TECHNICAL BULLETIN

METAL CONSTRUCTION ASSOCIATION

Lightning Strikes and Metal Roofing

Overview

In every aspect of our daily lives, we are surrounded by electronics. Whether the television we're watching, the computer we're working on, or the lights we are reading by, our lives are dependent on electricity in both our homes and workplace. Taking this into consideration, a lightning strike on an occupied building is a concern not only for the electronics surrounding us, but for the risk of fire caused by that strike. Concern over the use of metal roofs in construction has raised the issue of whether metal roofs attract lighting strikes more than other types of roofing materials.

Research has shown that the material used in roof construction does not influence the risk of a lightning strike. There are several other factors that may influence the risk of a lightning strike that will be discussed however the presence of a metal roof may actually be beneficial in a situation where a lightning strike has taken place.

Discussion

Concern over the impact of effect of lightning and lightning strikes is not a new item. Research and the earliest comments on the effect of lightning go back to 1752 when Benjamin Franklin performed his famous "kite and key" experiments. Franklin's original idea was to use a sharp point to draw charges from a cloud and then discharge that charge to prevent lightning and lightning strikes that could cause far greater loss of property and life.

Generally speaking, lightning is a flow of negatively charged electrons from the clouds looking for the path of least resistance to the positively charged surface of the earth. The visible means of transport is a lightning bolt that can carry millions of volts of devastating power. While the dramatic part of the strike is the flash of light, the average length of a lightning flash is only about 30 microseconds. Though short in duration, the overall impact of a lightning strike can be tremendous. If the electrical charge is strong enough and no continuous direct path is available, lightning can also arc from one material to another. Resistance to this flow of electricity generates heat energy that may cause explosions, fires, and other significant damage.

A great deal of research has gone into the science of lightning protection in the 20th century. Most notable is the creation of a standard to determine the level of hazard and where lightning protection is most required and how lightning protection should be installed on a structure (NFPA 780). Development of a model for lightning protection has also been developed and incorporated into some European standards since the early 1960's (Horvath). Finally, the development of a National Lightning Detection Network (NLDN) in the 1990's resulting from university research going back to the 1970's had greatly improved the understanding of lightning and lightning strikes.

In assessing the risk of a lightning strike, two different areas of concern need to be analyzed.

- *Probability* of a lightning strike
- *Consequence* of a lightning strike.

The use of lightning protection systems have been shown over many years of experience to lessen consequence of a strike.

Probability of a lightning strike

There are no practical measures known that can lessen the probability of a lightning strike.

The probability for a building to experience a lightning strike is influenced by a number of significant factors:

1. **Area Topography**: The probability of a lightning strike is increased when the subject building is located on an elevated site such as a mountain or hilltop as lightning is drawn towards the highest object in a strike area.
2. **Height of the Building**: A tall building, relative to other structures in the surrounding area is more likely to have a lightning strike than a building that is the same relative height as surrounding structures (buildings, trees, towers, etc.) The presence of a very tall structure in proximity to a small, short building will tend to reduce the likelihood of a strike to the small building.
3. **Size of the Building**: While not necessarily the tallest structure in a strike area, those buildings covering a larger surface area provide a more accessible target for lightning strikes.
4. **Frequency/Severity of Thunderstorm Activity**: Certain geographic areas are more prone to the development of storms that lead to lightning and lightning strikes.

Note that none of the significant factors above include the material used in construction of the roof. Metal roofs **do not** attract lightning strikes; nor do metal roofs protect a building against lightning.

A metal roof is no more or less likely to get struck by lightning.

Based on the factors listed above, the probabilities of a strike to a metal-roofed structure are no more or less than any other kind of structure, as these probabilities have to do with height and size of the structure and its surroundings rather than its construction materials.

Consequence of a lightning strike

In order to adequately assess risks involved with lightning events, the consequence of a strike must also be studied. In other words, what will happen if lightning does strike a subject building?

Obviously, there is a potential threat to human life associated with a lightning strike in addition to the threat of damage to either the contents of the building, the building itself, or both. These threats are affected by the following factors:

1. Construction Materials: Conductivity of both framing and roof covering materials is key to performance in case of a lightning strike. If these materials are (electrically) conductive, the electrical charge will pass through these materials and not build up heat through material resistance. The threat of fire and explosion are both reduced also reducing the threat to human life.
2. Noncombustible Materials: While the use of metal roofing will provide a conductive material that will transfer and dissipate the charge rather than build heat causing a potential fire, if the construction materials are noncombustible, the threat of damage due to fire is reduced. These materials will not contribute a fuel source to any fire resulting from a lightning strike.
3. Building Contents: The physical contents of the building can increase the overall risk. If the contents are flammable, the risk of a major fire or spread of fire to other portions of the building or between buildings is increased. If the contents are highly sensitive electronic or other equipment the possibility of damage due to arcing of an electrical charge can be quite high leading to loss of apparently untouched equipment.
4. Building Occupancy: High occupancy buildings such as schools and churches would be considered to be at a higher risk than unoccupied or sparsely occupied buildings. Not only is there danger posed by the initial electrical charge, but the chance of fire and smoke is increased and poses a threat to human life.

5. Building Location: If the building is remote with respect to fire fighting and medical emergency response, the risks of physical loss due to fire as well as human perils are increased.

Summary

Based on all of the available evidence, on any given building, a metal roof is no more or less likely to be struck by lightning than any other type of roofing material. In fact, a properly grounded metal roof, in accordance with the requirements of NFPA 780, will actually conduct the energy from a lightning strike over the broader area of the roof reducing the amount of heat transferred to the building and reducing the potential of damage do to fire. As an electrical conductor and a noncombustible material, the risks associated with use of a metal roof may even be a more desirable construction option.

It should still be stated that to minimize the risk of damage due to a lightning strike, it may in some cases, be prudent to consider additional lightning protection. A lightning protection system provides for a continuous conductor from sky to earth (and vice versa) so that the electrical charge is furnished a path of least resistance through which electrical energy can flow, thereby reducing the risk to (electrically) resistive construction materials and human life.

For additional information on the use of lightening protection, see NFPA 780 Standard for the Installation of Lightning Protection Systems. 2017 edition. National Fire Protection Association, Quincy, MA.

References

- The Basis of Conventional Lightning Protection Technology; Report of the Federal Interagency Lightning Protection User Group June 2001.
- NFPA 78 Lightning Protection Code (Inactive)
- NFPA 780 Standard for the Installation of Lightning Protection Systems (2017)
- Development of the National Lightning Detection Network by Richard E Orville; American Meteorological Society (BAMS February 2008)

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