmission of pre-recorded announcements, the system must allow situation-specific announcements to be made via a microphone. When selecting the various components and during system installation, attention must be given to ensuring that the announcements will be sufficiently loud and clearly understandable in all areas.

Smoke extraction system

Due to the number of different ignition sources present, the greatest probability of fire occurring will be in the stage area. A smoke extraction system should therefore be installed in this area that will extract smoke from the ceiling. The system should be so designed that in the event of fire a smoke-depleted layer of at least 2.5 m can be ensured (providing visitors with sufficient visibility to exit the building). In addition, 4 automatically controlled smoke vents should be installed with a total area of 10 m² (1% of the floor area). These openings should be positioned at the highest point in the hall and vent directly into the open air. In the remaining areas the smoke will be vented via doors and windows. The opening of the smoke vents and the activation of the smoke extraction system will be controlled by the fire protection system; however, these may also be operated manually via a suitably positioned and clearly visible control panel.

Emergency lighting and exit signs

With the exception of the offices, all areas of the event venue should be equipped with emergency lighting. Appropriate signs should also be mounted along the escape routes and at the exits.

Extinguishing systems

To enable trained staff to extinguish small fires manually, an adequate number of hand-held ABC powder fire extinguishers (6 kg) should be installed in easily visible and accessible locations. To deal with larger fires two water hydrants should also be installed in the hall. In addition, the foyer, hall, stage area and escape routes should be fitted with a sprinkler system.

Although the solution presented here primarily focuses on technical measures, the necessary attention must also be given to structural and organizational measures. The declared objective "save life and minimize property damage" can only be achieved by the careful coordination of all relevant measures.

... and functions such as banquets or wedding receptions





Figure 1 Positioning of system elements

System elements	Rooms
1. ASA neural fire detector	A. Stage
2. Optical smoke detector	B. Hall
3. Manual call point	C. Foyer
4. Hand-held fire extinguisher	D. Bar
5. Flame detectors	E. Storeroom
	F. Cloakroom

Details	Comments/Notes
Foyer ASA neural fire detectors	Environment <ul style="list-style-type: none"> 420 m² floor area with a ceiling height of 9 m Minor influence by deceptive phenomena Detector behavior <ul style="list-style-type: none"> High sensitivity (standard behavior) Medium sensitivity during events with deceptive phenomena
Corridor ASA neural fire detectors	Environment <ul style="list-style-type: none"> 57 m long corridors and areas near rest rooms, with a ceiling height of 4 m Medium influence by deceptive phenomena Detector behavior <ul style="list-style-type: none"> Medium sensitivity (standard behavior) Robust behavior during events with deceptive phenomena
Hall ASA neural fire detectors	Environment <ul style="list-style-type: none"> 1000 m² floor area with a ceiling height 9 m Medium influence by deceptive phenomena Detector behavior <ul style="list-style-type: none"> High sensitivity (standard behavior) Robust behavior during events with deceptive phenomena
Stage ASA neural fire detectors Flame detectors	Environment <ul style="list-style-type: none"> 200 m² floor area with a ceiling height of 7.5 m Large to severe influence by deceptive phenomena Detector behavior <ul style="list-style-type: none"> Medium sensitivity (standard behavior) Very robust behavior during events with deceptive phenomena (no alarm activation without a temperature rise) Detector behavior <ul style="list-style-type: none"> Medium sensitivity (standard behavior) Isolation of detectors during performances with open flames
Ancillary rooms in stage area ASA neural fire detectors	Environment <ul style="list-style-type: none"> Small areas with varying ceiling heights Medium influence by deceptive phenomena Detector behavior <ul style="list-style-type: none"> Medium sensitivity (standard behavior) Robust behavior during events with deceptive phenomena
Visitors' cloakroom and ancillary rooms (e.g. offices) Smoke detectors	Environment <ul style="list-style-type: none"> Small areas with a ceiling height of between 3 and 4 m Minimal influence by deceptive phenomena Detector behavior <ul style="list-style-type: none"> Medium sensitivity

Further Comments/Notes

In addition to automatic fire detectors, manual call points are also installed to allow alarms to be activated manually.

Alternatively

If only minimal exposure to deceptive phenomena is expected in the hall, an ASD system could be installed in this area. The advantage of such a solution would be the increased sensitivity and lower maintenance effort required (as devices could be installed at normal working height). However, if an event were to be organized where deceptive phenomena are expected, then the ASD system would need to be switched off during the event as the risk of false alarms would be too great

Practical experience

There is no standard solution for event venues. The solution described above should be understood as a “solution for medium sized venues”. Larger venues with higher risk factors (e.g. large kitchens with a high danger of fire or long escape routes) require additional fire protection measures, so that the fire risk can be reduced to an “acceptable level”.

Fire prevention

Fire risk is the product of the probability of a fire occurring and the consequential damage of that fire. Consequently the risk can be reduced either by reducing the probability of a fire occurring and/or by reducing the consequences of such a fire. Practice shows that the probability of fire occurring can be markedly reduced by giving due attention the following two important issues:

Compliance with fire safety regulations

Compliance with clearly written, building-specific fire safety regulations can contribute greatly towards reducing the probability of fire. However, this will only be the case when the responsible members of staff are given the appropriate training. Strict enforcement of smoking bans, careful handling of flammable materials, safe usage of open flames and correct procedures in the event of fire are topics that need to be addressed. Events with large numbers of people and a heightened fire risk (e.g. rock concert with pyrotechnic effects) will require additional staff, who are trained for specific fire protection tasks and are well acquainted with the local organization.

Regular inspection of electrical equipment and installations

In an event venue there are numerous types of electronic equipment and electrical installations. Faulty electrical appliances or extension cables, and overloaded multiple power sockets are possible ignition sources that must be avoided. To minimize the danger posed by such equipment, they need to be tested regularly. Faulty equipment and installations that do not comply with current safety regulations must be repaired immediately or taken out of service.

Reliable fire detection

At events with large numbers of visitors, reliable fire detection is an absolute necessity. In this context the term reliable is understood to include early warning of an incipient fire together with minimal risk of false alarms. A delayed alarm heightens the danger for the visitors and false alarms can lead to staff not reacting quickly enough in the case of a genuine fire or that panic situations may arise amongst the visitors.

Depending on the type of event, the environmental conditions can vary considerably and the behavior of the automatic fire detectors must change accordingly. To determine the optimal behavior settings requires a good knowledge of the expected deceptive phenomena. Practical experience, however, has shown that a purely theoretical assessment of the deceptive phenomena does not provide a sufficiently sound basis for selecting the

most appropriate settings. Consequently the optimal response characteristics of the detectors must be determined by practical means; with the help of a suitable test fire combined with the generation of the expected deceptive phenomena.

Swift and orderly evacuation

People who are often present in a particular building are generally aware of the escape routes that must be used in an emergency and are able to get themselves to safety without difficulty. The situation for visitors who do not know the building, however, is a very different one. In the event of a fire, most people will try to leave the building the same way they entered, often ignoring quicker, more appropriate escape routes: others may panic if they are unable to find a suitable escape route quickly. In such cases they need the support of trained staff and clear orientation guidance in the form of escape route signage and appropriate instructions via a voice alarm system. The type of individual elements depends largely on the building layout and the number of people needing to be evacuated. In a small single story hall standard emergency exit signs and a general voice announcement would be adequate. In a larger hall with numerous levels it would require considerably more to achieve an orderly evacuation. In such a case a voice alarm system should be installed that allows individual loudspeaker groups to be addressed separately. Such a system would allow appropriate announcements to be made to people in different parts of the building, enabling a phased evacuation to be carried out.

Targeted extinguishing

Reliable fire detection and orderly evacuation help people get themselves to safety in good time. The extinguishing systems installed in such buildings primarily serve to minimize property damage. Small fires can be dealt with using suitable hand-held fire extinguishers. In the majority of cases the universally applicable powder extinguishers should be provided. As this type of extinguishing agent can cause considerable consequential damage, however, CO₂ fire extinguishers should be provided in areas which contain a large amount of technical equipment.

ASAtechnology

For intelligent, reliable fire detection with genuine alarm guarantee

ASAtechnology is a unique technology from Siemens that converts signals into mathematical data which is compared with programmed values in real time using intelligent algorithms. The special signal analysis process is very reliable in preventing false alarms caused by deceptive phenomena, such as steam, tobacco smoke or exhaust emissions.

Find out more about [Sinteso](#) or [Cerberus PRO](#) fire detectors with ASAtechnology.

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".
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- Clear and fast alerting and evacuation processes.

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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.

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