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TECHNICAL REPORT

colour inside

Managing fire risk related to photovoltaic (PV) systems on buildings

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Managing fire risk related to photovoltaic (PV) systems on buildings

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FOREWORD

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IEC TR 63226, which is a Technical Report, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this Technical Report is based on the following documents:

Draft TR	Report on voting
82/1500/DTR	82/1553A/RVDTR

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

PV systems provide electric energy in an environmentally beneficial way. They work silently, without pollution or other emissions and can be mounted nearly anywhere in close proximity to where people use electricity including living, working and sleeping facilities. However, since they contain electrical equipment, they share a similar risk of causing damage on both the DC side and on the AC side of an installation as any electric or electronic equipment.

This document is about fire prevention measures and additional measures for supporting firefighters. In general, PV systems are considered safe when relevant product and installation standards are applied. But even for PV systems installed according to relevant safety standards, there is a remaining risk that a fire is caused by the PV system. Additional measures are considered to further improve the situation at special locations, independent of whether the PV or an external event is the source of a fire. Also the restrictions to firefighters facing damaged PV systems in case of fire are considered in general.

At some locations or buildings there are greater needs due to higher risks. For such locations additional requirements often apply. This is why building and fire codes often vary based upon risks to safety. Also in the installation standards there are additional requirements for fire safety, for example IEC 60364-4-42 or IEC 60364-5-51. In case of higher risks regarding fire, people's safety, and financial risks, additional measures are reasonable depending on the building itself. This document is designed to assist PV designers and insurance companies to select suitable measures to address the on-site specific needs of special locations. This document contains measures for reducing risks in general and depending on the on-site conditions.

General information is provided to further reduce fire risks of PV systems. Also, information is given how to handle PV systems after a fire.

MANAGING FIRE RISK RELATED TO PHOTOVOLTAIC (PV) SYSTEMS ON BUILDINGS

1 Scope

This document, which is a Technical Report, is intended for use as guidance for reducing fire risks in general and for site-specific needs for buildings with PV systems. In addition to the general recommendations, technical, installation, and maintenance measures can be selected to reach the intended safety level of the PV system and building, depending on the results of a risk assessment. This document contains general information about building related risks and includes measures for reducing those risks. These measures are not general requirements or recommendations. They are explained as a guide for selecting suitable measures depending on the on-site needs.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 Risk evaluation

4.1 General

It is recommended to perform a risk evaluation, to identify, if additional measures are needed and which measures are reasonable in order to reach the intended safety level. Such a site-specific evaluation can help the needs of all stakeholders to be covered without putting unnecessary requirements on all PV systems.

4.2 Site selection

The selection of the site can have a major impact on the recommended measures. The designer should evaluate if the proposed building or part of the building is the best choice for a PV installation. Shifting to another part of the building, to another building or to a ground installation can be a reasonable step to avoid additional measures.

The fire zones and the position of fire protection walls should be evaluated. The PV array should not provide a fire path (bridge) between adjacent fire zones.

4.3 Aspects for building risk evaluation

4.3.1 Roofing materials

Roofing materials have an impact on how much damage an exterior fire will cause to a building. In some countries, for example USA, building codes require fire ratings of roofing systems based upon the occupancy of the building. Buildings, where people assemble, such as theatres and churches, require a higher level of roof fire ratings than warehouses. Both are susceptible to exterior fires, but the assembly occupancy has a higher risk to human life and is therefore required to have a more fire-resistant roof.

Roofing materials are tested for certain fire withstand capabilities. However, these product characteristics may not be sufficient to withstand the energy from an arc or fire caused by a fault. If a roofing material is capable of being ignited by an arc or fire caused by a fault, additional measures may be taken into account. Additionally, the presence of PV modules in close proximity to roofing materials may trap or radiate heat from a rooftop fire causing additional roof damage. The higher the fire resistance of the roofing system, the less likely a rooftop fire will cause widespread damage.

Depending on the occupancy of the building and the financial risk of loss for the building, it may be necessary to upgrade a roof system's fire resistance when a PV system is installed on the roof or use additional measures to reduce the fire risk. If the cost of upgrading the fire resistance of the roof or additional equipment is too high, then other installation locations should be considered that require less investment.

For buildings covered with exposed flammable roofing materials, additional safety measures should be considered to help prevent fire ignition. Flammable roofing materials include many common roofing materials such as bitumen, asphalt, tar paper, and various polystyrene and polyisocyanurate insulating materials. Higher fire-rated roofing systems that incorporate the most flammable polystyrene insulating materials normally include what is referred to as a cover board between the roof membrane and the insulation to prevent a fire on the membrane from involving the flammable polystyrene materials beneath the membrane.

All roofs in Europe – with or without PV – must comply with fire resistance classes according to CEN/TS 1187. There are four different regions with four different tests within Europe. Generally, the requirements are separated into building-integrated PV (BIPV) where PV modules need to comply with the same requirements as the roof skin and building-applied PV (BAPV) with lower requirements related to fire resistance such as ignitability.

Building products and building materials in Europe are classified according to the EN 13501 series, for example class E. Ignitability (e.g. in Germany for BAPV "normal ignitability" is required by building codes – DIBt) is tested according to ISO 11925 (all parts).

4.3.2 Building construction

Not only is the roof construction important to the fire risk of a building, the entire building construction is also important. Buildings constructed of concrete, brick, and stone are more fire resistant than steel or wood structures. The concern with building construction types may be accelerated building collapse or propagation of fire to adjacent structures.

4.3.3 Building contents

In the case of buildings that warehouse flammable materials, these contents can add significantly to the risk of loss should the fire originate inside the building or penetrate the roof and get into the building. Examples of flammable contents are polymeric materials, butter, and wood-based products. Should the fire engage these contents without adequate fire sprinkler systems to control the fire, contents fires are capable of destroying buildings, even those with good fire-resistant construction. The contents of buildings such as warehouses may change over the lifetime of the building and may require that the risk evaluation be revised based on the change of contents.

4.3.4 Use of building

4.3.4.1 General

Building use can play a major role in the risk profile of a project. The financial risk of a fire is closely related to the risk to human life and the risk to structures and building contents. A barn housing hay for livestock may be a low risk, particularly if the livestock is not housed in the structure. A warehouse storing consumer electronics may have a higher financial risk in case of fire. Thus a building full of people, such as a theatre or a shopping mall, has a much greater financial risk than either of the previous examples given the threat of loss of human life. These building types generally require more sensitive fire alarm and fire suppression equipment to help mitigate these risks. A PV system installation should take into account these varying levels of risk due to building use, especially with respect to the operation times (daylight) of the PV system, and employ the highest safety levels for buildings with the highest risks.

4.3.4.2 Building type considerations regarding risks to humans

Where risks to humans are involved, fire prevention measures and measures supporting firefighter safety are important (e.g. hospitals). Additionally, firefighters need quick access to the fire location to extinguish and avoid the spread of fire in the early stages of a fire before it becomes a problem for the people inside the building regardless of whether the PV was the cause or not. In order to access the fire, firefighters may need to open parts of the roof, depending on the location of the fire. Where this area is covered by PV modules, there is already a time delay, caused by removing modules and mounting structure.

Firefighting tactics vary from country to country. Therefore, measures for supporting firefighter activities should be chosen accordingly.

4.3.5 Building type considerations regarding financial risks

Additional safety measures may be selected according to the financial risks involved with losses at a particular building and place of business. This includes costs for any building contents and inventory as well as costs for interruption of the facility operations. For instance, a manufacturing process that is critical to the production of a particular product may require a high level of safety since the loss of facility production could interrupt the production of the final product. Facilities that have redundant manufacturing options would be a lower risk to the production. Also, the value of stored products will impact whether the facility has a higher or lower financial risk in the event of a fire. Safety measures should be selected based on the level of risk. Often the insurance company will determine the classification of risk.

In order to address financial risks, fire prevention measures are recommended as well as measures supporting firefighters. Damages and losses can be reduced when quick access to a fire location is enabled. This allows firefighters to extinguish the fire quickly and avoids the spread of fire in an early stage. In order to access the fire, firefighters often need to open parts of the roof. Where this area is covered by PV modules, there is additional time delay, caused by removing modules and mounting structure.

4.4 Measures for supporting firefighter and rescue service operations

4.4.1 General

Buildings are often constructed with a variety of measures that are intended to assist emergency responders in rescue and fire operations. The level to which these measures are employed is often correlated with the risk levels of the building, occupants and contents, and the response time available from the fire service and other emergency personnel. For example, buildings located more than 15 to 20 minutes from the closest fire response may need much more significant internal fire suppression equipment to address the longer fire response time.

4.4.2 Response times of emergency responders and available apparatus

When determining the overall risk of loss for a building, the response time of emergency personnel is an important factor. The difference between a 10-minute response time and a 20-minute response time after a fire is detected may mean the difference between a minor loss and a total loss. Also, the type of apparatus and water that is available (height of ladder trucks, water pressures, water volume, water source) can heavily impact the ability to fight a fire – particularly roof fires. Depending on the response time of fire services in general, and the location of water supply and ladder trucks, where needed for access, the risk for the building may change and additional measures may be taken into account.

4.4.3 Geometry, height, accessibility of building

4.4.3.1 General

Roof fires can be the most difficult to reach and engage for the fire service because of limited perimeter access to the building and the height and width of a building. A low-rise building with full perimeter access for large fire apparatus and limited width (under 50 m wide) may provide for the widest variety of fire-fighting apparatus to address a rooftop fire.

4.4.3.2 Height and width of building

The higher the roof with a PV system, the more difficult it is for firefighters to access and extinguish a fire. This delay leads to a higher spread of the fire, which leads to greater damage and the risk of a building loss. Building height also impacts the need for higher water pressure to get water to the middle of a roof. It is safest for the fire service if fire apparatus can fight the fire from the perimeter with minimal or no direct roof operations. For wider and higher roofs, rooftop standpipes may be necessary so that hose lines can be connected to a water source near the middle of the roof. This allows for water to be locally supplied from on-site water sources, reducing the need for off-site water sources and longer water spray distances. If this cannot be ensured, additional measures according to Clause 5 are recommended to lower risks.

4.4.3.3 Access pathways and fire response sections

Where PV systems are mounted on rooftops, access pathways need to be maintained if the fire service needs access for rooftop operations on the building. This requires coordination with the fire service at the design stage so that pathways can be laid out specifically before PV system construction. This may include identification of fire response roof sections planned in advance. Fire response sections can be established in the planning stage of a building or PV system installation so that there are adequate pathways from the roof perimeter to roof ventilation opportunities such as skylights and smoke hatches. Also, roof standpipe access should be provided from the roof perimeter so that hose lines can be quickly and easily deployed where necessary. Pathways through a PV array are important to keep firefighters away from conductors. For larger buildings and higher risk facilities, it is necessary to establish good communication with the local fire service so that valuable time is not lost at a fire scene due to poor information or communication. Access pathways should be included in the documentation (see 7.4).

4.4.3.4 Accessibility of roof

Perimeter access to a building's roof can be critical to the ability to fight a rooftop fire. Full perimeter access for large fire apparatus is ideal, but many buildings simply do not have the ability to provide for such access. For a building of any size, it is preferable to have at least two locations where ladders can access the roof from ground level. Those access points should be at locations where the fire service can deploy equipment and personnel at the roof level. Larger buildings will require wider access pathways around the perimeter. For example, in the USA the building codes require a 2 m perimeter for buildings larger than 80 m on a side and 1,3 m for buildings smaller than 80 m on a side. Bad accessibility of the PV array – for example due to height, long distances (to walk) or restriction in using ladders – increases the risks. This leads to additional measures to compensate. Additional measures may include installing fixed ladders to compensate and prevent further delays.