Development of Methods for Instrumental Diagnostics of Control Devices for Fire Alarm Systems

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Abstract. This article is devoted to the actual task for today - the creation of a methodology for assessing the operability of fire alarm systems. From the timely operation of a functioning fire alarm system, the effectiveness of measures aimed at localizing and extinguishing the fire and the success of the evacuation of people from a burning building depend. The article considers existing approaches to the assessment of the state of the fire alarm system and the requirements imposed on them both by domestic and foreign standards. The methods of fire alarm diagnostics developed by us on the basis of the "Gefest" GC are considered, and the corresponding software and hardware complex allowing to evaluate the operability of the elements of this system.

1. Introduction

Unfortunately, fires were and remain one of the main problems for people. Often, there are a lot of victims and heavy material losses during such events. Active fire protection systems, which include fire alarms, are implemented to timely detect a fire and to reduce the damage from it. Therefore, questions about improving the means of fire automatics and fire alarm aimed for detection and suppression of combustion are more than relevant for today.

Fire alarm (FA) is one of the basic elements of security, which is installed at any enterprise. The essence of the FA is detection of a fire at early stages and the transmission of a signal to the control panel. A more advanced version of the FA is the Automatic Fire Alarm System (AFAS). In addition to detecting a fire, functions of alerting the threat, as well as the activation of automatic fire extinguishing, smoke removal are added.

The purpose of our research was the development of requirements and the creation of a set of technical means that allow the mobile verification and prediction of the operation of various fire automation systems. To achieve the goal, we developed a number of devices for monitoring the condition of fire alarms at the "Fire safety" department of Saint-Petersburg Polytechnical University. Immediate monitoring device of fire alarm systems (DOC-FAS) - serves to simulate signals: "Warning", "Fire-1", "Fire-2", "Short-circuit", "Clipping", etc., coming from the loop to the receiving-control device.

Being downloaded through the computer CDC-01, a program tests various receiving and monitoring devices with active or passive fire detectors, this device provides diagnostics in manual and automatic modes. It allows testing the threshold of receiving and monitoring devices with different infor-
mational content, both separately and together with the loop and fire detectors in different operation
modes (see figure 1).

![Image](image_url)

**Figure 1.** The device of the operative control of the fire alarm system (DOCFAS).

The interface of the test report of the AIMD device, when it is output to a monitor for further printing, is shown on the figure 2. COD-PS and Automatic examinations of the UCS-PS. are on the Table 1.

**Table 1.** Immediate fire alarm monitoring device.

| Name               | Signal 10 | Name               | IP 212-3 SM |
|--------------------|-----------|--------------------|-------------|
| Circuit number     | Rd 2200   | Supply voltage min | 10          |
| Supply voltage min | 17        | Supply voltage max | 28          |
| Supply voltage max | 19        | Operating current  | 0.05        |
| Wire resistance    | 22        | Operating voltage min | 7.5    |
| Signal type        | 100       | Operating voltage max | 8.5    |
| Half-period T+     | 0         | Operating Current min | 20    |
| Half-period T-     | 0         | Operating Current max | 20    |
| Ra                 | 2200      |                    |             |
| R                  | 65000     |                    |             |
| Ro                 | 4700      |                    |             |

**Table 2.** Automatic Inspection AIMD.

| Verification name | Time | Number of current-consuming detectors | Maximum number of detectors triggered | Maximum resistance of wires in the loop |
|-------------------|------|---------------------------------------|--------------------------------------|----------------------------------------|
| Norm              | 20   | 3                                     | 3                                    | 0                                      |
| Short circuit     | 20   |                                       |                                       |                                        |
| Breakage          | 20   |                                       |                                       |                                        |
| Fire 1            | 20   |                                       |                                       |                                        |
| Fire 2            | 20   |                                       |                                       |                                        |
| Fire N            | 20   |                                       |                                       |                                        |
| Fire 1A           | 20   |                                       |                                       |                                        |
| Fire 2A           | 20   |                                       |                                       |                                        |
| Fire NA           | 20   |                                       |                                       |                                        |
| Fire IPRr         | 20   |                                       |                                       |                                        |
| Fire IPR3         | 20   |                                       |                                       |                                        |
| Water             | 20   |                                       |                                       |                                        |
2. Fire alarm tester (FAT-01)
Fire alarm tester is intended for examination of fire alarm loops with fire detectors, as well as the integrity of low-voltage electrical circuits. It provides an opportunity to assess the condition of individual parts of the loop with fire detectors, the ability to perform their functions. It allows to measure the resistance of the loop in direct and reverse polarity, as well as under reduced voltage (= 5 V) and at a current of less than 5.5 mA to ensure safe testing of electrical circuits executive devices of fire automatics.

![Figure 2. Fire alarm tester (FAT-01).](image)

It should be noted that the main task of TPN-01 is to provide digital indication of monitored parameters, but it is not a measuring instrument. If it is necessary to carry out the measurements with the required accuracy, it is necessary to use the certified measuring instruments.

3. Auxiliary immediate monitoring device (AIMD)
AIMD (see figure 5) allows to simulate increase in line resistance, decrease in the value of insulation resistance of wires, reverse polarity of wires of communication lines and control, simulate an open and short circuit in the control circuits in order to evaluate the response of the receiving and monitoring device to responses to these effects.

![Figure 3. Auxiliary immediate monitoring device (AIMD).](image)
The principle of the device is as follows:
The AIMD is connected to the break of the fire-signal line, communication lines, warning and control lines. It makes possible to assess the stability of the operation of fire control devices and monitoring in the conditions of changing the parameters of control circuits within the permissible limits.

![Figure 4. Stand of FA, executed by employees of "Gefest" Enterprise group.](image)

4. Conclusion
Designed methods and equipment will make it possible to assess the real efficiency of the operated fire automatics systems in many premises and determine directions for improving a regulatory and technical base in the area of enhancing the operability and reliability of fire alarm systems.

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