

Investigation and Analysis of Lightning Disaster in a Coal mine

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Abstract Based on the site investigation of a lightning stroke accident in a coal mine in Weiyuan County during a strong thunderstorm process on the night of August 10, 2024, combined with the investigation data of the accident site, the causes of the lightning stroke accident were analyzed, and the corresponding rectification suggestions were put forward.

Key words Coal mine; Lightning disaster; Investigation; Analysis

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On the evening of August 10, 2024, a thunderstorm process occurred in Weiyuan County, so that some monitors in the monitoring room of a coal mine in this county could not operate normally, and the fault was rectified after the control boards of the monitors were replaced. In this paper, the lightning accident in the coal mine was analyzed, and some rectification suggestions were put forward.

1 Site investigation

The staff of the monitoring room said that when it began to rain, it thundered several times, but the monitoring system could still operate normally. At about 24:00, it thundered suddenly several times, and the thunder was loud. As a result, some monitors in the monitoring room could not operate normally, and after re-starting, they were still unable to return to normal. After the control boards of the monitors were replaced, the monitors operated normally.

The monitoring room is located on the first floor of the office building of the coal mine, and the office building is an all-metal structure. There are 8 grounding electrodes, and grounding resistance is 3.8Ω . The monitoring signal from the mine and the factory is sent to the optical signal modem in the eastern machine room by optical cables. The electrical signal cable after demodulation by the optical modem is laid in the non-metal bridge, and it is sent to the next monitoring room as a display signal.

2 Analysis

According to the site investigation and inspection, the direct lightning protection of the office building of the coal mine is qualified.

Through further inspection, it is found that in the non-metal bridge of the signal cable output from the optical signal modem, not only the signal cable is laid, but also a grounding cable for protection, a power supply cable and signal cable are in the same non-metal cable slot, while the signal cable is not shielded (Fig.1). It does not comply with the safety spacing specified in Table 5.3.4-1 and Table 5.3.4-2 in the *Technical Code for Protection of Building Electronic Information System Against Lightning* (GB 50343-2012)^[1].



Fig.1 Power cables and signal cables installed in the same non-metal cable slot non-metal cable trays

According to Table 5.3.4-1 in the *Technical Code for Protection of Building Electronic Information System Against Lightning* (GB 50343-2012), it is stipulated that the minimum parallel net distance between electronic information system cables and protective earth cables shall not be less than 50 mm (Table 1). Table 5.3.4-2 specifies that the minimum spacing of 380 V power cables (with the capacity of less than $2 \text{ kV} \cdot \text{A}$) and electronic information system signal cables during parallel laying is 130 mm (Table 2).

Table 1 Spacing between electronic information system cables and other pipelines

Other pipelines	Clear distance between electronic information system cables and other pipelines	
	Minimum parallel net distance//mm	Minimum crossing net distance//mm
Lead line for lightning protection	1 000	300
Protective earth cable	50	20
Feed pipe	150	20
Compressed air pipe	150	20
Heat pipe (not enveloped)	500	500
Heat pipe (enveloped)	300	300
Gas pipe	300	20

Note: When a cable is laid at a height of more than 6 000 mm, the crossing net distance between the cable and the lead line for lightning protection must be greater than or equal to $0.05H$ (H is the distance between the lead line for lightning protection and the ground at the crossing point).

Table 2 Spacing between electronic information system signal cables and power cables

Class	Proximity to electronic information system signal cables	Minimum spacing//mm
380 V power cables with the capacity of less than $2 \text{ kV} \cdot \text{A}$	Parallel to the signal cabled	130
	One side is in a grounded metal trough or steel pipe	70
	Both sides are in a grounded metal trough or steel pipe	10
380 V power cables with the capacity of $2 - 5 \text{ kV} \cdot \text{A}$	Parallel to the signal cabled	300
	One side is in a grounded metal trough or steel pipe	150
	Both sides are in a grounded metal trough or steel pipe	80
380 V power cables with the capacity of more than $2 \text{ kV} \cdot \text{A}$	Parallel to the signal cabled	600
	One side is in a grounded metal trough or steel pipe	300
	Both sides are in a grounded metal trough or steel pipe	150

Since the power supply cables, signal cables and protective earth cables from the equipment room to the monitoring room are mixed in the same non-metal cable trough, their spacing seriously does not meet the requirements of the *Technical Code for Protection of Building Electronic Information System Against Lightning* (GB 50343 – 2012). When lightning flashes in the office building, the strong electromagnetic field generated by the lightning surge as it drains down the lead line is induced to the signal cables, protective earth cables, and power cables in the non-metal cable trough without electromagnetic shielding effect. Then, the lightning surge pulses are induced in the power supply cables, signal cables and protective earth cables, so that the lightning surge induced in the signal cables would damage the control boards of the monitors.

3 Rectification suggestions

Based on the electromagnetic shielding principle, the electrical signal output from the optical signal modem is laid in the metal bridge, and the metal bridge should be earthed. In order to ensure the electromagnetic shielding efficiency of the metal bridge, the joint of the metal bridge should be made of equal potential jumper. According to the spacing specified in Table 5.3.4 – 1 and Table

5.3.4 – 2 in the *Technical Code for Protection of Building Electronic Information System Against Lightning* (GB 50343 – 2012), the safety spacing between power cables, signal cables, and protective earth cables should be ensured.

Shielding means using a shielding object to block or reduce the transmission of electromagnetic energy. The so-called shielding object, which is the object that exists at the interface of two electromagnetic spaces, can divide this electromagnetic space into regions that exist independently of each other. The shielding object uses its reflection, absorption and guiding effect on electromagnetic energy to separate the shielding area from other areas, and these effects are closely related to the surface of the shielding object and the induced charge, current and polarization phenomenon in the body. According to its principle, shielding can be divided into electric field shielding, magnetic field shielding and electromagnetic shielding^[2].

References

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