Development of Techniques for Instrumental Monitoring of Reporting Lines and Control Devices for Paga

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Abstract. The systems of warning people about the fire play a key role in ensuring the safe evacuation of people. Often, on the objects of protection, the notification system is not properly serviced and controlled, which can eventually lead to the loss of its destination, and this is absolutely unacceptable. Timely diagnostics of such systems is an extremely important task during the operation of the protection facility, as the correct operation of the PAGA ensures the correctness of the evacuation operations and the preservation of people's lives. At the moment there is not a sufficiently informative operational method for determining the correctness of warning systems when exposed to external factors not associated with a fire. Electromagnetic interference, improper selection of equipment for operating conditions, errors in calculations, or factory failure are difficult to determine in the conditions of routine tests for compliance with fire safety standards. In this article, the existing methods of chain monitoring are considered, as well as a description of the devices and techniques for implementing instrumental monitoring of fire alarm systems for people about the impact on the main parameters of their operation of adverse phenomena arising in operating conditions.

1. Introduction

In recent decades, the global statistics of accidents are overflowing with cases of occurrences of fires in buildings with mass stay of people. Often, such incidents are accompanied by, unfortunately, a large number of casualties, as it happened in case of fire in the shopping and entertainment complex «Zimnaya Vishnya» (Kemerovo). This is due primarily to the difficulties encountered in conducting the evacuation of visitors and staff of the protected object. People just do not have time to promptly recognize impending danger and to leave a burning building. Therefore, measures aimed at improving the effectiveness of fire safety systems are more than relevant. Public Address and General Alarm System (PAGA) – one of the most important components of the security system. The main purpose of the PAGA is a timely warning of people in a compartment about the emergency situation and to coordinate their actions in carrying out the evacuation. From its performance directly affects people's life [2-7]. Depending on various characteristics and conditions alerts, provides for five types of PAGA in fires, ranging from simple sound (sirens, tinted signals, etc.) and light alarm (fire board), to complex voice systems, with the possibility of red alert and coordination running from one fire post to all building systems.
Federal law №123 "Technical regulations about requirements of fire safety" contains an important requirement for notification lines, which distinguishes it from all previous regulations – it is monitoring of their operability, namely, the integrity of circuits of executive devices.

Today, in practice, four basic monitoring circuits are used:
- monitoring via extra lines;
- address marks monitoring;
- impedance monitoring (or "installed capacity");
- direct current (DC) monitoring with the use of blocking elements.

**Monitoring via extra lines** is carried out in two stages. The first stage checks the first monitoring line applying a second control wire. In the second stage – checks the second control line applying the first control wire. This method of control is fully justified in cases when it is necessary to use sirens from different manufacturers in one system, and if this need is more important. The advantages of this method include the possibility to complete monitoring lines along the entire length and control of the signaling devices on "pass". The disadvantages are additional costs for laying wires of the control and appliance control security - fireman for monitoring the integrity of lines.

**Address marks monitoring** is the most promising method of control at present time. Its essence is as follows – each alarm has its own address which is transmitted to the management device. Together with the address of the alarm can transmit its status and other parameters in digital form. This kind of monitoring can be applied in radio systems and voice alarm. Its advantages are the automatic control of the line broadcast alarms, monitoring alarms, and additional options. But this method is not deprived of disadvantages. The main ones are the high cost of equipment and the use of sirens made only by certain manufacturers.

**Impedance monitoring** (some manufacturers also call it "monitoring via the installed capacity"). The method is based on measurement of impedance of the line alert alternating current (AC). The main problem in the practical use of this method is significant inductive and capacitive components of the lines of alerts, and the influence of environmental factors (such as temperature, humidity, electromagnetic interference) [8-10]. As a result, the error may reach 20% or more. Advantages of this monitoring method include: the ability to control the line of alerts and alarms (especially in small quantities); two wires are enough for the monitoring; no need for additional locking elements. The disadvantages are the high cost of the monitoring device and high tolerance of the monitoring method, especially when a large number of sirens used.

**DC current monitoring with the use of blocking elements** is implemented by increasing sound alarm resistance to DC via the series connection of the blocking element (capacitor). Advantages of the method include: accurate monitoring of alert along the entire length; monitoring of removal of acoustic systems; two wires are enough for the monitoring. Disadvantages of this method are the complexity of operation monitoring of sirens and the need to install external capacitors for operation monitoring functions. It is also worth noting that with this monitoring parasitic power loss during message playback is possible. However, some manufacturers exclude this by implementing a monitoring circuit line resistance of the EOL resistor. In the end, monitoring is greatly simplified and reduced to the conventional monitoring loop.

According to European standards [11-14], the basic requirements for voice alarm systems outlined in the following: EN 54-16 "Fire alarm Systems - components of voice alarm systems. Equipment control and indication voice alerts", EN 54-24 "Fire alarm Systems - components of voice alarm systems. Part 24. Speakers" and EN 54-2 "Fire alarm control panel".

The above standards define the requirements, test methods and criteria for the operation of equipment control and display voice alert, which are used in fire alarm systems in buildings or neighboring buildings, where the alarm is in the audible form or in the form of voice messages (or a combination), and provides the assessment of conformity of equipment with the requirements of these standards.

European normative documents contain the following basic requirements:
- requirements directly to equipment control and indication voice;
- requirements to voice alarm emergency microphone;
- requirements to light-emitting indicators;
- requirements to sound signaling devices.

Special attention is paid to standards mode warning fault. OIRA should switch to this mode when receiving signals that after any required treatment has been identified as a fault, and recognize at the same time all the faults in not more than 100, since the problem occurs or after signal reception about this fact.[15-16].

Domestic standards, unfortunately, do not contain such rigid requirements to the diagnostics and control systems, in the absence of methods and tools intended for the implementation of these activities. [5]

Based on the research, a unique complex that allows to diagnose and to detect any malfunction of fire alarm systems and automation in the process of its operation was created.

This complex in figure 1 is called "a set of operational diagnostic systems of fire automatics" (CODE SPA) and is intended for diagnostics of automatic fire alarm, alert, fire receiving and control devices, fire controls and power supplies.

![Figure 1. CODE – SPA.](image)

This complex consists of the following devices:
- Computer diagnostic complex (CDC-01);
- Immediate monitoring device of the fire alarm system;
- Tester of fire alarm system plumes;
- Immediate monitoring device of monitoring and power supply units;
- Auxiliary immediate monitoring device;
- Commutation module.

In terms of control of efficiency of notification and evacuation systems it is proposed to use a set of immediate diagnostics of monitoring devices and power supply units (PU and BP CODE "M1 Line"). This set is intended for diagnostics of fire appliances from notification monitoring circuits, fire devices activation monitoring circuits, and for diagnostics of operability of power supply units.

The set of operational diagnostics of the monitoring devices and power supply units CODE PU and BP "on the M1 Line includes.
2. Immediate monitoring device of monitoring and power supply units

![Immediate monitoring device of monitoring and power supply units](image)

**Figure 2.** Immediate monitoring device of monitoring and power supply units.

This device in figure 2 examines the ability to withstand the current load of monitoring devices and uninterruptible power supply units within the estimated project time.

CDC-01 (computer diagnostic system) empowers activation circuit elements examinations parameters current values in the standby mode and in the operating mode, operation mode examination time and switching off time in the case of overload.

At the end of the tests you can save test results to a file on the computer CDC-01 and print them, see figure 3, where FDL it is fire detection loop.

3. Auxiliary immediate monitoring device

The device in figure 4 is connected to fire alarm, notification and monitoring circuits break. It allows estimating the stability of devices of receiving-control and management of fire in the context of changing parameters of the control circuits are within acceptable limits.

This device provides a diagnostics of devices (power sources) in the following modes:
- the short circuit mode, providing short-time current up to 40A;
- the mode of connection of extra series element to the circuit – resistors simulating the resistance increase of the connection line;
- the mode of connection of extra parallel elements to the circuit – resistors, condensers simulating resistance of leakage and capacity of the connection line;
- breakage mode of the communication line (load shedding), providing the current up to 5A under voltages up to 110 V.
Figure 3. Test protocol CDC – 01.

| Date     | Time | Group | Check                                      | Installation | Entrance | PCN | V | V | mS | mS | V | mA | mA | Req. | kOhm | Ry+ | kOhm | Ry- | kOhm |
|----------|------|-------|--------------------------------------------|--------------|----------|-----|---|---|----|----|---|----|----|------|------|-----|-----|-----|------|
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 19.99 |
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 20  
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 60  
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 60  |
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 20  |
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 60  |
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 60  |
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 60  |
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 60  |
| 10.07.2012 | 15:57 | FDL   | Current with a rated voltage of PDL         |              | 4.98    | 11.91| 60  |

Figure 4. Immediate monitoring.
This device allows simulating the increase of line resistance, a decrease in the insulation resistance of wires, a polarity wire of monitoring and communication and monitoring lines, to simulate breaks and short circuits in control circuits with the aim of evaluating the fixing the control panel responses to these impacts.

After the diagnostics, recording and issuing of the Protocol validation results are practiced, on which basis a specialist can draw conclusions about workability and adequate operation of the warning system and evacuation management at the facility.

4. Conclusion
In conclusion, we would like to note that today such device base is needed, which provides correct diagnostics of workability of notification and evacuation systems, that is why the complex of technical devices meeting these requirements was designed. This complex is planned to be tested at facilities of SPBSTU of Peter the Great in the nearest time.

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