5th INTERNATIONAL CONFERENCE
TRANSPORT SYSTEMS TELEMATICS TST'05

ZESZYTY NAUKOWE
POLITECHNIKI ŚLĄSKIEJ 2005
TRANSPORT z.59, nr kol. 1691

AUSP,
fire control signaling system

Waldemar SZULC[1]

ELECTRONIC FIRE-CONTROL SYSTEM FOR THE RAILWAY PASSENGER-CARS AND BUS

Implementation of new alternative technologies resulted in the great progress of development of passenger trains. The area of special interest for these technologies is fire protection. The paper discusses the development of a concept of active fire-control protection of cars. The fire-control system concept is based upon the fire-control center and calling center

ELEKTRONICZNY SYSTEM PRZECIWPOŻAROWY DLA WAGONÓW PASAŻERSKICH I AUTOBUSÓW SZYNOWYCH

Wprowadzenie nowych, alternatywnych technologii spowodowało ogromny postęp w dziedzinie rozwoju pociągów pasażerskich. Obszarem szczególnego zainteresowania dla tych technologii jest ochrona przeciwpożarowa. Artykuł poświęcono opracowaniu koncepcji aktywnej formy zabezpieczenia przeciwpożarowego wagonów. Koncepcję systemu przeciwpożarowego oparto na centralce przeciwpożarowej i centralce przywoławczej.

1. INTRODUCTION

Implementation of new technologies has caused an enormous progress in the area of development of passenger trains and various safety systems thereof. Similarly, the case applies also to the rail buses. The area of special interest for these technologies is fire control and both in the long-distance and suburban trains as well as in the rail buses.

Thus it was decided to take care of travelers' safety by application of appropriate design in the cars and rail buses themselves to reduce the fire hazard. These changes include mainly application of appropriate non-flammable materials, creation of safety zones in the cars, use of fire bulkheads etc. These are operations constituting a so-called passive passenger control.

The purpose of this paper is to present preliminary technical assumptions and prototype solutions concepts being a basis for development of detailed designs of fire control systems.

[1] Warsaw University of Technology, Transportation Department, Koszykowa 75, 00-662 Warsaw, Poland
wsz@it.pw.edu.pl
The Warsaw Management Academy of The Society of Economic Enterprises, Kaweczyńska 36, 03-772 Warsaw, Poland

The design part consists of developed assumptions that should be fulfilled by the entire system, as well as its components, in order to make the project compliant with all the requirements and regulations concerning PKP as the end user.

2. GENERAL CONFIGURATION OF AUTOMATED FIRE SIGNALING EQUIPMENT (AUSP)

Fig.1. presents an instance of AUSP configuration. The name AUSP covers all the devices for detection and signaling of alarm condition (fire) in its initial phase (in accordance with the standard PN-92/M-51004/01)

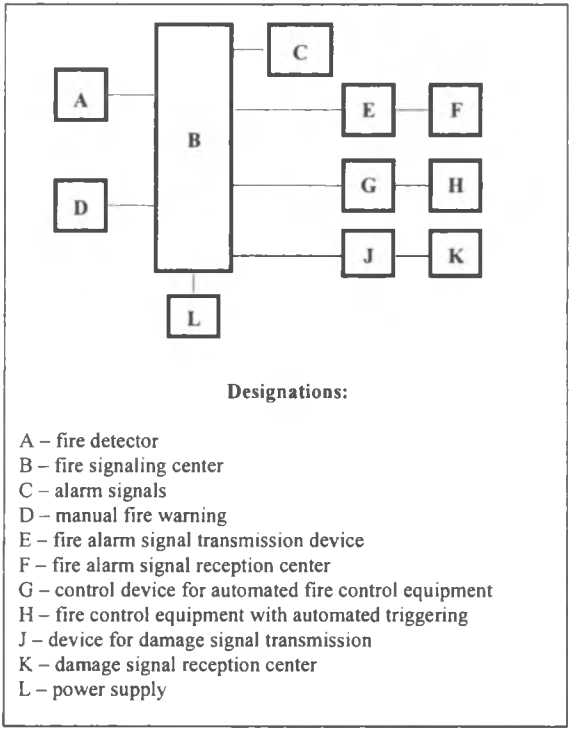

Fig.1. General block diagram of AUSP (Instance)

The presented general AUSP bloc diagram is in accordance with the basic principles of fire signaling installation design. For the movable objects such as train rolling stock it is an additional challenge, at least because of environment conditions, issue of power supply and electromagnetic compatibility. The principles of fire control systems are very clear for stationary facilities. However, the same system design for moving facilities is much more difficult.

AUSP are designed for possibly early detection of hazard and signaling in with alarm in order to undertake appropriate measures such as evacuation of people, salvage of property, calling fire brigade). Thus it is necessary to have an alarm transmission system and automated triggering of extinguishing process. We have to remember that the car stock is a rolling object, although fires happen also to cars in standstill position and in the car shed (also for cars not included into the stock). It is worthwhile to present the basic distribution from the point of view of a possibility to point out the specific location of fire. There are two methods of addressing in the AUSP system: collective and individual.

Collective addressing consists in indication of a supervision line wherefrom a connected detector send an alarm signal. Thus it is possible to identify the threatened area (wagon and compartment inside it).

Individual addressing (single detector, groups of detectors, control elements), enabling a precise determination of threatened room or zone and initiating selected fire extinguishing, signaling, warning devices (among others using addressable control elements)

There exists also another division from the point of view of type of transmission track between the detector and the center. Depending of type of the connection between the detector and fire control center, three types of lines can be distinguished: open, loop and lateral.

Another division of fire control signaling equipment from the point of view of communication between centers and detectors are:

a. monolog (unidirectional exchange of information),
b. dialog (bi-directional exchange of information),

A very important division in the area of fire control is division from the point of view of information transmission :

a. transmission using the value of flowing current
b. puls transmission
c. Digital transmission

Elements that directly realize the alarm criteria are the detectors. Through the supervision lines, the detectors send the alarm criterion to the alarm fire control center. Thus the detector is one of the basic AUSP devices and as such it mainly governs the time between the appearance of hazard and its signaling by the center.

There exist a detector division considering the parameters used for fire signaling, such as:

a. spot and linear temperature detectors),
b. smoke detectors (ionizing, optical and laser),
c. flame detectors (infrared and ultraviolet radiation),
d. spark detectors (react to the infrared radiation accompanying the mechanical sparking)

The „heart" of an AUSP system are fire signaling centers. A fire signaling center fulfills the following tasks:

- using the supervision lines it supplies the installed fire detectors;
- realizes transmission of information from and to the detector;
- checks whether the signals received are fire alarm signals;
- signals every fire alarm acoustically and visually;
- signals acoustically and visually failures and emergency conditions of the center and cooperating equipment;
- records the more important events (all types of alarms);
- transfers signals about fire or failures through the alarm transmission devices to the fire brigade (monitoring systems)

In the proposed fire control systems for passenger cars the centers have to be supplied with so called on-board voltage (for PKP cars it is U_{ZAS}= 24V (16V to 32V). Also there should be a standby power supply (in accordance with the regulations) of uninterruptible type.

Microprocessor systems installed in the fire signaling centers are prone to noise, software errors, sudden power supply drops. In the railway car installations, because of growing number of electronic devices and a possibility of traction equipment impact the issue of electromagnetic compatibility takes a new meaning. Testing the system's resistance against electromagnetic noise is aimed at determination of reasons for occurrence and elimination of false alarms caused by these disturbances.

Transfer of information about fire hazard is a function of fire alarm transmission systems. Supervision of the object (train) by the fire detectors includes:

- transfer of normal status signal (supervision status))
- transfer of signal about occurrence of a hazard (status caused by fire)
- transfer of failure signal (information about the alarm status systems that renders impossible its operation in accordance with the standard)

The monitoring routes may be various: radio, permanent connection or calling exchange designed especially for the needs of passenger cars.

The important features of facilities in terms of selection of fire extinguishing equipment may be:

a) presence of people in the protected area and possibilities of their evacuation ,
b) properties of flammable material (quantity and position),
c) geometry of protected area ,
d) resistance of property to the fire extinguishing media .

The presently applicable fire extinguishing technologies use the following media: water, foam, powders, carbon dioxide, water mist, neutral gases mixtures, halo, chemical substances being its replacement.

3. SELECTION OF FIRE PROTECXTION SYSTEMS FOR THE NEEDS OF CARS AND RAIL BUSES

In Poland there is no manufacturing of fire control signaling systems that would have the PKP acceptance and for application in cars and rail buses. This is probably due to the low interest or fear concerning high costs of such a system. An additional delaying factor may be that the Polish railways for the next several years are permitted to use passive fire control form only.

3.1. ASSUMPTIONS

Presently there is no precise and published requirements concerning fire control systems in the cars and rail buses. Such assumptions have to comply with both Fire Brigade's requirements for fire control equipment and the overall requirements for equipment to be used on PKP.

3.2. PURPOSE OF FIRE CONTROL OF PASSENGER TRAINS

The most important aim is to protect human life and health – passengers, railway employees and third persons. Secondary objectives are: protection of social property and protection of natural environment.

Taking into account the most important aim and in terms of hazard to human health and life, the railway passenger rolling stock may be divided into the following groups:

a. (*particularly high hazard*) – includes sleeping cars, cars with cots, restaurant- and buffet cars,
b. (*high hazard*) – two-storied cars,
c. (*average hazard*) 1 and second class cars , designed for long distance,
d. (*low hazard*) – includes cars for suburban traffic as well as electrical traction equipment and rail buses.

However, the most characteristic is that the highest probability . of fire, the highest hazard to the property and to the natural environment occurs in the rolling stock of 4^{th} group and the lowest in the 1^{st} one.

The extent of hazard may be witnessed by the statistic data concerning fires in PKP over the period 1994 – 2004 where the average number of car fires oscillated between 117 and 120.

3.3. TECHNICAL ASSUMPTIONS

The fire control systems in the cars should ensure realization of the following functions that somewhat decide upon the effectiveness of these systems:

a. have to detect the fire already it its initial phase .
b. passengers have to have a possibility of quick evacuation .
c. fire may not spread without obstacles .
d. fire is automatically extinguished.

A separate and very important issue is equipment specification, here disregarded, because of its size. Thus very important are: power supply to the car fire control systems (basic and standby) and electromagnetic compatibility.

4. CONCEPT OF ELECTRONIC FIRE CONTROL SYSTEM FOR PASSENGER CARS AND RAIL BUSES

4.1. THE PROPOSED OPERATION ALGORITHM FOR FIRE CONTROL CENTERS

Fig.2 presents a program algorithm for the center in the case of occurrences of an alarm coming from the detector and manual fire warning device.

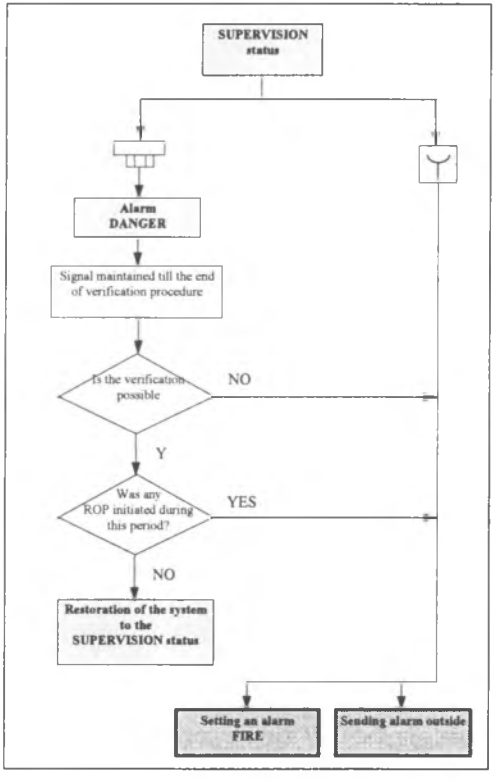

Fig.2. Proposal of operation algorithm for SSP center

According to this algorithm, at the moment of appearance of an alarm signal generated by the detector, the system goes into danger mode. In this mode, the center makes a verification attempt. If after reset of the detector, the alarm status appears again, the center goes unconditionally into "fire" mode and acoustic signals are set into operation. However if the danger verification is positive, there also other statuses for fire warning devices to enter into, in order to prevent the erroneous verification of hazard condition. When the warning devices are in idle mode, the system goes into supervision status
Otherwise the center goes to the alarm status.
There exist also a possibility to introduce repeated verification of alarm status through introduction of an additional loop with one condition and repetition counter..

4.2. DESIGNS OF FIRE CONTROL SYSTEMS

Presented are 3 proposals of fire control system solutions, All the proposed solutions have been analyzed also from the point of view of fulfillment of transmission recommendations for fire signaling systems.

a. The first design is based on use of collective addressing. This solution enables indication of this supervision only that initiated the alarm (using certain technical measures may increase this accuracy),

b. The second design is based upon use of individual addressed systems in the cars and buses. This solution is more costly but enables an accurate determination of fire location and results in reduction of necessary supervision lines in the system.

c. The third design is an attempt to combine the previous solutions . It is a form of combination of collective addressing (used on the corridor) and individual addressing (in the compartment or bus cab).

4.3. CONCEPT OF THE FIRE CONTROL SYSTEM

Based upon the synthetically presented three projects, we will show a concept of a fire control system. This system treats a single car (or rail bus) as a subsystem provided with its own fire control equipment that is connected with the main system centre installed in the train locomotive with a transmission data-bus. Thus, the terminal installed in the locomotive is a "master" terminal and specific wagon terminals are its subordinates and fulfill the role of sub centers. Fig.3 shows the concept of train fire control system according to the first design.

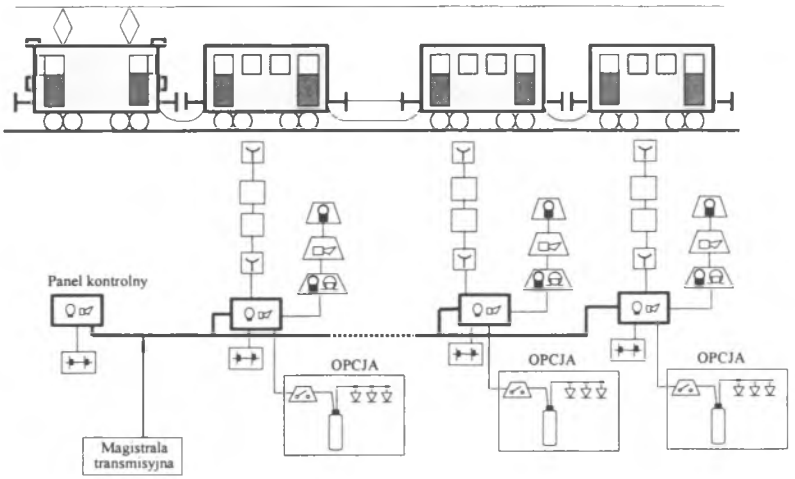

Fig.3. Concept of a train fire control system (first design)

5. CONCLUSIONS

The issue of fire signaling systems and fire extinguishing systems in the passenger cars is a very comprehensive and complex issue and costly. Rail buses are in a similar situation. This results in a fact that only a small number of railway managements has decided upon implementation of these systems for use.

An additional problem during designing of these systems is a necessity of broad cooperation between railway services, fire brigade and manufacturers of the systems both in technical and organizational aspects.

The assumptions presented in the study impose to the equipment manufacturer certain strict requirements that result from a broad scope of national and international, railway and general standards.

The concepts contained in the study show some possible variants of fire control solutions that could be used in practice in the nearest future. However, each of them would require additional separate studies related with adaptation of car design, the fire signaling equipment itself etc.

This study may be then treated as a novelty attempt of breaking the last existing barriers on PKP in the area of implementation of active fire protection form in the passenger cars.

BIBLIOGRAPHY

[1] SZULC W. „Prace własne" (Own Works) Transportation Department, Technical University of Warsaw, Warsaw 2004/5r.

[2] CISZEWSKI J. „Podstawowe Zasady projektowania instalacji sygnalizacji pożarowej" (Basic principles of fire signaling installation design) Wyd. Centrum Kształcenia i Doskonalenia Kadr", Warsaw 2003.

[3] MANTURZYK T. „Opracowanie koncepcji elektronicznego systemu przeciwpożarowego dla potrzeb nowej generacji wagonów" (Development of a concept of electronic fire protection system for the needs of a new generation of passenger railway cars) M. Sc. Thesis lead by Dr. Waldemar Szulc, Transportation Department, Technical University of Warsaw, Warsaw 1997r.

Reviewer: Ph. D. Jerzy Mikulski