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High risk industries for advanced lightning protection system

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ABSTRACT

Lightning strikes are a serious risk for high-risk facilities like oil and gas plants, mines, explosive storage, and data centers. These places hold the sensitive equipment and dangerous materials, and a lightning strike can cause major damage, leading to expensive downtime or even disastrous events such as fires or explosions. That's why having a strong lightning protection system is not just a matter of following rules, but it is crucial for protecting both people and property. The complete lightning protection solutions designed to meet the specific needs of these critical industries. The services include lightning simulations and both isolated and attached lightning protection systems. This study investigates the real-time installation and testing of advanced lightning protection systems across high-risk industries like oil and gas plants, mines, explosive storage, and data centers. This ensures that the facility stays safe and continues to operate, even during severe weather. By investing in an effective lightning protection system, you can help secure your assets and keep everyone safe, focusing on what really matters in your industry.

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1. INTRODUCTION

There are so many issues happening in high-risk industries, like oil and gas plants, mines, explosive storage, and data centers. These places hold sensitive equipment and dangerous materials. During the lightning strike hit. It may be hit directly at the structure, fire exposures, or sensitive equipment. In this paper [1]-[3], the authors executed their solutions for this concern by determining the possibilities of lightning strikes hitting the industry buildings. And they planned to protect the internal equipment and workers during the lightning strikes. During the lightning strike, a large amount of energy will be generated that should cause damage to the structure, electrical and electronic equipment, workers, employees, and humans with lightning interactions and lifelines. To overcome the problem, the author implemented the solution, for this is they used wood, rocks, and clay to reduce conductivity. And this is another method for lightning protection for high-risk industries. Authors presented [4]-[7] the related interactions and safety measures during lightning strikes in high-risk industries. Many people don't know when lightning strikes happen in certain areas, such as construction areas, oil, and gas industries, and how to prevent them. Because 70-80% of the bolts of thunder spark reach the ground and ground objects are harmless, but the most dangerous areas are construction areas and high-risk industries are most dangerous. Because the internal sensitive equipment will react very quickly. So, it will harm full and takes to death to the peoples like internal workers and employees, so in this paper, the authors use a lightning metal rod that is directly connected to the ground to discharge the lightning current.

Authors implemented in [8]-[13] metallic conductors to transfer electrical current into the ground for lightning current overvoltage protection. Because when lightning strikes happen on large buildings or industries, they may cause severe damage; that is why the authors came up with this solution. A lot of research is ongoing on these issues, but some problems still lack effective solutions. Therefore, we are implementing an advanced lightning protection system for high-risk industries. In this method, a large amount of lightning current is safely grounded. When a lightning strike hits high-risk industries, hospitals, and commercial buildings, a large amount of energy is generated, which may cause serious damage and losses. The damages and losses include structural damage, injury to living beings due to electric shock, physical damage, fire explosions, mechanical destruction, chemical release due to lightning current effects, internal system failures, loss of human life, disruption of public services, and cultural loss [14]-[20]. To minimize these damages and losses, we proposed a new solution, namely an advanced lightning protection system for high-risk industries. This system minimizes damages and losses during lightning strikes by following IS/IEC standards and by installing real-time down conductors and conducting real-time testing.

2. BLOCK DIAGRAM

The block diagram of high-risk industries for an advanced lightning protection system is shown in Figure 1. The overall process of the system works when a lightning strike happens in the high-risk industries and commercial buildings. and how the implemented system will work during lightning strikes. That will be explained in this paper. When a lightning strike or lightning flash happens in high-risk industries and commercial buildings, that time the large amount of energy is generated. That should damage the structure of the building and the damages and losses are structure damage, injury of living beings by electric shock, physical damage, fire explosion, mechanical destruction, chemical release due to lightning current effect, internal systems failures, loss of human life and service to the public and loss of culture. To minimize these, we came up with this new method called high-risk industries for an advanced lightning protection system, real-time installation, and testing. Our system works on one strategy, and we provide as two categories. One is a general lightning protection system, and another one is a special lightning protection system [21]-[25]. The general lightning protection system we follow is the one ICE 62305-3 standard, it is focus on the structure, physical damage, and life hazards. When a lightning flash happens in any high-risk industries or commercial buildings, this standard will be applied, and another one is the special protection system IEC 62305-4 it is focus on the designing, installation, inspection, maintenance, and testing of surge protection measures for electrical and electronics systems to reduce the risk of permanent failures due to lightning electromagnetic impulse within the structure. This standard focuses on the installation, inspection, maintenance, and testing to reduce the permanent failures from the surges during lightning strikes.

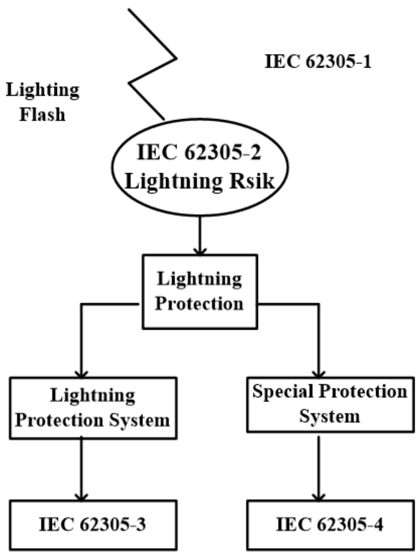

Figure 1. Block diagram of high-risk industries for advanced lightning protection system

3. METHOD

In this paper, we will explain the real industry selection, site selection, selection of materials, real-time installation, and real-time testing results in detail, and how industries deal with real-time lightning strikes in high-risk industries and buildings. The selection process is very important when installing a lightning protection system in high-risk industries and commercial buildings. We follow the IEC 62305 standard for selecting high-risk industries and commercial buildings. First, we will discuss high-risk industries [26]-[30]. In the selection of industries for a lightning protection system, we prefer high-risk industries because they contain sensitive equipment and dangerous materials, and a lightning strike can cause major damage to these industries. That is why we strongly recommend a lightning protection system for high-risk industries to protect equipment and human lives from lightning strikes. The selection of high-risk buildings is also important because it depends on the height of the buildings. We prefer buildings above 15 meters in height for installing the lightning protection system because buildings above 15 meters have a higher chance of being struck by lightning. Therefore, we prefer to install lightning protection systems in buildings above 15 meters in height, whether in hospitals or commercial buildings.

Materials used description of lightning protection system used: In the high-risk industries for advanced lightning protection systems, we used some materials. There are 10 mm MS (mild steel) solid round down conductor, 10 mm copper bonded solid round conductor, earth stud, conductor holder, 10 mm MS and stainless steel (SS) cross link connector, vertical air terminal, lightning event counter, MMR-620, and Vernier scale. The functions of these materials are explained as follows. The 10 mm MS solid round down conductor is used for discharging or grounding the lightning strike current. This conductor grounds the large amount of high current without disturbing the internal lines in the high-risk industries and commercial buildings.

Another one is 10 mm copper bonded solid round conductor: This 10 mm copper bonded solid round conductor is also used for grounding purpose and it has higher conductivity compared to MS conductor, but it is more expensive compared to MS conductor. Another one is earth stud: This earth stud is used for earthing and testing purpose because the continuity test is performed by connecting the earth stud. Mainly, it is used for earthing in the high-risk industries. Conductor holder: conductor holder is used for holding purpose on the parapet wall to avoid disturbances from the wind and rainfall. 10 mm MS and SS cross link connector: 10 mm MS and SS cross link connector is used for connecting the two conductors in cross direction for looping purposes. Vertical air terminal: This vertical air terminal is used for catching or collecting lightning strikes. It is connected with down conductor to pass the lightning strike current to the ground. Lightning event counter: Lightning event counter is used to count the lightning strikes. It stores the data with date, time, and year in the memory card. MMR-620: MMR-620 is a testing device used for continuity testing in the high-risk industries and commercial buildings to check whether the lightning protection system is systematically installed or not. Vernier scale: Vernier scale is used for conductor thickness checking purpose.

4. REAL-TIME INSTALLATION PROCESS

This section discusses the real-time installation process in detail for the lightning protection system for high-risk industries. The installation process is very important for any real-time system before testing the system in real time. In these high-risk industries, the advanced lightning protection system is installed step by step by following the guidelines. Figure 2 shows the connection of the earth stud with the MS solid round conductor inside the wall. In our installation process, we use the MS solid round conductor from below ground level to the top floor of the industries or commercial buildings. The MS conductor is connected with the earth stud on each floor, and it is also connected with many other devices and materials such as the vertical air terminal and lightning event counter [31]-[35]. These are the main components of the advanced lightning protection system for high-risk industries. Without these components, we cannot test the lightning protection system properly or obtain accurate results. Figure 3 shows the installation of the MS solid round conductor with the conductor holder. The MS solid round conductor is used to carry the lightning current to the ground. This conductor runs along all sides of the buildings. Figure 4 discusses the installation of the vertical air terminal. In real time, the air terminal catches the lightning strikes and passes the lightning current through the MS solid round conductor to the ground level without disturbing the internal equipment of the industries or commercial buildings. Figure 5 shows the installation of the lightning event counter. The lightning event counter is connected to the MS solid round conductor to record lightning strike events. Table 1 shows the predefined values of the MMR-620 device.

Figure 2. Connection of the earth stud with an MS solid round conductor inside the wall

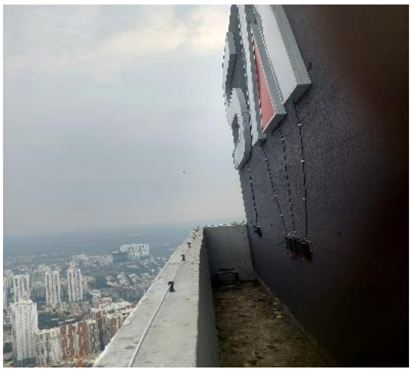

Figure 3. Real-time installation of an MS solid round conductor

Figure 4. Installation of a vertical air terminal

Figure 5. Installation of the lightning event counter

Table1. MMR-620 device predefined values

Range	Resolution	Test current	Accuracy
0...999 μΩ*	1 μΩ	10 A	
1.000...1.999 mΩ	0.001 mΩ	10 A	
2.00...19.99 mΩ	0.01 mΩ	10 A	
20.0...199.9 mΩ	0.1 mΩ	1 A	
200...999 mΩ	1 mΩ	0.1 A	± (0.25% m.v. + 2 digits)
1.000...1.999 Ω	0.001 Ω	0.1 A	
2.00...19.99 Ω	0.01 Ω	10 mA	
20.0...199.9 Ω	0.1 Ω	1 mA	
200...1999 Ω	1 Ω	0.1 mA	

5. REAL-TIME INSTALLATION TESTING RESULTS

In real-time testing of high-risk industries for an advanced lightning protection system, the connections, equipotential bindings, earthing conductors, and continuity test are checked first in the industries and commercial buildings. This continuity test is very important because it defines whether the lightning protection system is properly installed or not. We use some devices to check the continuity test, but the most commonly used device is the MMR-620. This device gives accurate results for the continuity test. Figure 6 shows the MMR-620 device, and Figure 7 explains the working of the MMR-620 device. This device helps to check the connections, equipotential bindings, earthing conductors, and continuity test in the lightning protection system. While testing the lightning protection system for high-risk industries, we check the connections, equipotential bindings, earthing conductors, and continuity test using this device. The predefined testing value is 0.2 ohms. If the device exceeds this value during testing, it means that the installation is not properly completed or the conductor is not properly installed. These are the main reasons for this problem during the testing process [36]-[40]. Table 2 shows the output results for the lightning protection system.

Table 2. Output results for the lightning protection system

MMR-620			
Tested output results	Range value	Test current	Accuracy
33.0 m Ω	20.0...199.9 m Ω	1 A	± (0.25% m.v. + 2 digits)
14.2 m Ω	2.00...19.99 m Ω	10 A	
86.48 m Ω	20.0...199.9 Ω	1 mA	

Figure 6. MMR-620 continuity test device in off position

Figure 7. MMR-620 continuity test value

Figure 8 shows the testing in commercial buildings. Figure 9 describes the lightning protection system testing on connections, equipotential bindings, earthing conductors, and continuity test for another MS solid round conductor in the commercial building. Figure 10 shows the lightning event counter. The lightning event counter is used for storing the data of lightning strikes with time and date. When lightning strikes happen in high-risk industries, the lightning event counter stores the lightning strike data in digital form.

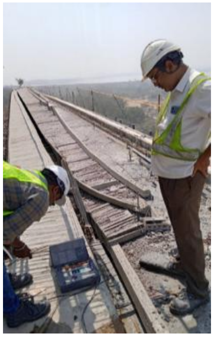

Figure 8. Testing in a commercial building

Figure 9. MMR-620 continuity test for random MS solid round conductor

Figure 10. Lightning event counter

6. CONCLUSION

This paper gives a solution for lightning strikes. Lightning strikes are very dangerous to high-risk industry facilities such as oil and gas plants, mines, explosive storage facilities, and data centers. These places often contain sensitive equipment and dangerous materials, and a lightning strike can cause major damage, leading to expensive downtime or even disastrous events such as fires or explosions. Having a strong isolated lightning protection system for high-risk industries is not just a matter of following rules, but it is also crucial for protecting both people and property. The complete lightning protection solutions are designed to meet the specific needs of these critical industries. The services include lightning simulations and both isolated and attached lightning protection systems. Our aim is to provide electrically insulated solutions with down conductors and lightning rods that can handle up to 100,000 volts. This ensures that the facilities stay safe and continue to operate even during severe weather conditions. By investing in effective lightning protection systems, industries can secure their assets and improve overall safety.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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