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CHOSEN ISSUES OF THE POWER SUPPLY SELECTION FOR ELECTRONIC SAFETY SYSTEMS USED IN TRANSPORT

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Abstract

The safety of transport facilities depends not only on effectiveness of the applied individual safety systems but also on their power supply systems' proper operation (also including electromagnetic interferences). Therefore, in this paper, the authors analysed the power supply selection for the electronic safety systems applied in transport, taking into account the reliability and exploitation requirements included in the regulations and standards on these systems. The appropriate electricity supply to electric safety systems is the basis of their proper functioning. It means that the power supply, with required parameters for a given device, should be connected to individual electric receivers of electric safety systems. However, only supplying electricity to the device is not equivalent to provision of its operation continuity and the appropriate level of values of the reliability and exploitation indices. Therefore, emergency power supply systems should be used. The authors developed an algorithm of the power supply selection for electronic safety systems, including the categories of power and hazards occurring in the facility. In further considerations, it is planned to carry out further analyses taking into account other types of power supply systems, and the development of a computer programme, which constitutes an exemplification of the obtained deliberations.

Keywords: *transport, power systems, reliability, exploitation*

1. Introduction

In the Republic of Poland, within the Government Centre of Security, a document entitled "National Critical Infrastructure Protection Programme" was developed. It includes the characteristics of 11 systems classed as the critical infrastructure. These systems are essential for proper functioning of the entire country. The carried out tasks provide the continuity of the administrative structure functioning, and also protect citizens from different kinds of hazards. Among these systems, transport is also included. All sorts of telematics solutions are used in many modes of transport, starting from the road one [17, 24], through the railway and air transport [15, 16], and ending at sea [25] and inland waterway transport [10]. Since there are currently various types of hazards (including, among others, terrorist threat), ensuring the appropriate level of safety to transport facilities (both stationary and mobile) is what is strived for. The paper paid particular attention to the issues related to ensure the proper power supply to the electronic safety systems applied in transport.

The full risk alarm system is formed with the following systems distinguished depending on the detected hazards, as the systems of:

- intrusion and panic alarm,
- fire alarm,
- access control,
- CCTV,
- protection of external sites.

The protection resulting from operation of these systems can be supplemented by the following systems:

- health condition and personal threat alarm,
- environmental threat alarm,
- anti-theft system,
- voice alarm systems,
- car protection against burglary and abduction.

Alarm transmission systems are a very crucial element of electronic safety systems. Their composition includes, among others, devices and ICT networks, used to transfer information on the condition of one or more safety systems to one or more alarm receiving centres.

In the face of using such diverse individual safety systems, it is important to make the integrated safety system counter threats as broadly as possible, and at the same time, to make its reliability and exploitation indices reasonable [4, 6, 7, 12].

The safety of transport facilities depends not only on effectiveness of the applied individual safety systems, but also on their power supply systems' proper operation (also including electromagnetic interferences [5, 9, 19]). Therefore, the authors analysed the power supply selection for electronic safety systems used in transport, taking into account the reliability and exploitation requirements [1, 13] included in the regulations and standards of these systems. It is also very important to take into account the quality of information [21-23].

The issues related to reliability in power supply systems have been considered in references for many years. Among them, item [2] can be classified as the most important. In this item, the issues related to the reliability of energy systems were presented. Furthermore, the systems' reliability models, including the damage and repair intensity, were also described. The probability distribution of reliability indices was also determined. The reliability graph containing the state of ability and unfitness as well as the graph additionally including the state of the device's exclusion from the entire system operation were also presented.

Despite the conducted analyses in the field of reliability and exploitation of power supply systems [11, 18], it seems necessary to develop the algorithm of the power supply selection for electronic safety systems. Considerations in this area are presented in the following chapters of this paper.

2. Power supply of electronic safety systems

The appropriate electricity supply to electronic safety systems (ESB) constitutes a basis of their proper functioning. It means that the power supply, with required parameters for a given device, should be connected to individual electric receivers of the electric safety systems (i.e. proper value of input voltage, frequency and current efficiency) for a given device. However, only the electricity supply to the device is not equivalent to provision of its continuity of operation and the appropriate level of values of the reliability and exploitation indices. The loss of power supply voltage at the main elements of electronic safety systems (e.g. control panels, videos recorders) is unacceptable, and it can result in a lack of execution of part of the functions, for which the system was designed. Therefore, the devices should be provided with adequate power supply for 24 hours a day and 7 days a week.

The necessity to obtain uninterrupted operation of electronic safety systems forced the use of the emergency power supply systems of AC voltage. Currently, this type of solution is applied in many stationary transport facilities. It results from the fact that a momentary loss of the primary power supply can cause damage to devices, a loss of data or a threat to human life [14, 20].

One of the most important reasons for interruptions in the electricity supply or interference of its parameters include, among others, sudden switching on and switching off the high power receivers, a short circuit in electrical circuits or lightning.

In case of the AC voltage emergency power supply of electrical circuits of electric safety systems applied in transport facilities, the dynamic or static systems can be used.

UPS devices (uninterruptible power supply) are static systems. They can operate in one of three modes: on-line, off-line or line-interactive. The devices connected to them are provided with the uninterruptible power supply at the time, which is dependent on the included batteries. An additional function that is implemented by UPS is the elimination of the main power network interferences.

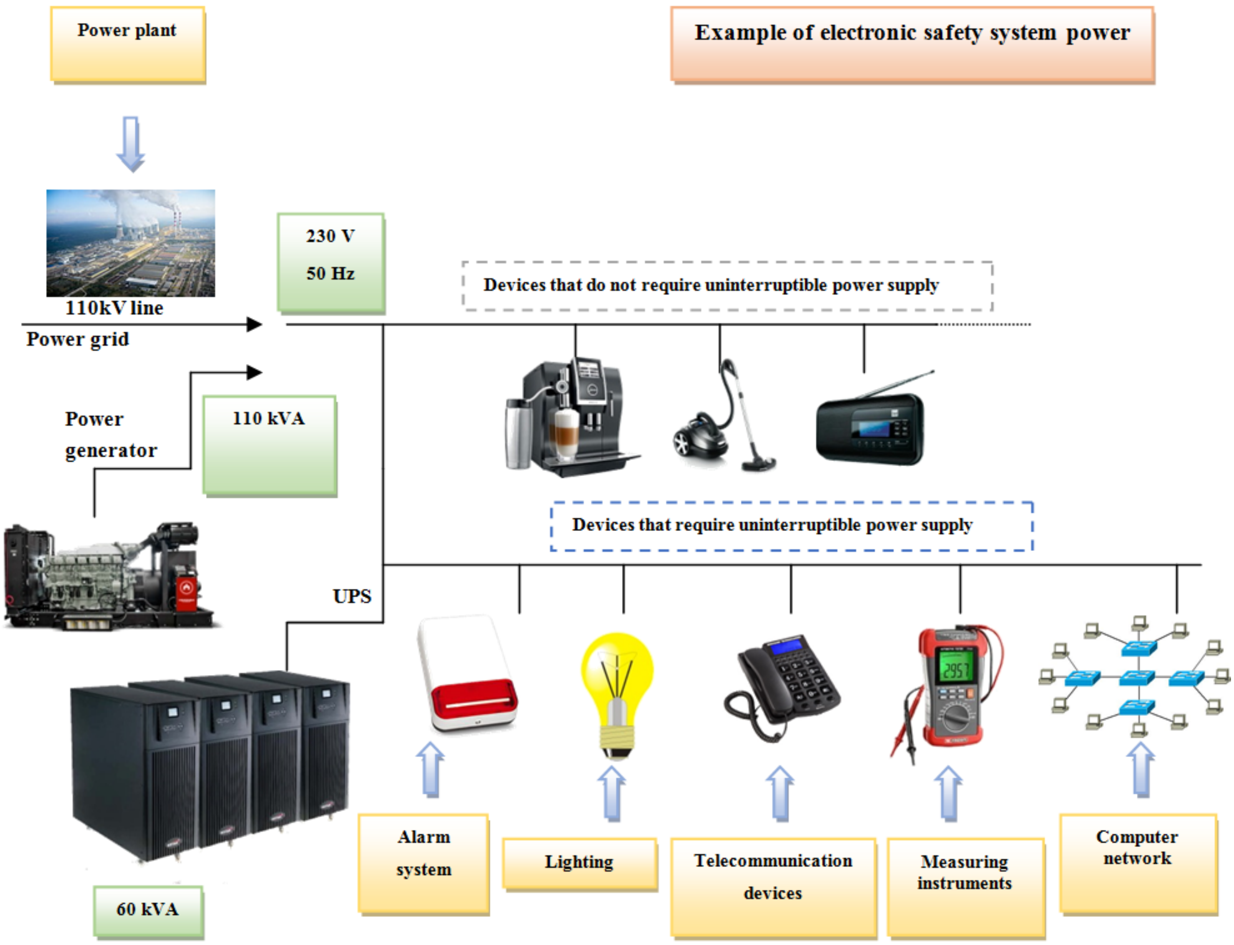

Fig. 1. Power supply provided for safety systems

Power generators are classified as dynamic systems. Similarly to UPS devices, they ensure the continuity of AC voltage supply to the devices of electronic safety systems, which are connected to them, with the difference that power generators fulfil the role of power supply after a few seconds. These limits result from the necessity to start a combustion engine. The time, at which power generators will provide back-up power to electric safety systems, is dependent on the quantities of available fuel and the connected devices' demand for electricity. It should be also emphasised that the power generator does not provide a stable effective value of voltage and its frequency. In this paper, the issues related to the impact of vibrations, which result from operation of the combustion engines of power generators [3], are not considered.

Both the UPS device and the power generator are usually applied (Fig. 1). Thus, it is possible to obtain the advantages of both individual solutions. An important issue of the use of the generator and UPS device is the ability to reduce the number of accumulator batteries cooperating with UPS to the minimum. The selection of an appropriate emergency power supply system in the transport facility should be economically justified taking into account the requirements included in the regulations and standards. It is also important to remember that the predicted demand for power consumed by given systems changes with the facility's original purpose.

One of the most important parameters, which determines the quality of power supplied to the receiver (electronic safety systems), is the power reliability. This parameter is related to the continuity of power supply. The aim is to make the power supply interruptions as short as possible, and occurred the least often. Various requirements related to the power supply reliability are the reason for introduction of the division of receivers. In Tab. 1, the categories of electricity consumers, depending on the power reliability, were presented.

Tab. 1. Categories of electricity consumers, depending on the power reliability, were presented

Category	Reliability requirements	Possible solution	Examples of occurrence
I basic	Relatively long interruptions between ten and twenty minutes	Power supply with a single radial line of the power grid. No requirement for the back-up power supply	single-family houses in rural areas
II medium	Acceptable interruptions between ten and twenty seconds	Power generator. Emergency lighting	high residential buildings
III high	Power supply interruptions should not exceed one second	Two independent power supply lines of the electricity system and the back-up power supply system with fully automatic control	hotels, hospitals, radio and television stations, railway stations and airports
IV highest	UPS, power supply interruptions are unacceptable	UPS from the back-up power supply source. Power generator adapted for the long-term supply	operating rooms of hospitals, computer systems of banks, stock exchanges

When selecting the appropriate power supply categories of electronic safety systems, the energy balance should be determined. For this purpose, it is necessary to know which elements, devices, will be powered, as well as what the demand for power will be, and what power reliability we plan to achieve for specific transport facilities. Each structure of the system, which ensures the continuity of power supply, can have other reliability and exploitation indices. Then, we use various technical possibilities in order to provide the continuity of electricity supply – appropriate reliability structures, reserving, and redundancy, etc.

Transport facilities and electronic safety systems installed in them, for which the continuity of supply is the most important parameter, require the correct back-up power supply selection at the time, when the primary mains supply is not provided due to failure or modernisation of the existing electrical grid. In case of these facilities, it is important to exactly determine the volume of power that is needed. Therefore, the energy balance calculation is conducted for all the devices, which must operate without interruption. At this point, we can provide the facilities (systems) with the additional UPS devices, power generators or power supply from other power lines that are independent of each other.

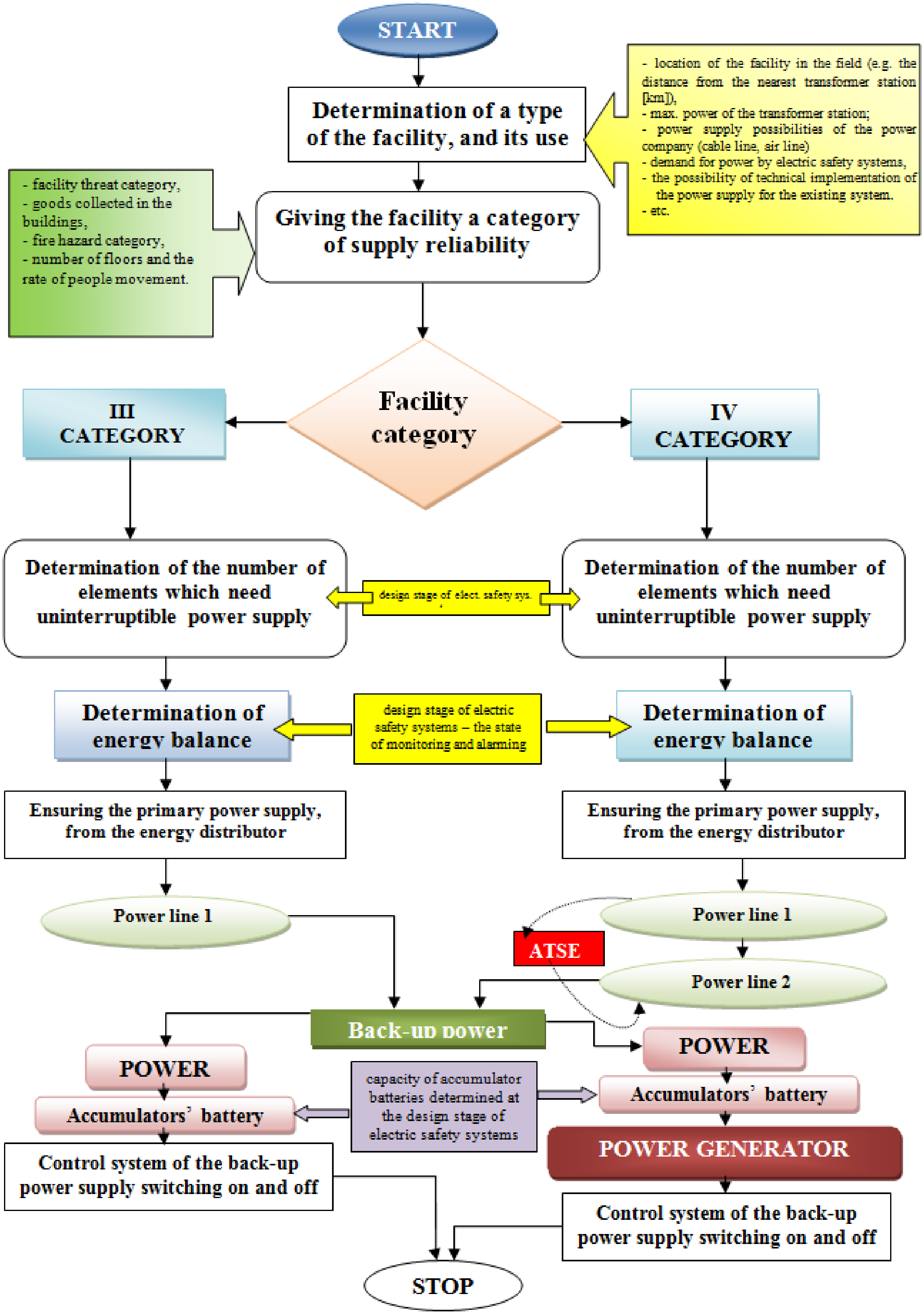

Fig. 2. Algorithm of the power supply selection for electronic safety systems for III and IV power supply categories

In Fig. 2, an algorithm of the power supply selection for the needs of the transport facility, in which the electronic safety system is installed, was presented. The first stage is to determine the type of facility and its purpose. After initial recognition of hazards and technical data, the category of the power reliability is given to the facility.

In case of facilities, where electric safety systems are installed and there is a specific hazard category in the buildings, III and IV power supply categories are used. At the design stage, the number of elements of electronic safety systems, which require uninterruptible power supply, is determined, and the energy balance is made. The primary power supply is implemented for electronic safety systems by industrial power lines (distributor – power plant). In the event of a failure to the primary power supply, electronic safety systems turn to the back-up power supply or the accumulator battery, which is independently connected to each alarm system in the building – access control system, intrusion detection system, fire alarm system, etc. These are the independent accumulator batteries systemically controlled by control panels of individual alarm systems. The power supply transition from the power line 1 to 2 is carried out automatically by the Automatic Transfer Switching Equipment (ATSE).

3. Conclusions

The issue presented in the paper concerned the power supply selection for electronic safety systems applied in the transport facilities. The appropriate energization of electronic safety systems constitutes a basis of their proper functioning. It means that the power supply, with required parameters for a given device, should be connected to individual electric receivers of electric safety systems. However, only the electricity supply to the device is not equivalent to provision of its operation continuity and the appropriate level of values of the reliability and exploitation indices. Therefore, emergency power supply systems should be used. Currently, this type of solution is applied in many stationary transport facilities. It results from the fact that a momentary loss of the primary power supply can cause damage to devices, a loss of data or threat to human life. The authors developed an algorithm of the power supply selection for electronic safety systems, including the categories of power and hazards occurring in the facility. In further considerations, it is planned to carry out further analyses taking into account other types of power supply systems, and the development of a computer programme, which constitutes an exemplification of the obtained deliberations.

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