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EFFECTS OF LIGHTNING SURGES ON FIRE PROTECTION SYSTEM

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Summary: Modern fire protection systems realize many functions. First one is to signal and remotely inform when fire appears. Second is to turn on extinguishing system also very important. Lightning strike to the lightning protection system of building or nearby can be dangerous for fire protection system installed inside this building. Any malfunction of this system can cause large financial damage by needlessly turn on or not turn on the extinguishing system. In this paper a typical fire protection system will be presented during different types of impulse tests simulated the lightning risk.

Keywords: Lightning protection, fire protection system

1. Introduction

In some cases protection against fire realized complex electronic systems. Particularly, this concerns the large systems in chemical or petrochemical industries and fire protection of rooms with electronic equipments (gas or chemical medium extinguishing systems).
Modern electronic fire protection systems must realize the following basic functions:

- signal and remotely inform when fire appears,
- turn on extinguishing system.

The main part of this system is electronic central with automatic control of different fire-fighting systems. Lightning strike to the lightning protection system (LPS) of structure or nearby structure with installed fire protection system (FPS) can cause destruction of this system or malfunction in its work. In this last case, incorrect turn on of FPS can cause large financial losses and temporal lack of protection against fire.
During lightning strike the following FPS risk factors are taken into account:

- Overvoltages in low-voltage power installation used for FPS supply,
- Overvoltages in internal circuits, sensors and other FPS additional devices,
- Direct influence of impulse electric and magnetic field caused by lightning current and spark discharges on FPS individual elements (central as well as sensors).
- Potentials increase and potentials difference caused by lightning current distribution in structure conducting elements.

In this paper the investigation of typical fire protection system during standard and non-standard EMC tests are presented.

2. Range of EMC investigations

All tests were performed on the real fire protection system, which consists of digital automatic control and indicating central, 2 fire warming sensor lines with 8 standard fire sensors, 1 laser fire detector – 1000 times more sensitive than standard one, helper systems, GSM data exchange system and status printer (Fig. 1).

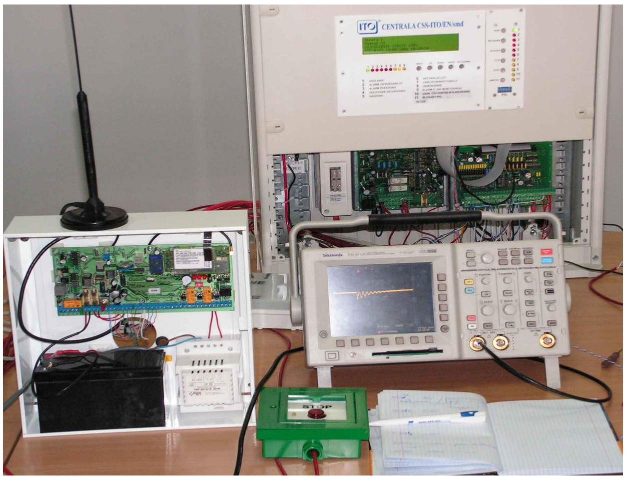

Fig. 1. Fire protection system during the EMC tests

In accordance with standard EN 50130, the resistibility requirements and test procedures for fire-fightning systems on surges (impulse 1,2/50 - 8/20) are the following:

A.C. power system ports

line – line	0,5 kV and 1 kV	investigation between L and N
line – ground	0,5 kV; 1 kV; 2kV	investigation between L/N and PE

Different supply/signal ports

line – ground	0,5 kV and 1 kV	

Such tests are realized by FPS producers. Surges with higher peak values can cause disturbances in work or destruction of systems. These kinds of risks were simulated in laboratory. The EMC standards recommendation forms were taken into account during the lightning risk analyzes. Additional special attention was turned onto potential increase of wire PE in electric installation caused by lightning current distribution during strike to the LPS of structure (Fig. 2.).

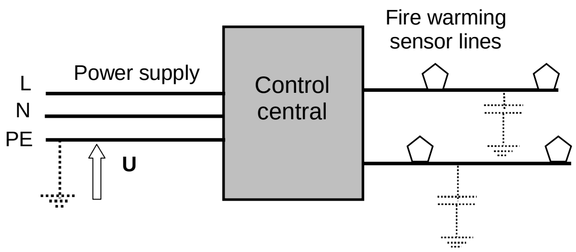

Fig. 2. Risk caused by potential increase.

In the investigations risk caused by surges in low-voltage electric installation was neglected because the cases of incorrect work were observed in FPS connected to installations with three steps overvoltage protection systems.

The FPS lightning risk was investigated by:

1. Impulse currents inflow to the signal cables shields. These currents are caused by the potential increase.
2. Overvoltages between the wires and the shield of signal lines.
3. Overvoltages between signal wires.
4. Impulse magnetic and electric fields influence on the fire warning signal line and sensor.
5. Voltage surges with long duration time between signal lines, influent directly on signal inputs/outputs.

During the fire warning sensor lines risk investigation surges 1,2/50 - 8/20 were putted into:

a) Shield of signal cable 20 m away from FPS. To couple the generator with signal line capacitor 10 nF was used (Fig. 3.).
b) Shield of cable with direct connection of generator to shield. Distance between putting point and FPS - 20 m.
c) Between signal wires and shield,
d) Between signal wires.

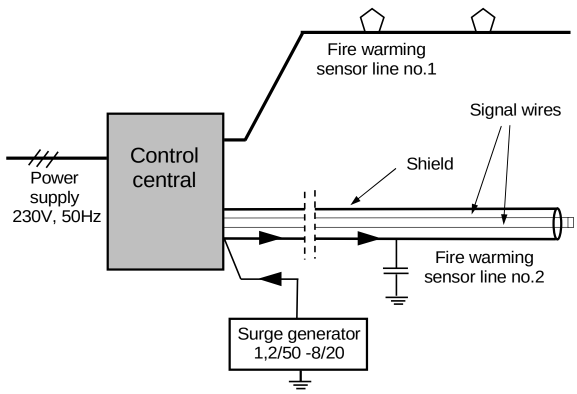

Fig. 3. Risk caused by surge current in the shield

General rule of connecting the generator 1,2/50-8/20 to sensor line was presented on fig. 4.

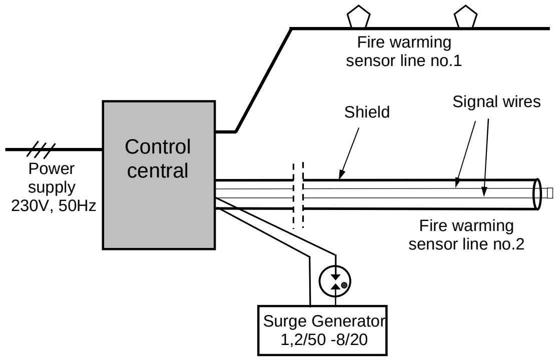

Fig. 4. Impulse voltage between wire and shield

Some examples of overvoltages between wires caused by current and voltage surges are presented in Fig. 5 and 6.

a)

b)

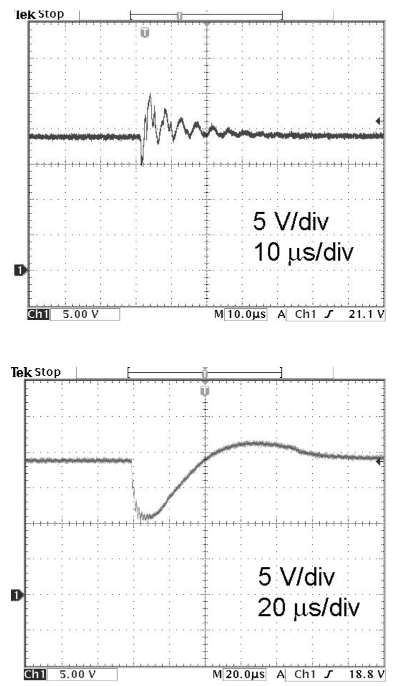

Fig. 5. Overvoltages observed between two signal line wires. Source of disturbances - surge generator 2 kV in arrangement: a) surge generator - shield - capacity 10 nF, *b)* generator - shield

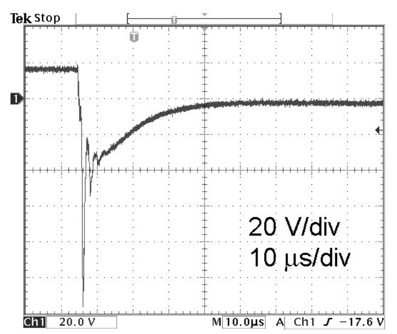

Fig. 6. Overvoltages observed between two signal line wires caused by surge voltage 1 kV input between signal wire and shield

Overvoltages between wires reached the values from ten to twenty volts when the surges are putted in to shield of sensor line. For surges putted between signal wires and shield larger values of overvoltages were observed. In this case the impulse voltages which appeared in signal ports of control central reached:

- up to 400 V (peak value) - surges up to 2kV were putted between the signal wires and shield,
- up to 1400 V (peak value) – surges up 1500 V were putted between two wires of signal lines.

In this last case the overvoltage destroyed sensor nearest the place, where the surge was initiated.
During the investigations incorrect work of FPS was not affirmed. Only appears short fade information about damage in sensor line. In next step, the influence of electric and magnetic fields on sensor line was investigated (Fig. 7).

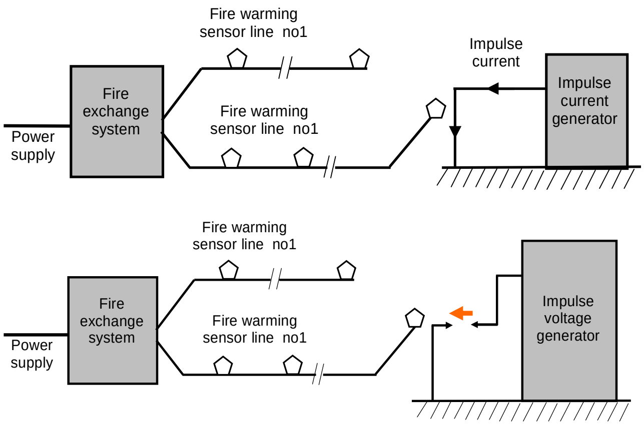

Fig. 7. Risk caused by impulse magnetic and electric fields.

The impulse electric and magnetic fields were produced by impulse current generator - peak up to 40 kA, shape 8/20 μs and impulse voltage generator – up to 220 kV, shape 1,2/50 μs. During investigation the overvoltages between wires in sensor line reached the values up to 400 V. Some example of overvoltages between wires is presented in Fig. 8.

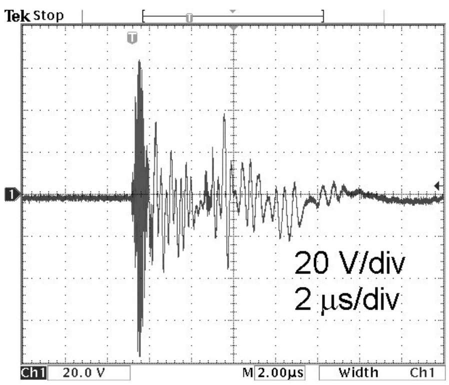

Fig. 8. Overvoltage observed between wires caused by impulse electric field

During tests, impulse electric fields caused single crashes or incorect work of FPS. It also destroyed GSM system used for remotly fire notification.
One should be notice, that during lightning strike the disturbances will be longer in comparison to surges produced in laboratory investigations. Overvoltages between wires were caused by lightning currents which have times of duration from a few hundred microseconds to some milliseconds. In order to tests the maintenance of FPS central during influence of long-lasting impulse voltage coupling arrangement was prepared, which connect sensors line with voltage rectangular wave generator. Generator has the possibility to regulated peak value, frequency and degree of fulfilments.
Investigations showed that impulse voltages with comparatively small peak values (up to 10 V) and times of duration in range 800 - 1000 μs can cause incorrect FPS work every time.

3. Conclusions

Results of investigations showed the possibility of incorrect work of FPS during long-lasting (hundred microseconds – some milliseconds) impulse voltages with small peak values (to 10 V). Such tests stray from typical EMC tests. They simulated risk caused by lightning current distribution in natural conditions. Protection against this type of risk can be realised by appropriate process of testing sensor's state.

Acknowledgment

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4. References

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