IK
RAILWAY RESEARCH INSTITUTE (IK)
Advanced Rail Technologies
NEWSLETTER

*October, November, December 2018*, No. 15

ISSN 2449-6049

IN THIS ISSUE



## *Editor's*

**Artur Rojek**
*Head of Electric Power Department, Railway Research Institute*

The Railway Research Institute carries out a number of research and development projects related to railway energy.

We have completed the first, large stage of the project regarding energy storage, including energy from recuperative braking of vehicles and returning it later to the overhead contact line. The Institute also continuously participates in work aimed at increasing the equipment energy efficiency, including, for instance, electric power supply equipment, and reducing energy losses as well as new types of overhead contact line, aiming at lower voltage drops and reduced energy losses during the transmission of electricity from the substation to the traction vehicle.

As far as energy storage is concerned, the Institute has funded the construction of an energy storage prototype on a 1:1 scale, carried out its full tests and patented it. It is the "heart" for the next projects related to energy storage, strengthening the power supply system or reducing energy consumption due to accumulating it from recuperation. We have also conducted projects at the request of the industry concerning electrical energy meters, including those for traction vehicles, which further translates into the introduction of energy-saving drives, so-called eco-driving. The Institute also performs work that involves the optimization of vehicle operation, better traffic, command and control equipment, optimization of timetables and overcoming bottlenecks. It all affects energy saving.

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## Reforms of regional and agglomeration transport services 1990 - 2018

The conference "Reforms of regional and agglomeration transport services 1990 - 2018", organized by the Faculty of Management and Economics of Services at the University of Szczecin, was held on December 10-11, 2018 in Szczecin. Nearly 100 participants attended the conference, including distinguished guests who contributed to the reorganization of the PKP company and the creation of a railway market currently operating in Poland, including: Mirosław Antonowicz, Krzysztof Celiński, Juliusz Engelhard, Cezary Grabarczyk, Aleksander Janiszewski, Andrzej Massel, Andrzej Wach, Ewaryst Waligórski, Adam Wielądek as well as representatives of regional and agglomeration railways management boards.

Photo: Szczecin University

## Research UIC Intercity and High-Speed Committee meetings in Hangzhou, China

UIC Intercity and High-Speed Committee plenary meeting was held in Hangzhou (China) on 26 – 27 November 2018. The meeting covered the outcomes of the Committee current work, inter alia, the preparation of new technical standards for high-speed rail, establishing the Alliance of Universities for High-Speed Railway and launching a new study relating to “Operation under difficult conditions: low temperatures and snow”.


Photo: UIC

## Global Debate on Mobility Challenges for Future Society

On 15th and 16th November 2018, a conference, called the “Global Debate on Mobility Challenges for the Future Society”, organized by the International Union of Railways (UIC) and Instytut Kolejnictwa (Railway Research Institute) was held in Warsaw. The aim of the debate was to exchange views on future transport and the role of railways in intermodal transport system. Then discussions was carried out in five thematic sessions:

1. New mobility system concepts
2. Towards an integrated transport system
3. IT – new opportunities and threats
4. Competitiveness of transport stakeholders
5. Sustainability and resilience of the transport system


Photo: IK

The conclusions from this Global Debate will constitute a crucial input to the update of the Global Vision for Railway Development document, which will be presented at the UIC Assembly General in 2019.

# Electric Energy Storage in 3 kV Traction Supply System

**Artur Rojek**
*Head of Electric Power Department, Railway Research Institute*

In December 2018, the Railway Research Institute (IK) completed the first stage of its internal project named “Development and research of electric energy storage systems in the electric traction supply system”. The project featured the electric energy storage development and construction, designated to supply electric traction facilities (traction substations and section cabins) in 3 kV system. A prototype energy storage was built and tested in laboratory and real-life conditions.

The energy storage was designed and built within the project at the IK Short-Circuit Laboratory where it is possible to connect the laboratory’s circuits with Mińsk Mazowiecki traction substation, which supplies Warszawa – Terespol railway line.

The prototype energy storage is characterized by the following parameters:

– continuous power: 350 kW,
– 15 min power: 1.1 MW,
– energy capacity: ≈ 0.5 MWh,
– operating voltage: 0 – 4.1 kV.

The storage is fitted with:

– a filter,
– a surge arrester system,
– overload- and short-circuit protection,
– a communication set,
– a measurement set.

The element that stores electric energy is an accumulator battery consisting of 504 lithium-iron cells with 200 A rated current and 3C overload capacity.

The battery work is supervised by BMS (battery management system), whose task is:

– to specify the maximum permissible charging and discharging current,
– voltage measurement – indication of the minimum and maximum voltage on the cells,
– to measure the temperature of each cell,
– to protect against discharging and overloading,
– balancing,
– safety control.


*Fig 1. 1/3 accumulator battery*

The energy storage research began with tests in laboratory conditions. The source of voltage for charging the storage was a rectifier set with a 4.4 MVA transformer, that the laboratory is equipped with, and a diode rectifier with a rated current of 1700 A. High power resistors were used as the storage load. The change of load was acquired by high power resistors bypassed by contactors. An example of the voltage waveforms and currents recorded during laboratory tests is shown in Figure 3.


*Fig 2. Energy storage DC/DC converter*

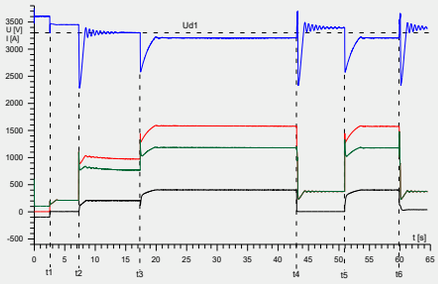


*Fig 3. Voltage waveforms Ud (blue) and currents Id (red), Izp (green) and Im (black) recorded during laboratory tests with the attached rectifier set*

Having positively completed the laboratory tests, the energy storage research was carried out in real conditions. During these tests, the storage was connected to the main rails of the 3 kV DC switchgear of the Mińsk Mazowiecki traction substation.

During the tests, work tests of the storage included in the section cab circuit were also carried out. What’s more, in these conditions, the storage gave off energy in the moments of excessive voltage drops in the overhead contact line and accumulated recuperative braking energy.

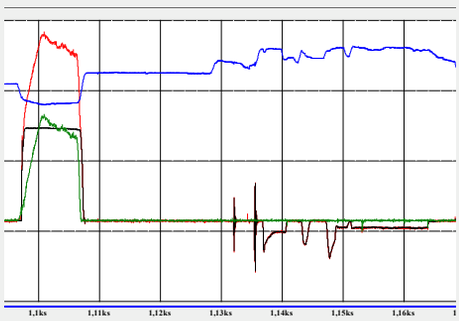

*Fig 4. Voltage waveforms Ud (blue) and currents Id (red), Izp (green) and Im (black) recorded during tests in real-life conditions*

In the current year, it is planned to transfer the storage to the traction substation supplying the IK test track near Żmigród and continue the operational tests, including determining the possibility of reducing the 15-minute momentary power consumed by the substation from the power supply system.

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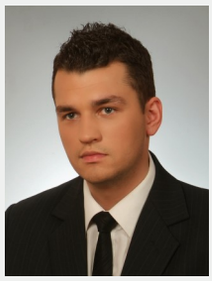
# Studies of Disturbances from Overvoltages and Lightning Strikes in the Catenary

**Dominik Adamski, Krzysztof Ortel, Łukasz Zawadka**
*Railway Traffic Control and Telecom Department, Railway Research Institute*



The area and level of impact of this type of disturbance is not fully recognized and therefore, innovative research was carried out at the Railway Research Institute in order to determine the conditions of overvoltage propagation in rails couplings, determine the attenuation of overvoltages in the catenary in distance domain, develop a new system of catenary protection against overvoltages.

Measurements of overvoltage attenuation in the catenary were carried out for three configurations: unloaded section of the catenary (open network), catenary section loaded with resistance of 240 Ω and 120 Ω, the catenary section loaded with low-voltage varistor. Tests consisted in introducing impact pulses from the impact generator to the catenary and recording amplitudes of voltage and current pulses in characteristic places between the generator and the end of the measurement section, located in the Test Track Circuit of the Railway Research Institute in Żmigród.

The next task was to determine the optimal distance between varistors installed on the catenary in order to protect it from overvoltages. For this purpose, a physical model of 8 km of the catenary section was developed which fully reflected the phenomena in the area of overvoltage propagation in the same way as on the actual overhead contact line. The model consisted of 8 inductive elements and 8 ground capacities (Figure 1).

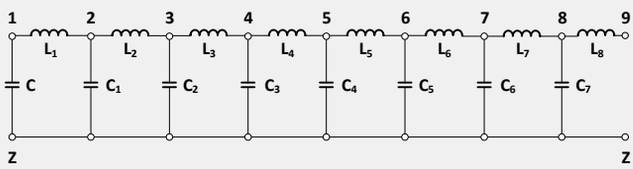



*Fig 1. Diagram of a catenary model*

A thorough study of the area of interaction between varistor surge arresters required measurements for different configurations in which the distance between varistors as well as the place of impact impulse supply would be changed. Therefore, two variants of surge occurrence in relation to varistor location in the developed model were adopted: surge in the middle between varistors with variable varistor spacing, i.e. 2, 4 and 6 km, and surge at the entrance to the model, where one of the varistors was installed at the end of the line model at the distance between varistors of 4 km.

The last stage was to verify the results on the actual catenary, using an impact generator with an amplitude

of about 15 kV and varistors, whose parameters are adapted to work on the catenary. Moreover, assumptions were to be developed necessary to carry out operational tests of the new system for protection of the overvoltage protection of the catenary on the PKP PLK network.

On the basis of recorded oscillograms of voltage shock pulses for three configurations, the attenuation characteristics of these pulses amplitude over the tested section of the catenary in distance domain (Figure 3) have been developed.

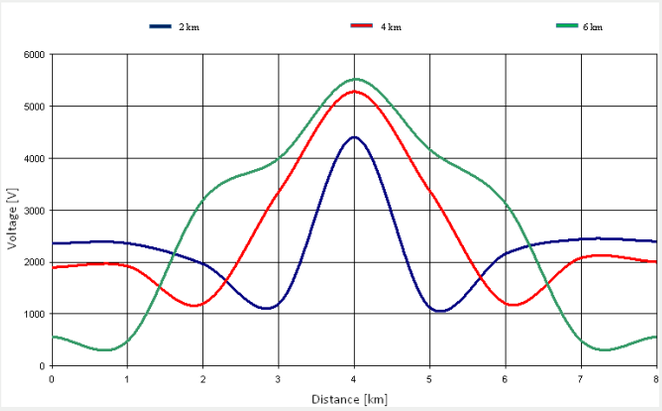



*Fig 2. Characteristics of pulse suppression (10/700ms) in catenary network (surge in the middle)*

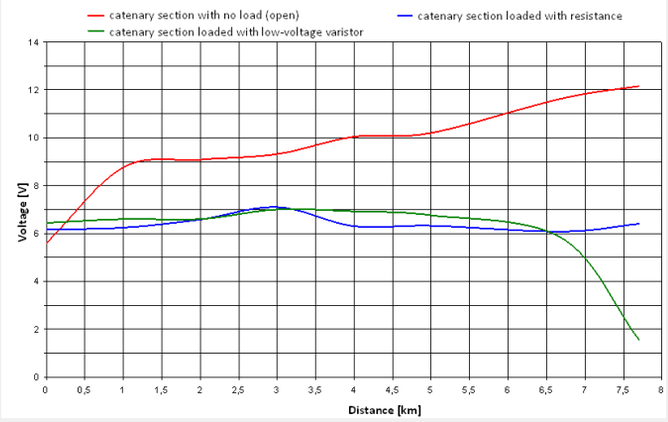



*Fig 3. Attenuation characteristics of pulses amplitude over the tested section of the catenary*

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# Railway Research Institute's New Portable Equipment for Measurements of Railway Infrastructure Geometrical Elements Dimensions

**Andrzej Aniszewicz**
*Engineering and technical specialist, Metrology Laboratory, Railway Research Institute*

Metrology Laboratory of the Railway Research Institute has acquired new measuring equipment in recent years. It is a 6-axis coordinate measuring arm with a measuring range of 2 meters and accuracy of measurements in this range of 0.03 mm. It allows for very precise measurements of geometric dimensions of objects and elements with a complicated spatial structure. The great advantage of this portable device is the possibility to extend its measuring range. By moving the coordinate system with the use of base cones, it is possible to measure elements up to 100 m in size. Thus, the device allows measuring long and complicated objects and elements. Along with the measuring arm, dedicated licensed computer software was provided.

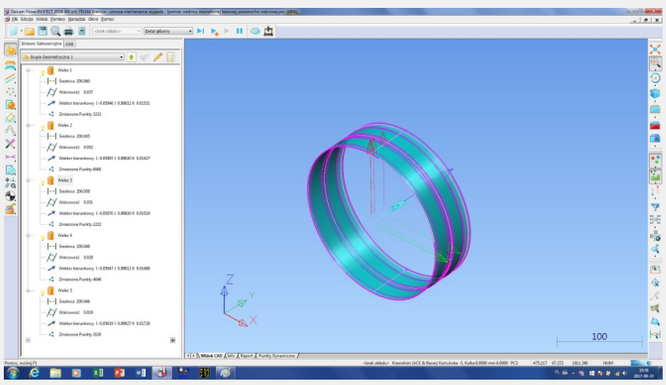

*Fig 1. Dedicated licensed computer software*

The software installed on a portable laptop enables the analysis and archiving of geometric measurements of length and angle and the determination of GD & T parameters (shape, direction and position tolerances).
The paper presents an example of application and measurement results of geometrical dimensions made with the use of a portable 6-axis measuring arm. Elements of rolling stock, eg: bogies, wheelsets, wheel disks and rims, etc. which are worn or damaged, e.g. as a result of derailment, are so deformed that their limit dimensions are exceeded. The construction of standard railway measuring instruments did not allow for reliable measurements. Only the use of a universal portable coordinate measuring arm allows determining the values of selected dimensions.
The measuring arm was used to determine the dimensions of pre-stressed concrete sleepers, the dimensions of bogies, wheelsets, wheel disks and couplers. Obtained results of measurements were used to conduct the analysis in the development of post-accident expert reports.


*Fig 2. Measuring arm*

Measurements of constructionally assembled elements and products became easy when portable accurate coordinate measurement arms appeared which are capable of operating in production conditions and software allowing for collective elaboration of measurement results obtained with the use of these devices. Therefore, not only is it possible to reliably and quickly measure, but also to assemble and compare several measurement results, to make graphs of shape errors or to analyze changes in surface geometry that progress along wearing. The coordinate measuring arm is useful at all stages of formation and operation of the device. It can be used to check the wear of components and to document the quality of new or renovated products.

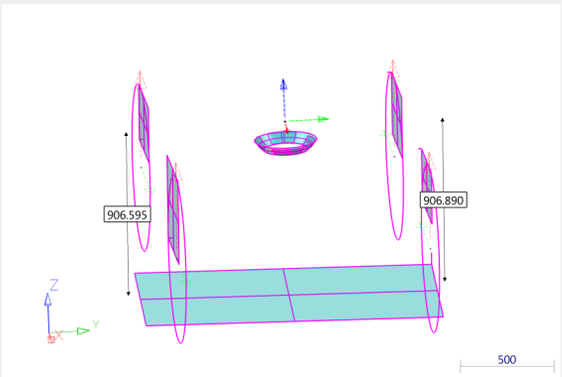


*Fig 3. Measurement results*

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# Calibration Measuring Instruments Used in Railway Transport

**Klaudia Bednaruk**
*Junior engineering and technical specialist, Metrological Laboratory, Railway Research Institute*

The Railway Research Institute's Metrological Laboratory is an accredited calibration laboratory (certificate of accreditation AP 024). The main activity of the laboratory is to carry out calibrations of the most popular measuring instruments (e.g. callipers, micrometers, gauge blocks, multimeters) as well as specialised measuring instruments used in railway transport (e.g. wheel profile callipers, wheel tread diameter).

Calibration is a very important process thanks to which it is possible to find out information about metrological characteristics of the instrument, which reflect the technical state of the instrument, and enables to state its condition - continue using or to withdraw it from use. Performing measurements using instruments with high errors may result in taking bad decisions such as allowing to use a wheelset which should be turned once again. Mistakes like that could affect people's health and safety. Calibration should always be done by competent laboratories. It is best to use services of accredited ones. Accreditation guarantees that laboratory:

- has qualified employees,
- uses high quality measurement standards,
- uses procedures which are compliant with current national and international standards,
- is subject to annual assessment by the Polish Centre for Accreditation auditors.

It is very easy to find laboratories performing accredited calibration of commonly used measuring instruments (for example accredited calibration of calliper could be done in Poland by 26 laboratories) but it is very hard or even impossible to find laboratories performing accredited calibration of specialized measuring instruments like the ones used in railway transport. This situation results from many factors. The most important one is low metrological awareness of people using or supervising measuring instruments. Because of that they very often choose the cheapest laboratories, not the most competent ones. Accredited laboratories will always have higher prices compared with not accredited ones.

In 2017, the Railway Research Institute's Metrological Laboratory became the first entity in Poland with accreditation for the calibration of specialised railway instruments: wheel wear profile measurements with analogue callipers, buffer centre line height over rails running surface measurements and wheel tread diameter measurements based on two contact-points. Moreover, the laboratory obtained accreditation for AC resistance measurements, due to which it is able to perform accredited measurements of the resistance of sleepers.

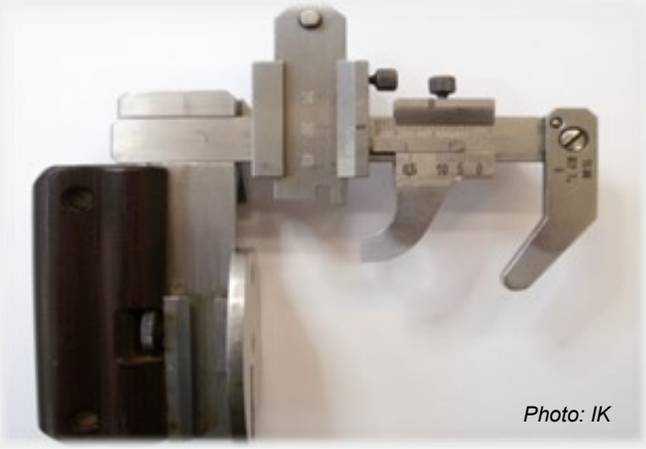


*Fig 1. Wheel wear profile calliper*


*Fig 2. Wheel tread diameter*

In 2018, the Polish Centre for Accreditation accepted the enlargement of the scope of the Laboratory's accreditation by adding instruments for measuring the distance between inner surfaces of wheels in wheelsets.

The Metrological Laboratory plans to further expand the scope of accreditation. The first step will be the accreditation of track gauges calibration method in 2019.

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# Strategies of Accessibility to Passenger Infrastructure according to TSI PRM

**Iwona Wróbel**
*Engineering and Technical Specialist Railway Track & Operation Department of Railway Research Institute*

The main objective of the European Union's policy in the field of transport is, inter alia, to create a single European railway area, by improving the interconnection and interoperability of national rail networks, as well as access to them. This objective is achieved using technical specifications for interoperability. One of them is the PRM TSI, which defines the requirements for the subsystems „Infrastructure", „Rolling Stock", „Operation and Traffic Management" and „Telematics Applications", which deals with the accessibility aspect of the EU rail system for disabled persons and persons with reduced mobility.

Among the requirements for the „Infrastructure" subsystem, there is a disposition of a written strategy by the infrastructure manager or manager of the station, aimed at guaranteeing access to the passenger infrastructure to all persons with reduced mobility throughout the station's operation. Despite the fact that the regulations governing the necessity of having a strategy have been in force for over a decade, the infrastructure managers and station managers still do not have such documents for railway service facilities in Poland.

In order to meet legal requirements, included in the TSI PRM, the Railway Track and Operation Department of the Railway Research Institute, as part of the internal project implementation, developed a research method using the facility questionnaire form, which includes accurate parameters having an impact on the accessibility as well as their evaluation arising from community law provisions.

The suggested survey of the facility contains over 200 questions, enabling the detailed characterization of the station and its particular elements, taking into account the accessibility for the disabled persons and persons with reduced mobility. The scope of information and data included in the project of the sheet was divided into the following thematic blocks:

A. General information concerning a passenger station,
B. Use of a passenger station,
C. Characteristics of the condition of the facility,
D. Access to a passenger station,
E. Platforms,
F. Passenger information,
G. Obstacle-free route,
H. Unstaffed Stations,
I. Assistance for boarding and alighting from trains,
J. Remaining information.

*Fig 1. Regulations for using the passenger station (placed on railway stations and platforms)*

This systematized information about given operational points facilitate developing a strategy for passenger stations, as well as enable to determine operational rules taking existing local conditions into account.

The project also includes:

- a proposal of the strategy for the passenger station document,
- definitions of disabled persons and persons with reduced mobility and a glossary of most important notions,
- a sheet of the passenger station characteristics,
- examples of descriptive parts of the strategy for the passenger station document.


*Fig 2. An example of information on passenger rights and assistance provided to travelers*

The assumption of the aforementioned internal project is to offer cooperation between the Railway Research Institute and railway infrastructure managers in order to provide advice and support in the preparation of access strategy documents.

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## Advanced Technologies in Rail Transport ART 2019

The Railway Research Institute has a great pleasure to invite you to participate in the thematic panel

**"Advanced Technologies in Rail Transport ART 2019"**

which will be held during the

**International Scientific Conference "TRANSPORT of the 21st CENTURY"**

organized by the Faculty of Transport, Warsaw University of Technology.

The panel will be dedicated to 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.

The conference will be held on June 9–12, 2019 in Ryn.

The aim of the conference is 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.

Detailed information about the conference can be found in the Announcement No. 1 and on the conference website: www.transport21.edu.pl

We would also like to inform you that the deadline for submitting the confirmation of participation in the conference and the title of the article has been extended until **March 24, 2019.**

Abstracts and full articles must be submitted by **April 20, 2019**

*Information concerning GDPR privacy policy relating to the organization of the International Scientific Conference "TRANSPORT of the 21st CENTURY" is available at: www.transport21.edu.pl/kontakt/obowiazek-informacyjny-rodo*

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