Article citation info:
Urbański P, Michalak P, Gallas D, Cierniewski M, Bajerlein M, Radziszewski P. Auxiliary rail vehicles – characteristics of the Polish rolling stock for special pur-pose works based on European Vehicle Number (EVN). Rail Vehicles/Pojazdy Szynowe. 2024;1-2:59-65. https://doi.org/10.53502/RAIL-195507

Rail Vehicles/Pojazdy Szynowe

www.railvehicles.eu

Auxiliary rail vehicles – characteristics of the Polish rolling stock for special purpose works based on European Vehicle Number (EVN)

Patryk **Urbański** [a, *], Piotr **Michalak** [a], Dawid **Gallas** [a], Maksymilian **Cierniewski** [a], Maciej **Bajerlein** [b], Patryk **Radziszewski** [a]

[a] *Łukasiewicz Research Network – Poznan Institute of Technology, 6 Ewarysta Estkowskiego St., 61-755 Poznań, Poland*
[b] *Poznan University of Technology, Institute of Powertrains and Aviation, Faculty of Civil and Transport Engineering, Poland*

ARTICLE INFO

Received: 27 September 2024
Revised: 30 October 2024
Accepted: 2 November 2024
Available online: 16 November 2024

KEYWORDS

Auxiliary rail vehicle
Special purpose rail vehicles
European Vehicle Number
National Vehicle Register

The obligatory National Vehicle Register (NVR) requires that each rail vehicle operating on railway lines be assigned a 12-digit European Vehicle Number (EVN). This enables, among others, efficient data management on rail vehicles. The article presents the coding method of EVN for auxiliary rail vehicles intended for special purpose works. The number of auxiliary rolling stock, average age and technical parameters were also analyzed, taking into account the vehicle subgroups. The analyses show, among other things, that in Poland in 2021, 3737 auxiliary rail vehicles were assigned EVN, of which 1285 vehicles had their own propulsion system. In general, for this type of vehicles, the average age was 38.1 years.

1. Introduction

According to data from the Office of Rail Transport (ORT) [16], 19,393 km of railway lines were in use in Poland in 2022, including 18,825 km of standard gauge and 568 km of broad gauge. This means that Poland ranks third in terms of the length of railway lines in Europe. Over the last twenty years, the length of railway lines has decreased by 805 km, which means a reduction of –4%. The largest year-on-year reduction was recorded between 2012 and 2013, when 698 km of railway lines were decommissioned (reduction of –3.5%). Considering the type of railway lines, electrified lines accounted for 63% of all lines [8] (the average for Europe is around 56% [1]). The remaining part is non-electrified, i.e. does not have suspended electric traction.

The proper functioning of rail transport is based on a well-developed railway infrastructure, which should be maintained at an appropriately high level. The technical condition of the railway infrastructure is of great importance for the effective operation of the railway system, and is also important for maintaining safety and reducing the risk of undesirable events [7].

Activities such as the improvement of the condition of the railway infrastructure is associated with continuous monitoring [9, 10] and repair works of the tracks, such as: maintenance, repairs (ongoing, major, emergency), modernization [3]. Specialized track machines designed for specific tasks are used to perform the above-mentioned tasks. Auxiliary rail vehicle, so-called special purpose rail vehicles, despite their low recognition, play a very important role on the railways.

In the case of rolling stock, the foreground vehicles associated with the railway are locomotives, multiple units, freight and passenger wagons, etc. Their quantity and characteristics in Poland are documented and analyzed in the annual reports of the ORT [16]. However, in the case of special purpose rail vehicles, probably due to the non-primary nature of the work of these vehicles, determining the numerical status for statistical analysis may be difficult. There are no studies on this type of vehicles.

* Corresponding author: patryk.urbanski@pit.lukasiewicz.gov.pl (P. Urbański)

In the case of rail vehicles that operate in European countries, the National Vehicle Register (NVR) system applies. Part of this register is the need to assign each vehicle an individual 12-digit EVN number (European Vehicle Number). This means that each vehicle moving on rail lines in Europe must have such a number. Using NVR and EVN [18] it is therefore possible to determine the characteristics and numerical status of individual groups of rail vehicles [15], including auxiliary rail vehicles.

This article explains the meaning of 12-digit EVN number, assigned individually to each rail vehicle. An analysis of the number, age and characteristics of auxiliary rail vehicles operated in Poland in 2021 was also realized.

2. Meaning of individual digits and number groups of the EVN number

Each rail vehicle used on the Polish rail network must be registered in the National Vehicle Register under the European Vehicle Number. This is a 12-digit designation containing information on the technical characteristics of the rail vehicle. The layout of the EVN is shown in Table 1 and the method of creating an EVN for special vehicles is presented in Fig. 1.

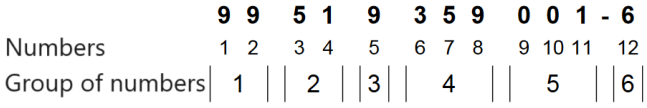

Fig. 1. Example of an EVN number for traction vehicles [4]

1) Group 1, digits 1 and 2 – type of rolling stock (digit 1) and type of traction or special vehicle (digit 2) in accordance with the codes given:
   a) For the digit 1 – only the code number 9, which denotes a railway traction vehicle or a special vehicle,
   b) For the digit 2 – only code number 9, which indicates a service vehicle (Table 2)
2) Group 2, digits 3 and 4 – digital identifier of the country of registration of the railway vehicle
3) Group 3, digit 5 – only number 9, which indicates the purpose of the vehicle – special vehicle (Table 3)
4) Group 4, digits 6, 7 and 8 – more important technical and operational features
5) Group 5, digits 9, 10 and 11 – serial number of the railway vehicle (from 000 to 999)
6) Group 6, check digit.

Table 2. Coding of the digit number 2 of the EVN number of traction and special vehicles according to the vehicle type [4]

Code	Type of traction or special vehicle
0	Various
1	Electric locomotive (except shunting)
2	Diesel locomotive (except shunting)
3	Electric multiple unit (high-speed) (railcar or trailer wagon)
4	Electric multiple unit (except high-speed) (railcar or trailer wagon)
5	Diesel multiple unit (railcar or trailer wagon)
6	Special purpose trailer wagon
7	Shunting locomotive with electric motor
8	Shunting locomotive with a diesel engine
9	Auxiliary special purpose vehicle

Table 3. Coding of the digit number 5 of the EVN number of traction and special vehicles due to the purpose of the vehicle [4]

Code	Type of vehicle
0	Various traction vehicles
1	Passenger locomotive
2	Traction unit or railcar for transporting people
3	Freight locomotive
4	Traction unit or railcar for transporting goods
5	Universal locomotive
6	Universal locomotive
7	Electric shunting locomotive
8	Diesel shunting locomotive
9	Auxiliary special purpose vehicle

In the case of group of numbers 1 (digit 1 and 2), for traction vehicles and special vehicles, these digits range from 90 to 99. Digits 3 and 4 (Group of numbers 2) indicate the country of registration of the vehicle. In the case of Poland, the digital identifier is 51, and the letter identifier is PL. The vehicle is classified as a special vehicle based on the designation of number 5, which for this type of vehicle is 9. The most

Table 1. Meaning of individual digits and number groups of the EVN number [4]

Types of rolling stock	Type of rolling stock and rail vehicle interoperability codes (Digits 1 and 2)	Digital identifier of the country where the vehicle is registered	Technical and operational parameters	Serial number	Check digit (Digit 12)
1	2	3	4	5	6
Freight wagons	00–09 10–19 20–29 30–39 40–49 80–89	01–99	000 0–999 9	001–999	0–9
Passenger wagons	50–59 60–69 70–79		00 00–99 99	001–999	
Traction vehicles	90–99		0 00–8 99	0 001–9 999	
Special vehicles			9 000–9 999	001–999	

important markings due to technical and operational features are contained in numbers 6, 7 and 8, which will be analyzed below. In this article, the analysis of group of numbers 5 and 6, concerning the serial number and check digit, have been omitted.

3. Group number 4 – technical and operational parameters

3.1. Digit 6 – Permissible speed for special railway vehicles according to EN 14033-1 and rail – road vehicles (two-way)

The digit number 6 in the EVN number for special vehicles is intended to determine the permissible speed of the vehicle according to the EN 14033-1 standard and road-rail vehicles. Based on the list, a general division of special vehicles was made according to the drive and permissible speeds. For this digit, 10 classifications are assigned (Fig. 2a), however, for digits 0 and 8 in the list there were no vehicles of this type in Poland (Fig. 2b).

The list shows that there were a total of 3,737 rail vehicles classified as special (auxiliary) in Poland in 2021. This means that in 2021 this group was larger than freight locomotives by 17% (3,188 units) and than passenger traction vehicles by 82% (2,050 units) [18]. For the digit number 6, the largest number of vehicles were classified under number 5 (1984 units), which constituted 53% of all special vehicles. These vehicles belonged to the group: "Special purpose vehicle, which can be included in the train at speed < 100 km/h or with limitation, without drive". This group of vehicles was also the oldest in the comparison, with an average age of 43.85 years (Fig. 2c). In turn, the smallest group, i.e. 33 units, which was also the youngest (4.33 years), was "A rail-road vehicle with a drive that cannot be included in the train".

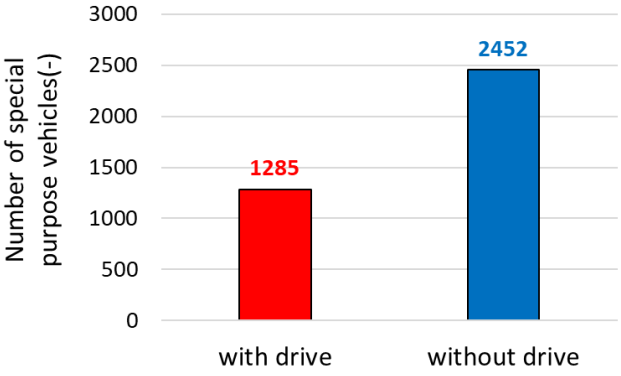

Fig. 3. Number of auxiliary special purpose vehicles by drive in Poland in 2021 (based on [4, 18])

The analyses also show that there were 1,285 special vehicles with drive in Poland in 2021 (Fig. 3) and they constituted 34.4% of all special vehicles. The rest

a)

Classification			Driving speed		
			≥ 100 km/h	< 100 km/h	0 km/h
Which can be included in the train at speed	V ≥ 100 km/h	with drive	1	2	
		without drive			3
	V<100 km/h or with limitation	with drive		4	
		without drive			5
Which cannot be included in the train		with drive		6	
		without drive			7
A rail-road vehicle with a drive that can be included				8	
A rail-road vehicle with a drive that cannot be included				9	
A rail-road vehicle without a drive					0

b)

Classification			Driving speed		
			≥ 100 km/h	< 100 km/h	0 km/h
Which can be included in the train at speed	V ≥ 100 km/h	with drive	67	161	
		without drive			58
	V<100 km/h or with limitation	with drive		682	
		without drive			1984
Which cannot be included in the train		with drive		342	
		without drive			410
A rail-road vehicle with a drive that can be included					
A rail-road vehicle with a drive that cannot be included				33	
A rail-road vehicle without a drive					

c)

Classification			Driving speed		
			≥ 100 km/h	< 100 km/h	0 km/h
Which can be included in the train at speed	V ≥ 100 km/h	with drive	13,30	30,27	
		without drive			17,66
	V<100 km/h or with limitation	with drive		31,73	
		without drive			43,85
Which cannot be included in the train		with drive		35,52	
		without drive			36,09
A rail-road vehicle with a drive that can be included					
A rail-road vehicle with a drive that cannot be included				4,33	
A rail-road vehicle without a drive					

Fig. 2. Classification of auxiliary special rail vehicles based on speed and drive: a) coding the digit number 6, b) number of vehicles in a given group, c) average age of vehicles in a given group (based on [4, 18])

of the vehicles (2,452 units) were not equipped with drive, which means that another traction vehicle is required to move them.

In the case of special rail vehicles, the dominant type of drive is internal combustion engines (ICE), mainly with Compression Ignition (CI). Work is currently underway to introduce alternative drives to rail vehicles [5], including special rail vehicles [2, 6]. Solutions like batteries [14], use of hydrogen [17] in form of fuel cells [11] or alternative and blended fuels [13] were already tested or introduced. However, it is a demanding and long-term process. The main reason for using ICE is primarily the need for universality, reliability and cheap exploitation of such vehicles. The work and travel of vehicles very often takes place on non-electrified lines or those under repair, which requires the use of an independent source of drive.

3.2. Digit 7 and 8 – Type and subtype of auxiliary special rail vehicle

Special vehicles, due to the seventh digit in the EVN number, can be divided into 10 subgroups, to which the digits from 0 to 9 are assigned (Table 4). For number 4, i.e. "Special railway vehicles for maintenance and construction works", there are no such special vehicles in operation in Poland, therefore in practice there are 9 operating groups.

Table 4. Coding of the digit number 7 of the EVN number of traction and special vehicles according to the vehicle type [4]

Code	Type of auxiliary special rail vehicle
0	Rail-road vehicles
1	Vehicles to maintain infrastructure and build railway roads
2	Special vehicles for track maintenance
3	Special vehicles for maintaining the catenary
4	Special railway vehicles for maintenance and construction works
5	Loading/unloading vehicles and for other technological works
6	Special measurement vehicles
7	Vehicles to remove railway network failure
8	Motor transport vehicles
9	Vehicles for removing impurities

Figure 4a presents a summary of the number of special vehicles, taking into account their division into subgroups. By far the largest subgroup, constituting almost half of the number of special vehicles (48.6%), are vehicles classified as "loading-unloading and for other technological works", of which there were 1,816 registered. These vehicles are adapted for loading and unloading goods and are primarily used for the

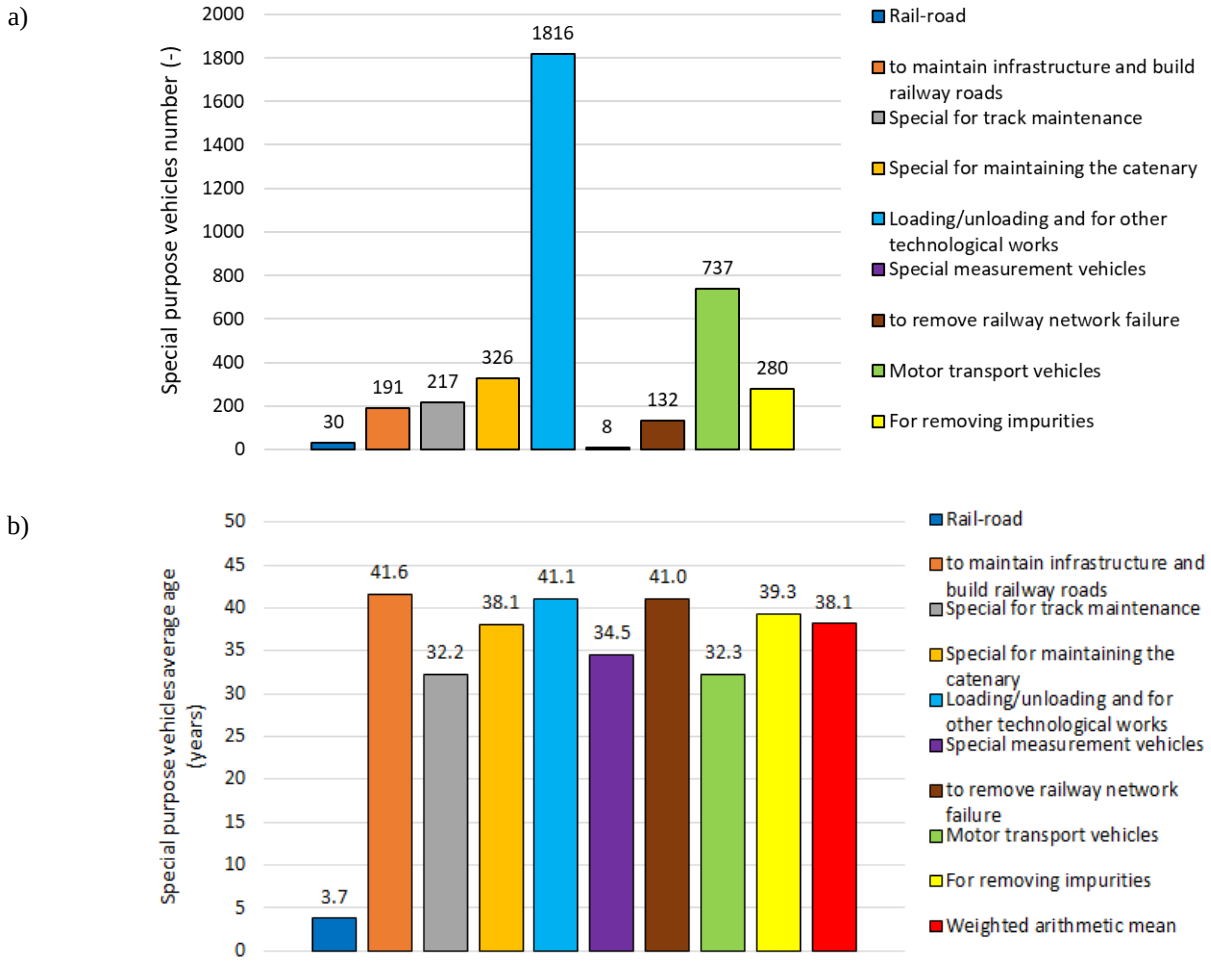

Fig. 4. Auxiliary special purpose railway vehicles in Poland in 2021: a) umber, b) average age of a given groups (based on [4, 18])

transport of: rails, bulk materials, sleepers, railroad switches. The second group, constituting 19.8% of special vehicles, are motor transport vehicles, of which there were 737 registered.

This group of vehicles includes, among others, traction vehicles, railcars and transport draisines. The remaining subgroups of vehicles, in terms of number, are special railway vehicles for maintaining the catenary line (326 units), devices for removing impurities (280 units), special railway vehicles for maintaining tracks (217 units). In the case of the remaining subgroups of vehicles, their number is less than 200 units.

The average age of auxiliary special vehicles for individual groups is presented in Figure 4b. It is visible that special vehicles are characterized by a significant average age, which for all vehicles was 38.1 years. The only exception are rail-road vehicles, the average age of which was 3.7 years. This is primarily due to the fact that vehicles of this type are a relatively new solution on the market and have only recently been put into operation by companies [12].

Table 5. Quantity and average age of the given groups of special rail vehicles in Poland in 2021 based on digits 7th and 8th in NVR number (based on [4, 18])

Digit 7		Digit 8		Quantity of rolling stock (pcs.)	Average age (years)
Number	Vehicle type	Number	Vehicle subtype		
0	Rail-road vehicles	0	Other	2	14,5
		1	Road-rail vehicle category 1	11	3.1
		3	Road-rail vehicle category 2	17	2.9
1	Vehicles to maintain infrastructure and build railway roads	0	Other	81	51.0
		1	Rail crane	6	41.5
		3	Rail replacement train	4	26.8
		4	Ballast cleaner/Undercutter	30	31.9
		5	Earthmoving machines	17	31,3
		9	Rail crane	53	37.1
2	Special vehicles for track maintenance	0	Other	19	33.2
		1	High-performance track tamper	39	33.5
		2	Other track tampers	15	34.7
		4	Tamping machine for railway switches and crossings	57	33.4
		5	Ballast profiling machine	61	30.6
		6	Dynamic track stabilizer	11	24.3
		7	Rail grinding or welding machines	15	33.5
3	Special vehicles for maintaining the catenary	0	Other	211	48.0
		1	Multifunctional machine	108	18.9
		2	Cable drum machine	1	49.0
		3	Catenary setting machine	3	8.7
		6	Elevating platform machine, superstructure machine	1	13.0
		9	Catenary checking wagon	2	70.0
5	Loading/unloading vehicles and for other technological works	0	Other (including technical and utility vehicles)	572	50.9
		2	Self-unloading transporter wagon for ballast, gravel, and other bulk materials	155	19.0
		5	Loading and unloading wagon for transporting sleepers	300	48.1
		8	Loading and unloading wagon for transporting switches	12	1.8
		9	Loading and unloading wagon for other materials	777	36.2
6	Special measurement vehicles	0	Other	2	13.0
		2	Track monitoring wagon	3	44.3
		3	Catenary monitoring wagon	1	46.0
		4	Track geometry measuring vehicle	2	35.5
7	Vehicles to remove railway network failure	0	Other	15	12.7
		1	Crane for removing the effects of railway accidents	38	40.8
		4	Rescue wagon	66	45.8
		7	Wagon for transporting rescue equipment	13	50.5
8	Motor transport vehicles	0	Other	2	31.0
		1	Traction vehicle	1	12.0
		3	Transport railcar	702	32.2
		5	Railcar	32	33.3
9	Vehicles for removing impurities	0	Other	80	37.3
		2	Snowplough	74	39.6
		3	Track snow remover	109	40.8
		5	Weeding railcar	17	38.2
			Sum / Average age	3737	38.1

In the case of the rest vehicles, as many as three subgroups were distinguished by an average age of over 40 years. These included the oldest vehicles in the comparison, those for infrastructure maintenance and construction of railways (41.6 years), the most numerous loading and unloading vehicles and those for other technological works (41.1 years), and vehicles for removing breakdowns in the traction network (41 years). The remaining subgroups of vehicles, excluding rail-road vehicles, were also distinguished by an advanced average age, with the youngest group being special railway vehicles for track maintenance (32.2 years) and motor transport vehicles (32.3 years). This means that the average age range for the groups described was between 32 and 42 years.

It should be noted that these are average values, which means that this indicator is also influenced by very old vehicles that are included in the list. An example is vehicles manufactured even in the 1930s and 1940s, and the oldest representative is a 100-year-old vehicle for maintaining the catenary, manufactured in 1921. Despite the very old vehicles in the list, they have been assigned an EVN number, which is necessary for moving on the railway line. It should be remembered that the number of such old vehicles is relatively small, which means that they do not have a significant impact on the overall average age of vehicles and their subgroups.

The real impact on this value is mainly on vehicles aged 30 to 50. Table 5 presents a detailed summary of the number and average age of the given subtypes of special vehicles in Poland in 2021 based on digits 7 and 8 of the EVN number.

4. Conclusions

It is important to emphasize that the analysis only include vehicles with an EVN number. This means that the analysis does not include vehicles without a number that authorizes them to move on a railway line. Therefore, the exact number of all auxiliary special vehicles in Poland is very difficult to estimate. Many vehicles can be operated without an EVN number, because the Regulation [4] does not apply to vehicles:

1. Moving only on a railway siding
2. Having a track gauge of less than 1435 mm
3. Historical vehicles used as immovable exhibits
4. Special vehicles moving only on a closed track or transported on other vehicles
5. Moving only on railway networks that are functionally separate from the railway system and intended only for local, urban or suburban passenger transport
6. Moving only on railway infrastructure belonging to managers of private railway infrastructure, for their own use within the framework of their own freight transport activities
7. Moving only on railway infrastructure intended exclusively for local, tourist or historical use
8. Historical vehicles not travelling on the railway network.

In reality, the total number and age of special vehicles may be significantly greater. Vehicles, may be operated independently in non-public areas, and registration and supervision of such vehicles is practically not applicable or is subject to less stringent requirements. It is therefore assumed that the technical condition of vehicles and drive systems and units may be of even lower quality than the vehicles presented in the analysis.

Acknowledgements

The authors thank the Polish Ministry of Education and Science for financial support (Applied Doctorate Program, No. DWD/4/23/2020 dated on 19.11.2020).

Nomenclature

CI	compression ignition
EVN	European Vehicle Number
ICE	internal combustion engines
NVR	National Vehicle Register
ORT	Office of Rail Transport

Bibliography

[1] Chamaret A, Mannevy P, Clément P, Ernst J, Flerlage H. Analysis, trends and expectations for low carbon railway. Transp Res Proc. 2023;72:2684-2691. https://doi.org/10.1016/j.trpro.2023.11.808

[2] Cierniewski M, Jakuszko W, Stobnicki P. Sterowanie obwodem głównym hybrydowego pojazdu szynowego. Electrotechnical Review. 2022;1:267-270. https://doi.org/10.15199/48.2022.09.62.

[3] Daszkiewicz P, Andrzejewski M, Urbański P, Woch A, Stefańska N. Analysis of the exhaust emissions of toxic compounds from a special purpose rail machine PŁT-500 during profiling the ballast cess. Journal of Ecological Engineering. 2021;22(7):80-88. https://doi.org/10.12911/22998993/139214.

[4] Dziennik Ustaw Rzeczypospolitej Polskiej. Obwieszczenie Ministra Infrastruktury z dnia 11 kwietnia 2019 r. w sprawie ogłoszenia jednolitego tekstu rozporządzenia Ministra Transportu, Budownictwa i Gospodarki Morskiej w sprawie sposobu prowadzenia rejestru oraz sposobu oznakowania pojazdów kolejowych n.d. (in Polish) https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20190000918 (accessed April 11, 2024).

[5] Gallas D, Stobnicki P. Adoption of modern hydrogen technologies in rail transport. Journal of Ecological Engineering. 2022;23:84-91. https://doi.org/10.12911/22998993/145291
[6] Gallas D, Stobnicki P, Jakuszko W, Urbański P, Kikut J. Application of alternative drive systems in modern special-purpose rail vehicles. WUT Journal of Transportation Engineering. 2023;136:23-33. https://doi.org/10.5604/01.3001.0016.3417
[7] Hong W-T, Clifton G, Nelson JD. Railway accident causation analysis: Current approaches, challenges and potential solutions. Accident Anal Prev. 2023;186:107049. https://doi.org/10.1016/j.aap.2023.107049
[8] Indepentent Regulator's Group – Rail. 11th MM Report – 2023. IRG Rail n.d. https://irg-rail.eu/irg/documents/market-monitoring/383,2023.html (accessed on January 17, 2024).
[9] La Paglia I, Carnevale M, Corradi R, Di Gialleonardo E, Facchinetti A, Lisi S. Condition monitoring of vertical track alignment by bogie acceleration measurements on commercial high-speed vehicles. Mech Syst Signal Pr. 2023;186: 109869. https://doi.org/10.1016/j.ymssp.2022.109869
[10] La Paglia I, Di Gialleonardo E, Facchinetti A, Carnevale M, Corradi R. A methodology to estimate railway track conditions from vehicle accelerations based on multiple regression. In: Limongelli MP, Giordano PF, Quqa S, Gentile C, Cigada A (ed.). experimental vibration analysis for civil engineering structures, Cham: Springer Nature Switzerland; 2023;203-210. https://doi.org/10.1007/978-3-031-39109-5_21
[11] Madovi O, Hoffrichter A, Little N, Foster SN, Isaac R. Feasibility of hydrogen fuel cell technology for railway intercity services: a case study for the Piedmont in North Carolina. Rail Eng Science. 2021;29:258-270. https://doi.org/10.1007/s40534-021-00249-8
[12] Merkisz J, Rymaniak Ł, Lijewski P, Kamińska M, Kurc B. Tests of ecological indicators of two-way vehicles meeting Stage IIIB and Stage IV standards in real operating conditions. Rail Vehicles/Pojazdy Szynowe. 2020;2020:1-9. https://doi.org/10.53502/RAIL-138495
[13] Oldknow K, Mulligan K, McTaggart-Cowan G. The trajectory of hybrid and hydrogen technologies in North American heavy haul operations. Rail Eng Science. 2021;29:233-247. https://doi.org/10.1007/s40534-021-00242-1
[14] Riabov I, Goolak S, Neduzha L. An estimation of the energy savings of a mainline diesel locomotive equipped with an energy storage device. Vehicles. 2024;6:611-631. https://doi.org/10.3390/vehicles6020028
[15] Sourdille E, Robbiano S, El-haimour N, Taunay L. Reconciliation of train-run data and train consumption data for a better traction energy consumption estimation, a new tool. Transp Res Proc. 2023;72:2716-2723. https://doi.org/10.1016/j.trpro.2023.11.812
[16] Sprawozdanie z funkcjonowania rynku transportu kolejowego w 2022 r. Urząd Transportu Kolejowego 2023 (in Polish). https://utk.gov.pl/pl/aktualnosci/20285,Sprawozdanie-z-funkcjonowania-rynku-transportu-kolejowego-w-2022-r.html (accessed on January 17, 2024).
[17] Sun Y, Anwar M, Hassan NMS, Spiryagin M, Cole C. A review of hydrogen technologies and engineering solutions for railway vehicle design and operations. Rail Eng Science. 2021;29:212-232. https://doi.org/10.1007/s40534-021-00257-8
[18] Urząd Transportu Kolejowego. Krajowy Rejestr Pojazdów Kolejowych (NVR). Portal statystyczny UTK 2021 (in Polish). https://dane.utk.gov.pl/sts/tabor/wykaz-pojazdow/17021,Krajowy-Rejestr-Pojazdow-Kolejowych-NVR.html (accessed February 19, 2024).