# MODERNIZATION OF METHODS OF SAFE CONDUCTING OF OPERATIONS AT RAIL TRACKS

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## ABSTRACT

The article describes the methods of safe production of works on railway transport, including the monitoring system «Worker on tracks». Ways to control the technological process while servicing railway infrastructure devices, for example, signaling, centralization and blocking distance, in particular, the control method using radio frequency identification (RFID) technologies, are presented. The variant of modification of marking of devices and equipment is offered. The statistics of the state of labor protection at the range of the October Directorate of Infrastructure is presented. The use of innovations will reduce the number of accidents at work, increase the safety of operation of railways. In addition, a positive effect is achieved in the field of environmental safety.

*Keywords: work safety, occupational safety, RFID technology, maintenance, rail transport, monitoring.*

**Background.** *No production indicator can stand above human safety. According to the Labor Code of the Russian Federation, labor protection is defined as a system for preserving life and health of workers in the process of labor activity, which includes legal, socio-economic, organizational, technical, sanitary and hygienic, therapeutic and preventive, rehabilitation and other measures [1].*

*Railway transport is a zone of increased danger, and not only when doing work on tracks. Responsibility for compliance with rules, regulations and instructions for labor protection, ensuring healthy and safe working conditions are borne by the heads of structural units. Penalties and fines are imposed for violation of labor protection legislation.*

*Persons performing work at the facilities of JSC Russian Railways should [2]:*

*– be aware of risks that accompany their activities and affect safety of their lives and health, as well as lives and health of others;*

*– be aware of personal responsibility for one's life and health, as well as for life and health of others;*

*– support the corporate culture of work safety;*

*– encourage the safe conduct of their colleagues;*

*– know and comply with the necessary safety standards, understand the possible negative consequences of non-compliance with established organizational and technical procedures.*

*At the enterprises various actions on maintenance of culture in the field of labor safety are carried out. However, it is not always in a satisfactory condition.*

**Objective.** *The objective of the author is to consider modern methods to provide safe operation on railways.*

**Methods.** *The author uses general scientific methods, comparative analysis, evaluation approach, comparative analysis.*

**Results.**

***Labor protection at the range of Infrastructure Directorate***

*For example, let's consider the site of October Directorate of Infrastructure, the Automation and Telemechanics Economy (from 01.01.2016 to 07.05.2016). According to the telegram of the head of the department of automatics and telemechanics dated 07.05.2016 (ISH NR16271 / CDI), labor protection at the enterprise remains unsatisfactory. During this period, five workers were injured, two of them with a severe outcome, and three with a light outcome.*

*The main causes of injuries are inattention and negligent attitude to the implementation of instructions for safe operation. The question arises: «How to make a person follow the instructions and conscientiously fulfill their duties?». Apparently, it is necessary to introduce full control over the activities of the employee for the time of his duty, to establish certain minimum requirements and limits in relation to personnel and the development of discipline.*

*According to the order «On the Goals and Tasks in the Sphere of Labor Protection, Industrial and Fire Safety for 2016 at the Range of the October Directorate of Infrastructure», certain guidelines have been established in this area.*

*The instruction on labor protection for the electrician and electromechanic [3] calls one of the aspects of safe work performance a proven and suitable tool. Any tool, whether dielectric or metalwork, must meet the most stringent requirements. There must be a note on the inspection. The following data are recorded on the tag:*

*– subject of verification;*

*– number assigned;*

*– name of inspector;*

*– verification date;*

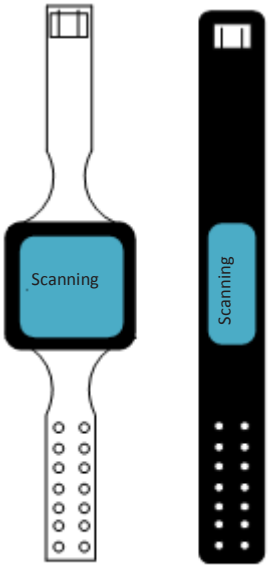
*– date of the next check.*

*The tag is made in paper form and often occurs in such a way that it can be torn off or it will become unstuck, and then it becomes impossible to understand whether the tool was suitable for work.*

*Replacement of paper tags with special electronic labels based on RFID technology will eliminate the problems that accompany paper. RFID (Radio Frequency IDentification) is a method of automatic identification of objects in which data stored in so-called transponders or RFID tags is read or written via radio signals [4]. The label consists of a chip and an antenna. The chip can record any information, for example, the one that contains a paper tag. Using the reader, scanning the label, you can get the necessary information. The label has an anti-vandal design and is resistant to environmental changes, even strong pollution cannot prevent from reading, even if it is even painted over. In the manufacture of new devices, it is possible to embed labels in the housing.*

*This technology is used in magnetic keys and BSK tickets. Such tags are suitable for identifying any items and allow to quickly and easily keep an electronic database.*

*Advantages of the technology is that the label is not visible for reading, which allows it to be sewn into the signal waistcoat and placed on it in places that are less susceptible to external influences. The other advantage is also the possibility of reading of several labels by one repeater at once.*




***Pic. 1. Appearance of the tracker.***

*When programming the label, it is possible to allow reading with a mobile phone with built-in NFC technology. To date, most smartphones support this technology.*

***Health monitoring***

*Taking care of a safe tool, it is necessary to establish informing about the health of the employee. Poor well-being negatively affects the quality of work, and also increases the likelihood of injury. If a person feels unwell, he loses vigilance, and can lose consciousness during the execution of work on the tracks or in production premises, which is fatal.*

*The solution of the problem is to equip the personnel with bracelets (trackers) that monitor the state of health (Pic. 1). The tracker can measure body temperature, pressure, pulse, body resistance and, on the basis of the data obtained, draw conclusions about the state of the carrier. If abnormalities are detected (heart palpitations, low / high blood pressure), the informer sends a message over the network, e-mail to the operator or other authorized person. In case of accidents, fainting or cardiac arrest, the tracker will send an alarm call to the ambulance with all the necessary information about the carrier (height, weight, possible electric shock, geolocation, name, age, etc.) for immediate response.*

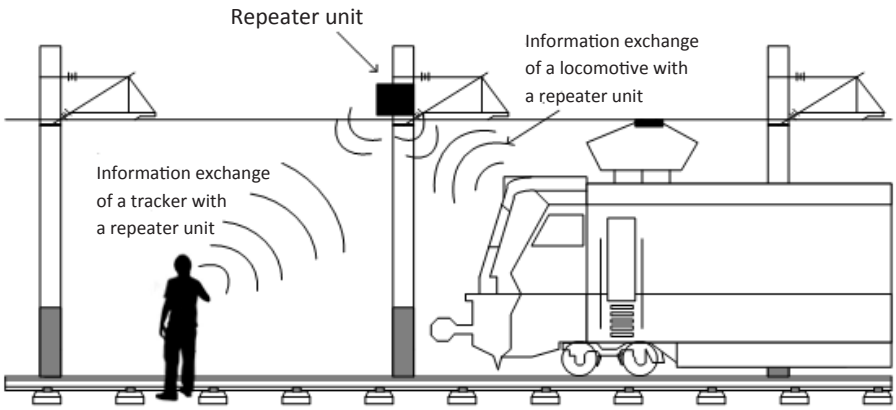
*Equipping the tracker with a screen and a speaker allows to signal the change in health to the carrier himself.*

*Work on the railway tracks is associated with a huge number of risks. We subdivide them conditionally into visible and invisible. To the visible can be attributed risks that a person is able to detect without additional means, while the invisible ones cannot be detected by him without auxiliary means. One of the examples of invisible risks is the presence of poisonous substances in the air. The presence of various vapors even with their small concentration adversely affects human health, may not be recorded by the main sense organs. Long-term presence of a person in such vapors will necessarily affect. When exposed to various substances, its internal state changes, palpitation, pulse, and breathing become more frequent. These symptoms can be perceived, for example, as a common cold or sleep deficiency. However, in the presence of a tracker, it is possible to quickly track the change in the health of the carrier and draw conclusions about the hidden danger.*

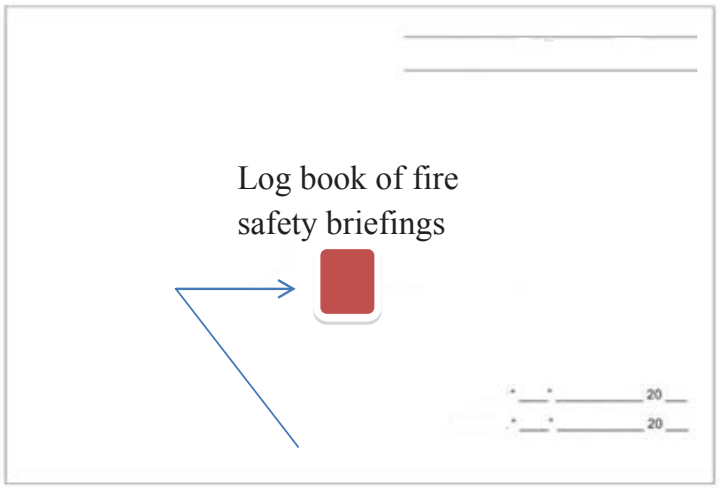
*By design, the tracker is a bracelet with a small single-band monochrome display and an emergency call button. The power consumption of the device should be minimized to increase autonomous operation. It is made of hypoallergenic silicone to achieve a more wear-resistant design and avoid allergic reactions of the carrier. The body of the tracker contains: heart rate monitor, skin resistance measurement sensor, vapor detection sensors, radiation, speaker, small vibrating motor. In the event of any dangerous situation, the bracelet will begin to vibrate and sound the alarm and display a running line about the type of dangerous situation. To ensure synchronization with mobile devices or a computer, you can use the Bluetooth module and microUSB connector.*

***Monitoring system «Worker on the track»***

*The next safety issue – when the workers are on the tracks – is related to runover of rolling stock during technological «windows» or carrying out other technical works [5]. At the moment, during the work on the tracks train drivers receive a*




***Pic. 2. Functioning of the «Worker on the Track» system.***



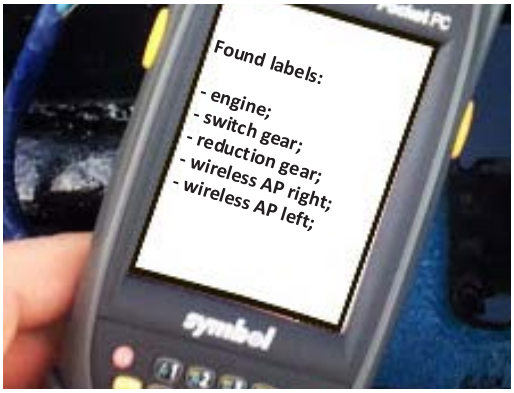

*Pic. 3. Tag on the logs.*

*Pic. 4. Location of labels in devices.*

*warning sheet. In most cases, the cause of rolling stock runover is unsatisfactory quality of operations, which makes people separate from the signalers and the observers with the radio set. The executor on the track does not know about the approach of rolling stock, and the machinist about the employee who has broken away from the team. To solve the issue, the tracking system «Worker on the track» would be useful. It should track the movement of workers and inform them in advance about the approach of the train, and the driver – about people in the traffic zone on tracks.*

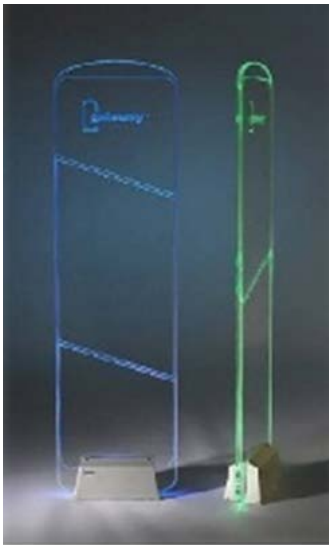
*The system can be divided into three components. The first is RF tags on staff. The sensor, which is a label, can be placed on the signal vest of an employee (sewn or glued) – an obligatory attribute on the railway tracks, and in the previously indicated health tracker. Energy consumption of the label is minimal.*

*The second component is the construction of a data transmission system. These include antennas sending and receiving signals, repeater-modems, as well as special software for monitoring the movement of labels. The repeater-modem is placed on the*




*Pic. 5. The reader is in search mode.*

*supports of the contact network. The transmission network already exists – it is a channel with its own protocol at a frequency of 868,7 MHz (deployed on the Torbino–Borovenka site). It is possible to implement systems based on satellite or cellular*



**Pic. 6. Electronic frames**

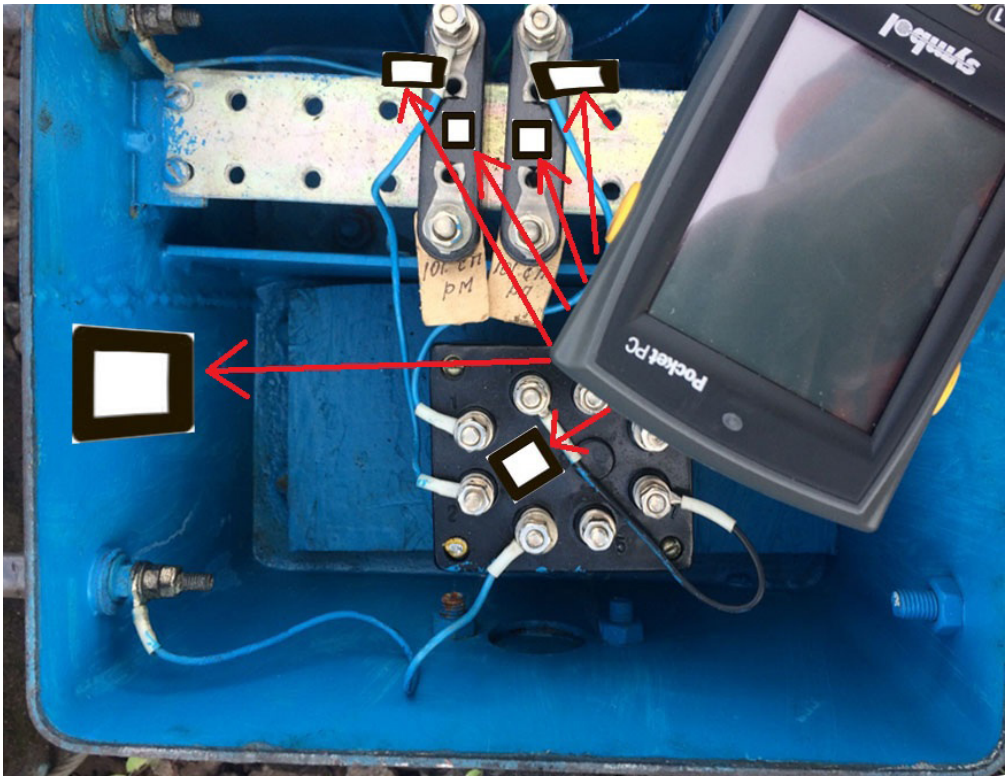
*communication, which requires the presence of a GPS module or, respectively, GSM-modules, through which information about the owner is transmitted. Using the method of triangulation through cellular networks, it is possible to track the movement of an employee.*

*The third component includes equipment installed on self-propelled mobile units of railway transport. The SMP block (personnel monitoring system) is located in the driver's cab. The equipment has an antenna mounted on the body of a self-propelled mobile unit. The block gives information about the approach to an object that has a radio tag. The system compares the position of the mobile unit and the adjacent radio tags. And if you have a health tracker, the notification of moving vehicles comes to the tracker. It starts to vibrate on the wrist of the carrier, and in the driver's cab the SMP unit emits a beep and shows the distance to the nearest mark on its way. That is, both the driver and the worker are warned of the dangers, and have the chance to take action (see Pic. 2).*

*In addition to warning about workers on the track, SMP blocks receive information about each other, and thus, for example, when two mobile units are in one track, their collisions are excluded. So, according to the instructions, if there was a breakdown of the mobile unit, the driver must decompose the signal firecrackers from the approaching other mobile unit, in order to warn of the danger. With the help of the personnel monitoring system, such actions can be excluded, since all movements will be monitored. When deploying a data transmission system at 868,7 MHz on the entire network of Russian railways, it will be possible to abandon satellite and cellular networks while tracking rail transport. The system is available for deployment on hauls and stations.*

***Control over production of operations***

*Safety directly depends on the method of production of operations. Maintenance of a particular device is performed using special technological cards, in which the instruction is described step by step, how and what to do [9]. Violation of the sequence or use of wrong measuring instruments can lead to danger to life of a worker. Therefore, it is necessary to control the quality of process execution, it is necessary to introduce video fixing or a new RFID radio identification technology.*




**Pic. 7. Tags in the junction box.**

*Video fixing will allow to keep a record of conducting briefings to employees before starting work, technical training and work (for example, see Pic. 3).*

*The use of RFID tags will help organize performance of monitoring. By placing tags on devices, say one outside and one inside, and using a reader, you can track when the service personnel were near the device and when they «opened» it (see Pic. 4).*

*So, for example, for maintenance of a junction box, the mechanic at the beginning of the shift is given a reader (Pic. 5) with the information about the employee entered there. Having received the target instruction, the mechanic applies the reader to the label on the log, the personal number of the employee is recorded in the label, and the reader is informed that the mechanic has been instructed on labor protection before the start of the work shift.*

*Having come to the input device, attaching the reader to the label, the employee records the time of arrival and opening of the device. Further he starts control over production of operations on process charts. The tags on all components in the junction box allow you to check what was removed in what sequence and then installed. It is necessary to place labels even on cable cores, including spare ones, in order to quickly have information on which wires are connected to what and what is better to take for replacement. The location of the labels is shown in the example of the junction box in Pic. 7.*

*Tags on protectors, surge-absorbers, transformers with information on the date of verification and those who checked are supplemented with the dates of dismantling and installation with the names of the maintenance personnel involved in the work. At the end of operation, closing the device, scan the label on the device and proceed to the next task or return to the post. At the end of the day from the reader you can remove the report for the period of the shift, indicating all the actions and their connection to the time and place of work.*

*The whole complex of systems is seen as a kind of PDA or a wrist brace, through which the full control over the employee's actions will be carried out. From its location to the report at the end of the work day.*

**Conclusion.** *Monitoring is a modern way of not only control over the technical condition of control facilities in railway transport [10–12], but also enhancing the technical culture of employees. The introduction of monitoring systems makes it possible to improve the quality of service and the reliability of the entire railway network. Controlling the movement of personnel makes production of works and stay on the tracks safer. Along with the increased safety of train traffic, the IEQ environmental index is also growing, as due to monitoring results the number of mobile units and catastrophes decrease.*

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