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IN THIS ISSUE

Editor's

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Deputy Director for the Study and Research Projects, Railway Research Institute

Photo: IK

The (IK) Railway Research Institute's mission is to carry out research and testing intended to develop rail transport In Poland, both for the needs of infrastructure managers and railway operators, as well as manufacturers of rolling stock and infrastructure elements. On order to enhance its research potential, the Institute has undertaken substantial investments in recent years. Several examples are worth presenting.

The Materials and Structure Laboratory has been enriched with a light chamber for the assessment of varnish coatings after aging and physical and mechanical tests as well as a xenotest for testing the effect of light on varnish coatings. Currently, purchases of other devices and apparatus for this Laboratory are underway, which will allow for carrying out research tasks in the field of strength tests of rolling stock components and rail transport infrastructure as well as in the area of fire tests.

The development of the Signalling and Telecommunication Laboratory's research base will allow conducting specialist tests, including electromagnetic compatibility (EMC) tests and photometric tests. For this purpose, the Laboratory has been equipped with a measurement system for EMC tests in the field of resistance to conducted disturbances, induced by radio frequency fields in the range from 150 kHz to 230 MHz, together with measurement control software and a dedicated computer to operate this station. The laboratory has completed the construction of a new test stand for climate tests, which will allow performing climate tests of large electrical and electronic devices. Its main element is a fully automated climatic chamber with a useable capacity of 6 m^3.

The new equipment for the Electric Power Department will allow conducting scientific research and development projects in the area of electric traction (catenary) and power supply. As part of the project currently underway, a new 3 x 3 x 2 m climate chamber will be built, and a rectifier transformer will be replaced in the short-circuit laboratory with an increase in its power from 4.4 to 6.3 MVA.

Continued on page 7.

International Scientific Conference "Transport of the 21st Century"

On June 9-12, 2019, the International Scientific Conference "Transport of the 21st Century" was held in Ryn. The aim of the conference was to present the achievements of national and foreign research and scientific centers dealing with the issues of rail, road, air and maritime transport in the technical, technological and organizational aspects as well as the integration of the environment which conducts research and education in the discipline CIVIL ENGINEERING and TRANSPORT. More information you could find on page 8.


Photo: WT PW

A UIC General Assembly and its Bodies' Statutory Meetings were Held in Budapest on 24–25 June 2019

One of the meetings was a Plenary Launch Meeting of IRRB (*International Railway Research Board*) – a UIC international research platform whose task is the coordination of a global railway cooperation in the area of research and innovation. IRRB was tasked to update the GVRD – *Global Vision for Railway Development* – document, which had been prepared under the responsibility of the chairman and the IRRB vice-chairman, Dr. Eng. Andrzej Żurkowski, the Director of the Railway Research Institute. Then the document will also be presented at the 12th WCRR (*World Congress on Railway Research*) in Tokyo at the end of October 2019.

IRRB International Railway Research Board

Lacquer Coatings for the Means of Transport and Elements of the Rail and Road Infrastructure

Open Doors event entitled Lacquer Coatings for the Means of Transport and Elements of the Rail and Road Infrastructure, which was held at the Railway Research Institute on 18 June 2019.

We hope that the agenda of meeting enabled all participants to exchange views, present their own experiences and needs or problems related to the application and operation of lacquer (paint) coatings in various applications, as well as keep you up to date with the achievements of paint manufacturers in terms of increasing the quality and durability of coatings.


Photo: IK

Certification Process of Control-Command and Signalling Subsystem

Magdalena Kycko
Deputy Head of the Quality and Certification Center, Railway Research Institute

Currently, the railway industry is experiencing dynamic development. In the coming years, a number of rail infrastructure investments adopted in accordance with the strategies and plans are planned in the rail transport development in Poland.

The certification process is a fundamental factor related to the investment, without which the investment will not be placed in service. Bearing in mind the safety of railway investments, the certification of the control-command and signalling subsystem and/or its components that are directly responsible for traffic safety becomes essential. The control-command and signalling subsystem is defined as any trackside and on-board equipment necessary to provide safety and control-command and signalling of train movement on the network.

Fig 1. Process of the EC subsystem certification

Each certification process is intended to confirm that a given system or equipment meets the requirements of the relevant Technical Specifications for Interoperability (TSI). The currently binding documents used in the certification process of control-command and signalling subsystem include the Commission Implementing Regulation (EU) 2019/776 of 16 May 2019 amending Commission Regulation (EU) 2016/919 of 27 May 2016.

The verification of subsystems is an important element in providing compliance with the basic parameters and essential requirements that ensure the interoperability of the rail system within the Community. The essential requirements that are verified in the certification process include: safety, reliability and accessibility, health, environmental protection and technical compliance. The very process of the EC certification process depends on the selected assessment module in accordance with Commission Decision 2010/713/EU of 9 November 2010. The modules that are most commonly used for assessment of control-command and signalling subsystems are written in bold in Figure 2.

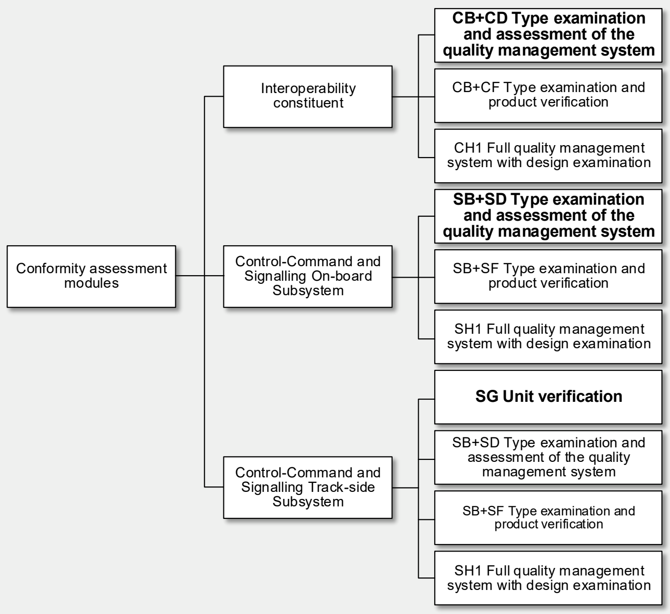

Fig 2. Assessment modules for interoperability constituents and control-command and signalling subsystems

On the basis of the EC certificates issued by the notified body, a given subsystem manufacturer may issue an EC declaration of conformity and then, together with the documentation, submit an application to the President of UTK for placing in service for a given subsystem.

The Railway Research Institute has competence in the scope of EC conformity assessment and EC verification in accordance with the requirements of Directive 2008/57/EC of all subsystems using all conformity assessment modules, which is confirmed by the accreditation granted by the Polish Centre for Accreditation (PCA) No. AC 128.

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Ensuring Completeness of the Safety, Security and Cybersecurity Measures for Rail Transport Systems and Other Guided Transport Systems

Marek Pawlik
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Photo: IK

Introduction

Since the very beginning safety measures used by railways were composed by active safety and passive safety systems. Active ones are the ones intended to prevent accidents while passive ones are intended to minimise consequences at the time of accident. Respectively e.g. interlockings and buffers could be pointed as examples. The Article is focuses on active safety systems as presently such systems are utilizing technics which are more and more exposed to different kinds of hazards. It is important to take into account, that rail transport systems are more and more supported by contemporary systems based on electronic components and having programmable modules. As a result seeing active safety systems as composed by interlocking layers and ATP systems has to be pointed as nowadays inappropriate.

Subdivision of the signalling into interlocking layer, ATP and many more

There is no doubt, that Interlocking layers composed by track occupancy checking systems (especially track circuits, axle counters, train-equipment-based tracking systems), switch equipment (especially point machines, switch blade and frog position control equipment), interlocking itself (presently usually composed by layered electronic components), as well as colour light signals and indicators are treated as basic signalling and required to follow not only fail-safe principle, but also to fulfil SIL 4 requirements. Moreover all data transmission systems between such components also have to fulfil SIL 4 requirements. There is also no doubt, that track-train transmission based systems, disregarding their sophistication (whether they are classified as automatic train protection ATP, automatic train control ATC or automatic train operation ATO) have to fulfil SIL 4 requirements both regarding track-side and on-board equipment. At the same time, however, it is obvious, that interlocking layer and ATP are not the only contemporary systems influencing railway safety. It is therefore vital to point and classify other systems which have to be taken into account when overall safety is analysed. New classification taking into account also other important systems was defined, as a result of a systematic approach based on functionalities, in a following way:

1. signalling systems:
1.1. primary signalling (interlocking, blocking, level crossing protection, marshalling together with cooperating: track occupancy systems, blade & frog drivers and controllers, signals & indicators, remote control, operational data acquisition & storage and associated data transmission systems),
1.2. mobile and wire based operational communication,
1.3. control command systems (AWS, ATP, ATC, ATO/ATS),
1.4. area emergency braking (equipment generating and receiving emergency signals requiring drivers to stop the trains and/or imposing emergency braking),
1.5. railway auxiliary automatics (clocks, passenger information systems with data management and visualisation units, train announcement systems, rear end checking, autonomic junction protection equipment, platform door control, platform edge clearance checking, escalators, elevators, etc.);
2. systems and devices dedicated to fire protection and unauthorised attempts:
2.1. fire and smoke detection,
2.2. automatic fire extinguishing,
2.3. access authorisation,
2.4. intruder detection;
3. electrical safety systems:
3.1. power supply automatics (diagnostic, steering, state monitoring, power consumption registration, etc.),
3.2. automatic power cut-off systems;
4. trains' malfunctioning detection:
4.1. running gear malfunctioning detection,
4.2. train-route compatibility checking,
4.3. pantographs malfunctioning detection;
5. systems dedicated to panic countermining and supporting rescue activities:
5.1. passenger information broadcasting,
5.2. self-evacuation routes emergency lighting,
5.3. emergency communication and alarm systems (public emergency: call, train braking, door opening, etc.),
5.4. passenger health supporting systems (e.g. ADE):
5.4. rescue supporting installations

Functional comprehensive approach to safety, security and cybersecurity

All types of systems, devices and components mentioned above have their influence on broadly understood safety of the railway system. As a result it is important to define overall approach to verify completeness of the protection. Such an approach was defined by the author and described in a monograph published in April 2019 (see reference). It is based on subdivision of functionalities between technical safety systems ensuring

Ensuring Completeness of the Safety, Security and Cybersecurity Measures for Rail Transport Systems and Other Guided Transport Systems

operational safety, security supporting systems ensuring life and goods protection and cybersecurity. The overall approach is based on knock-out and differentiating questions defined for sixteen groups of safety related functions and sixteen groups of security related functions. Knock-out questions and answers YES/NO are valued 1/0. Differentiating questions answers are valued 1/2. As a result, thanks to appropriate amount of differentiating questions, products of all answers regarding safety and security are equal 0, 1, 2, 4, 8, 16 or 32.

All groups of functions are using components spread geographically and communicating between each other. Even when components are used on a single station data transmission as well as data acquisition, processing, receiving, verification and storage are exposed to cyber-crime.

All transmission systems have to be protected. There is no doubt that transmissions utilized for signalling and for control command are protected, however, usually other systems, especially those related to passenger information systems and security, are not seen as requiring protection. Meanwhile cyber-attracts which already took place, in case of railway, were mostly associated with timetabling, ticketing and passenger information systems. Timetabling, ticketing, assets management, project management, contracting and payments are seen as IT systems, and therefore are covered by EU Directive 2016/1148 concerning measures for a high common level of security of network and information systems across the Union. That does not apply to all the OT systems, classified above, for which cyber-risks have to be considered. Therefore knock-out and differentiating questions were also defined for all types of data systems covering whole chains (acquisition, processing, sending, transmission, receiving, verification, using and storage). Questions were defined so, to ensure product of the same type (0, 1, 2, 4, 8, 16 or 32). Safety, security and cybersecurity are therefore represented by a vector.

$$[\textit{safety (SF), security (SC), cybersecurity (CS)}] \quad (1)$$

where:
SF – product of all answers regarding safety,
SC – product of all answers regarding security,
CS – product of all answers regarding cybersecurity.

The Functional Integrity Level for safety, security and cybersecurity, FIL level, is defined as a sinus of an angle between vector and reference geometrical plane, for which maximum vector is perpendicular.

$$FIL_{SF,\,SC,\,CS} = \sin \measuredangle \left(\begin{matrix} 0 & 32 & 0 \\ 0 & 32 & 0 \\ 0 & 0 & 32 \end{matrix}, [SF,SC,CS] \right) \; \Bigg| \; \begin{matrix} SF \neq 0 \\ SC \neq 0 \\ CS \neq 0 \end{matrix} \quad (2)$$

where:
$FIL_{SF,\,SC,\,CS}$ is a safety, security and cybersecurity functional integrity level.

An angle between vector and geometrical plane (represented by matrix) may only be right (= 90°) or acute (< 90°). Maximum FIL value equals "1" (as a sinus of 90°) when products of the answers regarding safety, security and cybersecurity are equal to each other. Growing discrepancies between products of the answers causes dropping of the FIL keeping it > zero for non-zero values of the SF, SC and CS.

Conclusions – FIL is friendly, helpful and with wider application possibilities

As a result it is easy to point deficiencies in safety, security and cybersecurity as even one knock-out question equal 0 result with SF, SC or CS equal 0. Already performed analyses show that on the one hand railways require highly protected primary signalling and control command and on the other it is easy to access a dispatcher post by unauthorised persons, block passenger information system and switch off all the lights.

Safety, security and cybersecurity functional integrity level FIL is a valuable approach complementary to Safety Integrity Level SIL 4. SIL is generally dedicated to individual systems (sometimes ensuring wide functionalities like interlocking based Local Control Centre), while FIL is dedicated to whole railway system comprising infrastructure, rolling stock and operation. It is easy therefore to apply FIL to homogenous individual systems an like individual railway line, separated from the network, ensuring connection e.g. to the airport. It was elaborated for railway, but it is easy to be applied to a tram system in a city, metro system, monorail and other guided transport systems including hyperloop. It is not easy to apply FIL to railway system of a country or EU. However, monograph defines step by step approach for using safety, security and cybersecurity functional integrity level FIL concept for complex systems to obtain safety, security and cybersecurity related recommendations.

Reference

Pawlik M.: Railway safety and security functional reference model built on data transmission based systems. ISBN 978-83-7814-908-8, Warsaw University of Technology Publishing House, Warsaw 2019.
(http://www.wydawnictwopw.pl/index.php?s=karta&id=3457)

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Compatibility Tests between an On-board and a Trackside Control-Command and Signalling Subsystem

Dominik Adamski
Research-technical specialist, Railway Traffic Control and Telecom Department, Railway Research Institute

Every vehicle subject to EC verification, irrespective of the chosen evaluation module based on Commission Decision (EU) 2010/713, must pass the tests of correct integration with the track-side subsystem. Such tests must be carried out by an entity having appropriate competences and qualifications. Most often it is a Notified Body (NoBo) or the Designated Body (DeBo) cooperating with it. The Railway Research Institute conducts tests on the compliance of on-board subsystems with track-side as NoBo or as DeBo depending on the function performed in the given EC verification process.

Since 2016 Railway Research Institute has had European Train Control System (ETCS) level 1 installation on Test Track Centre near Żmigród which at the beginning of 2019 was updated with the first in Poland ETCS L1 baseline 3.4.0 system version. It allows testing the compatibility of vehicles equipped with baseline 3.4.0 on-board devices with the infrastructure with the state of art system version.

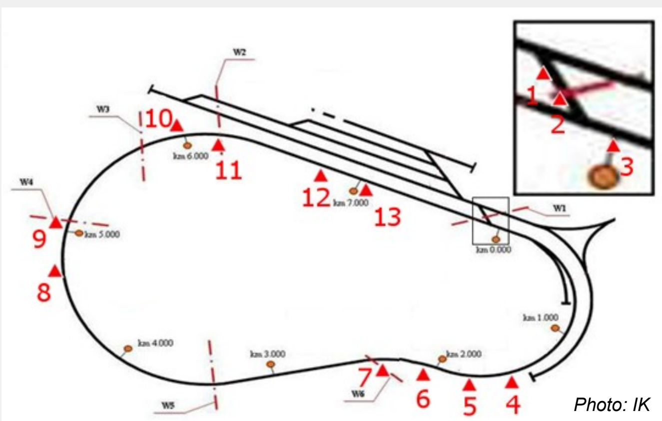

Fig 1. ETCS components (balises) layout on the Test Track Centre

In the case of level 2 ERTMS/ETCS tests it is necessary to conduct them on the line belonging to the Polish infrastructure manager PKP PLK, what determines a number of formal conditions that must be completed in order for the tests to take place. The procedure starts with specifying test track that meets the criteria for operational scenarios. Then technical and operational risk assessment is carried out for the tested vehicle, where all parameters influencing the tests are taken into account. Later on, in agreement with all parties involved in the study of a specific rolling stock, a temporary driving rules are created on the basis of which strictly specified track closures are introduced. At present tests of proper integration are carried out on the E-30 line Legnica Wschodnia – Miłkowice – Chojnów along with adjacent lines.

Fig 2. ETCS onboard equipment under tests

The issues of correct integration of the "Signalling On-board Subsystem" with the "Signalling Trackside Subsystem" are an important element in the approval of the rolling stock. This is the final verification of the vehicle before obtaining approval for the placing in service. Detected errors and irregularities must be eliminated by introducing changes to the vehicle before issuing the EC verification certificate. Each ERTMS/ETCS on-board equipment manufacturer has an individual approach to the manner in which he implements the requirements of subsets and TSIs what in the final result may require the implementation of additional measures to ensure full compatibility of subsystems. Therefore because of variance in national signalling equipment (e.g. interlocking's), operational rules, different interpretations, possible errors in design etc. tests mentioned above shall be performed in order to demonstrate the technical compatibility of the considered subsystems. The last but not least it should be remembered that laboratory and commissioning tests, due to their nature, do not allow to formulating the conclusion that the vehicle will properly cooperate with the infrastructure dedicated to it. Therefore commissioning checks should be extended by the aforementioned tests before placing rolling stock in the service.

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Introduction (cont.)

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Moreover, an impact generator, multi-voltage power supply with 400 kW ensuring the supply of tested devices with DC and AC voltages used in rolling stock in Europe and a high-current power supply (6.5 kA) will be purchased. The Rolling Stock Testing Laboratory has developed and implemented a unique coupler structure for testing rail brakes. The adaptation of the stand for testing friction pairs in this Laboratory is being carried out and its goal is to adapt this stand to the current requirements of TSI and UIC and to obtain a PCA accreditation.
The Test Track in Żmigród has extended its capabilities of testing ERTMS/ETCS Level 1 devices according to the current version of the TSI CCS specification, i.e. baseline 3.4.

The scope of investments carried out in the Railway Research Institute is very extensive in relation to the financial capabilities of the Institute. They are possible, inter alia, due to the funding of approximately PLN 4.7 million acquired from the funds of the Regional Operational Program of the Masovian Voivodship for 2014–2020, which the Institute received for the implementation of the apparatus purchase project.
The acquisition of new equipment is part of a broader IK program including a significant extension of the capabilities of the Test Track research and testing base in Żmigród. It is essential regarding the preparations for the construction of the Central Transportation Hub. The IK test track will allow, for instance, testing of rolling stock adapted to supply with 25 kV AC, as well as testing of on-board and track-side equipment of the ETCS Level 2 safe driving control system.

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Human Factor in the Railway Transport System

Iwona Karasiewicz
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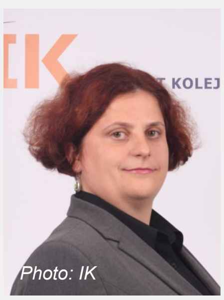

The human factor is one of the key factors in designing and improving an organization. A person in an organization should be considered as a reason for its development and as a source of arising errors. The identification of opportunities and threats related to the human factor in the rail transport should be directly linked to the provisions of the Railway Safety Directive, the Railway Interoperability Directive and e.g. RAMS regulations (EN 50126, 50128, 50129, 50129).
Based on the analysis of railway incidents for the 2010-2017 years, an increase in the number of railway incidents resulting from human errors can be noticed. This situation forces railway companies and infrastructure managers to develop a systemic approach to risk management involving human factor. Figure 1 provides a proposal for a hazard identification procedure.
The applied threat identification procedure allows to correctly include the human factor in the rail transport system. Thus, it is possible to minimize errors made by workers by adjusting the training system, designing changes in terms of the needs of their recipients.

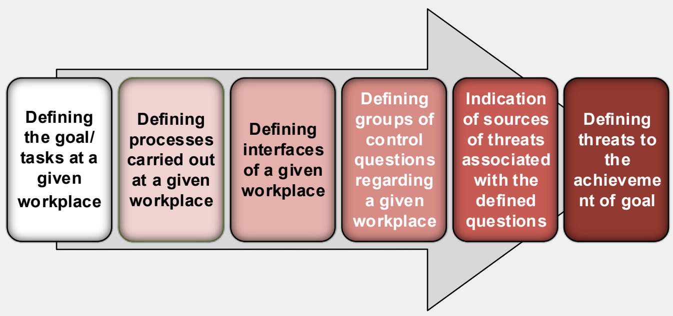

Fig 1. Threat identification procedure
Source: The author's own elaboration

Tab 1. Catalogue of sample questions on a checklist to identify

No.	CHECKLIST OF SAMPLE QUESTIONS	ANSWER TO SAMPLE QUESTION	
		YES	NO
Group of questions: I. Ergonomics of a workplace			
I.1	Does the workplace have sufficient space for freedom of work?	X	
I.2	Does the organization of the workplace allow free observation of the traffic situation at the station?		X
I.7	Do working conditions depend on atmospheric conditions?		
I.7.1	Is the building in which the train dispatcher works equipped with working air conditioning?	X	

Source: The author's own elaboration

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Advanced Rail Technologies ART 2019 Conference

During the Conference Transport of the 21st Century, **"Advanced Rail Technologies ART 2019"** conference panel took place, organized by the Railway Research Institute and the Faculty of Transport of the Warsaw University of Technology. It covered the following research areas of rail transport: railway traffic, railway operation, rail transport infrastructure, traction and rail vehicles, traffic command control and railway ITC, materials engineering and recycling in transport, organization and technology of rail transport.

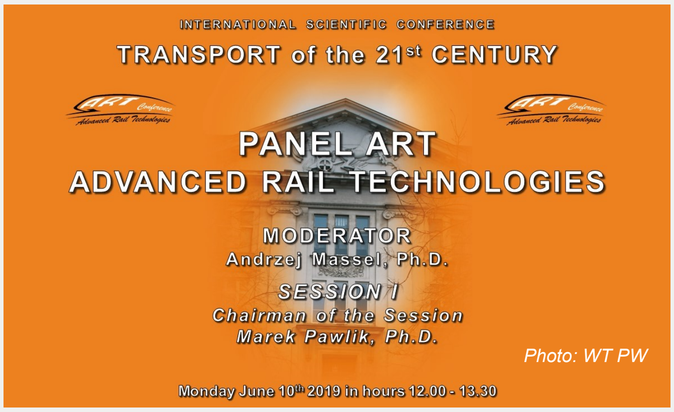

Photo: WT PW

The speeches presented by the Railway Research Institute's workers during the conference:

1) Dominik Adamski, Juliusz Furman, Krzysztof Ortel "Selected aspects of electromagnetic fields research generated by the diesel-electric locomotive"
2) Dominik Adamski, Krzysztof Ortel, Łukasz Zawadka "Research on proper integration between an On-board and a Trackside Control-command and Signalling subsystems"
3) Renata Barcikowska "Networking of research institutes in Poland"
4) Kamil Białek, Patryk Wetoszka "Analysis of elimination of electromagnetic disturbances at power ports of railway equipment"
5) Andrzej Białoń, Krzysztof Ortel, Łukasz Zawadka "Issues of description of EMC processes in direct current catenary"
6) Dariusz Brodowski (Railway Research Institute in Warsaw), Mateusz Flis (Polish Naval Academy in Gdynia) "Experimental verification of new methods in railway turnouts' heating – contactless heaters"
7) Andrzej Chojnacki "The process of obtaining an authorization to put rail vehicles into the service in Poland according to the TSI requirements"
8) Mateusz Flis (Polish Naval Academy in Gdynia), Dariusz Brodowski (Railway Research Institute in Warsaw) "Concepts of energy consumption optimization in the electric turnouts heating process"
9) Juliusz Furman, Andrzej Białoń "Influence of commutation interferences on analysis of harmonics in the traction current"
10) Stanisław Gago (Railway Research Institute in Warsaw), Mirosław Siergiejczyk (Warsaw University of Technology, Faculty of Transport) "Premises for developing an IT network design for railway transport in Poland"
11) Paweł Gradowski, Magdalena Kycko "Influence of the new investment task implementation on the certificated control-command and signalling subsystem"
12) Iwona Karasiewicz "Identification of hazards related to human factors in the railway transport system"
13) Włodzimierz Kruczek "The interaction of the DC traction system with the AC power system through grounding circuits"
14) Magdalena Kycko (Railway Research Institute in Warsaw), Wiesław Zabłocki (Warsaw University of Technology) "Risks in investment processes comprising the railway traffic control systems"
15) Andrzej Massel "What is the actual utilization of the train maximum speed?"
16) Andrzej Miszkiewicz, Krzysztof Tchórzewski "Levels of electromagnetic fields from railway vehicles in the context of the formal requirements applicable in the railway environment and the regulations on the protection of populations"
17) Marek Pawlik "Rail transport systems safety, security and cybersecurity Functional Integrity Levels"
18) Krzysztof Polak (Railway Research Institute in Warsaw), Jarosław Korzeb (Warsaw University of Technology, Faculty of Transport) "Measurements of noise originating from high speed rail vehicles"
19) Artur Rojek "Breaking time of DC high-speed circuit-breakers"
20) Marek Sumiła "Methodical approach to assessing interference in GSM-R network"
21) Waldemar Szulc, Marek Fiedziuk "Railway Test Track's Research potential and importance for railways"
22) Andrzej Wolff (Warsaw University of Technology), Jacek Kukulski (Railway Research Institute in Warsaw) "Initial numerical and experimental analysis of the heat transfer process in a railway disc brake tested on an inertial stand"
23) Łukasz Zawadka, Dominik Adamski "Selected aspects of Control-Command and Signalling On-board Subsystem verification".

Invitation for TRAKO 2019

Photo: IK

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