



The problems with measuring distance in goods wagons

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ABSTRACT

This article presents the current problems with measuring distance in goods wagons. The main problem where goods wagons are concerned is their lack of power supply. Owing to this, a distance-measuring system is hard to install. Meanwhile, the measurement of distance travelled and the service processes dependent on this measurement are becoming more and more important. Moreover, the railway accident in Viareggio on June 29, 2009 has resulted in increased interest in determining the accurate mileage of a wagon or, to be exact, of a wheelset. One has to realise, that a goods wagon is actually a combination of numerous elements (such as the body, the underframe, the carriage, the wheelsets, etc.) that can differ in mileage and can be exchanged between different wagons. This makes it necessary to register not only the mileage of the whole wagon, but also, at a minimum, of the carriage. This article is an attempt at outlining the current state of this issue.

KEYWORDS: distance measuring, odometer

1. Introduction

A goods wagon is a railway car, whose mileage measurement is technically problematic. The technical condition of the movable elements, including the influence of their operation, both time- and distance-wise on this condition, caused the minister of infrastructure to include a directive (concerning technical certificates) that can be interpreted to say that each wagon's mileage should be registered.

The Directive [6] says:

... §3. The validity of the certificate is limited with time, which is equal to the mileage (in kilometres) of a railway car between its periodical repairs, but not longer than the date of the next periodical repair specified in the certificate, which stems from the maintenance schedule adopted by the entrepreneur. ...

As we can see from the above, we should attempt to ensure that every railway vehicle, including wagons, has the ability to register its mileage in kilometres.

Currently, such mileage cannot be determined for wagons not equipped with GPS devices (most wagons used by PKP).

2. Chosen aspects of goods wagon management

Railway carriers offer goods transport using numerous different types of goods wagons.

According to the general AVV agreement [1] concerning the use and replacement of goods wagons in international routes, their outer walls should bear an identification consisting of:

- an inventory number,
- an alphabetic interoperability code,

31	RIV
80	<u>D</u> -DB
0691	235-2
Tanoos	

Fig. 1. Wagon labels

Source:[1]

where: 31 - interoperability code; 80 - country code; D - country code; DB - carrier's alphabetic code; 0691 - the most important technical and operational parameters; 235 - a serial number of the wagon; 2 - self-control number; RIV - means that the wagon conforms to the Technical Unity in Railway regulations

- an alphabetic code for the country of registration and the carrier using the wagon,
- an alphabetic identification of the type and series,
- other signs and labels as required by specific instructions.

The register of wagons is to be held by an assigned department within the carrier's company. Goods wagons are not generally assigned to a given place of use or maintenance. Only some specialised goods trains have their own "mother stations", which is dictated solely by commercial considerations. The mother station in this context is a chosen station, whose name is printed on the body, and to which the wagon is to be returned once unloaded, unless other instructions are given.

Some of the basic indications concerning the assessment of a wagon's operation are:

- wagon rotation coefficient, i.e. the time between consecutive loading operations
- wagon's performance
- average stay time at a station

The stations are required to register the times of wagon's stays. In order to provide a method to determine the history of a given wagon, including its approximate mileage, every station which provides shipping and transport services holds a numerical registry based on the full numbers of the wagons. This registration should allow for full processing of these data using computer systems.

After a train is completed, a list of cars in this train is compiled on an R7 form. This list is the confirmation of departure or arrival of the wagons. This list is compiled on the spot by filling in the R7 form or using a radio phone (the dispatcher dictates the wagon numbers). At the destination station, the dispatcher and the auditor use the same list to check the wagons in commercial and technical terms. The list is also used to confirm the receipt and transfer of the goods and railway bills between carriers, as well as for statistical and reporting

purposes. The list is usually done in two copies. The first copy stays at the original station, while the second one is meant for the destination.

3. Wagon inventory

PKP CARGO S.A. utilises an EWAG system, which is used to collect and record wagon information. The application includes a numeric inventory of all wagons in operation, together with their history since manufacture, all current and periodic repairs, up until their disposal. The system also allows for registering the replacements of the most vital elements, such as wheelsets, as well as repairs, using codes for faults that happen during operation. Instruction [7] in chapter 8, "a wagon's technical condition check-up" describes the method of registering incidents related to wagon repairs. Each removal of a wagon or its re-entry into the operating fleet is registered in the system, with the code of the cause of such removal.

Due to the lack of data concerning the mileage, the date of such incident is the main reference in the register.

The mileage can be estimated based on R7 documents and by determining the routes taken by the wagon, in order to add up the distance.

4. Determining the mileage in goods wagons

Currently, statistical data concerning the wagon's operation is used by PKP to determine the mileage of most goods wagons.

The mileage can be determined based on:

- periodical readings of the mileage meter
- the data in the wagon tracing systems based on GPS/GSM technology
- an analysis of the "List of wagons in a train" - R7.

Currently, the proportion of PKP wagons equipped with tracking systems or mileage registration systems is relatively small and includes mostly wagons from foreign carriers.

Due to this, the R7 analysis is most often used to register the mileage. The list includes such information as the starting and destination stations of every wagon in a given train. This data, combined with a table of distances, allows for estimating the mileage. It should, however, be noted, that both of these variables are imprecise. The table of distances gives approximate distances between stations with deviations that can be considered negligible when calculating short routes, but can become significant when summing up the total mileage. The second variable is the

wagon's route. The R7 form lists the starting and destination stations, and does not mention the route that a wagon actually travels. This means that the shortest route is usually used to calculate mileage, while the actual route may be longer. The R7 list of wagons only contains wagons that are parts of complete and running trains. It does not, however, include any movement during manoeuvres performed to form a train, so the mileage during these manoeuvres is not included in the analysis.

This situation results in real mileages that can be approx. 4% higher as compared to the estimates.

5. Mileage monitoring system in data collection and processing - premises

A mileage registering device which collects data directly from the axle (with no intermediate subsystems such as radio transmitters and GSM/GPS navigation) should provide quasi-constant mileage registration with no faults.

Data should be collected by mainly using portable terminals carried by dispatch personnel in the stations. Such terminal should be able to communicate with a desktop computer using a cable or WiFi connection in order to transfer the data collected by the terminal to a central data collection point. Depending on the user's preferences, such terminal could be equipped with GSM module, which would enable it to immediately transfer the data to a central location independently of stationary computers (this is important especially in the case of carriers with no extensive networks of offices in the stations, where the basic registration of wagons is often performed by the locomotive crew).

A further extension of this method of data collection using wagon-mounted devices would be to use pass-through gates in places where the wagons are operated, that would automatically read the data and transfer them to a central location.

An application providing access to the collected data as well as tools for processing them is required. Depending on the user's demand, it would be advisable to create software interfaces between the data management application in the central location and the applications used by the carriers to register their wagons (e.g. EWAG used by PKP CARGO S.A.).

Apart from the basic functionality of the system, i.e. collecting data concerning registered mileages, the system could include a number of additional functions to extend this functionality. One example of this would be the ability to include other valuable information in the wagon-mounted device, such as: date of production, dates of repairs,

wagon series and number, etc. Reading and processing this information would make it possible to depart from the traditional methods of registering wagons "on the spot" by automating, and thus speeding up the process. This would allow e.g. for automatically generating R7 wagon lists.

The second type of terminals, apart from the ones used to read the data, should also be able to save the data in a device. Such a device should allow for saving such parameters as wagon number, axle number, the diameter of the wheelset (updating this parameter is vital for the conversion of counted impulses into kilometres). Due to the importance of such changes, the access to the device and to the saving function should be verified by a PIN and checked against a database of authorised personnel. These terminals should be given to wagon receivers, repair shops or other personnel and institutions authorised by the carrier.

6. Goods wagons in the TSI specification - chosen aspects

The wagons should be labelled in order to:

- identify each wagon using its unique number, according to the "Railway traffic" TSI. The number is listed in the vehicle register,
- provide information required to complete a train, including the information concerning their braking weight, length including bumpers, their own weight, the speed table according to the load on different categories of routes,
- identify operational limitations for the personnel, including geographical and distribution limitations,
- provide appropriate information concerning safety to the personnel working on the wagons or participating in the rescue mission, including warning signs on powered traction and electrical equipment, lifting locations and safety instructions for particular wagons,

The vehicle should be able to transmit information between the stationary equipment and the vehicle.

Identification tags are not obligatory. If a wagon is equipped with a radio identification device (RFID-tag), the specification below should be used.

- two "passive" tags should be used, one on each side of the wagon, in areas specified in the drawing, in a manner that allows to read the unique id number by a trackside reader.
- if the trackside readers are installed, they should be able to read id tags on vehicles moving at speeds of up to 30 km/h and transmit the data to a ground data transmission system.

- physical cooperation between the reader and the id tag, the protocols and orders, as well as the diagrams for solving the collisions should conform to standard [8] type A.
- if the readers are installed, they should be located on entrances and exits where the train can be modified.

7. Vehicle identification

Each railway vehicle is assigned a 12-digit number (called a standard number) according to the scheme on fig. 3.

In each of the countries, the 7 digits designated to represent the technical characteristics and the serial number are sufficient to unambiguously identify any vehicle.

This number is accompanied by an alphabetic code:

- interoperability code
- a code of the country, where the vehicle is registered
- owner's code
- technical characteristic code

Owner's code (Vehicle Keeper Marking - VKM) is an alphanumeric code of 2 to 5 characters. The VKM is printed on every railway vehicle, near the vehicle number. The VKM marks the owner according to the register.

The VKM is unique in all countries included in the TSI and in all countries entering the agreement, which means that they have to implement the numbering and owner code system of the TSI.

The VKM shows the full name or an acronym of the owner's name, in a form that is the easiest to decipher. All 26 letters of the Latin alphabet can be used. VKM includes capital letters, but the letters that are not initials of the owner's name can be lower-case.

The vehicle's ability to transfer information between stationary centres and the vehicle

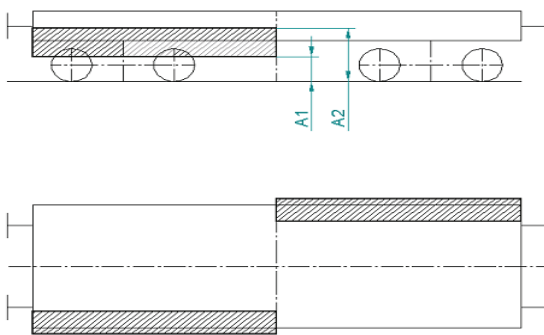


Fig. 2. Locations of identification elements on a wagon where: A1 and A2, respectively, signify the minimum and maximum distance from the top of the rail

Fleet type	Vehicle type and interoperability code (2 digits)	Country of registration (2 digits)	Technical characteristic (4 digits)	Serial number (3 digits)	Control digit (1 digit)
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Fig. 3. Goods wagon number structure

7. Conclusion

To ensure the accuracy of the data collected by a potential measuring system, the carrier using a mileage registration system should adopt a strict internal rule concerning the pairing of wheelsets and axle guards throughout the whole time between repairs.

In case of periodical repairs, when different wheelsets and axle guards are installed, the system has to be able to transfer the data concerning the current mileage to a data collection system, as well as an ability to be paired with a different registration device.

Currently, the mileage of wagons is not registered due to the lack of physical ability to determine such mileage. Due to the above, the EWAG application collects its data and plots them on the time axis, without pairing them with their respective mileages.

In view of the directive of the minister of infrastructure, the lack of mileage registration may be dubious to the Office for Railway Transport in case of carriers not meeting the formal requirement.

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Bibliography

- [1] General Contract of Use for Freight Wagons (AVV)
- [2] Technical Conditions WT-2
- [3] Instruction concerning railway traffic Ir-1
- [4] DSU for E-type wagons of PKP CARGO S.A.
- [5] Draft TSI technical specification "Railway fleet - goods wagons"
- [6] Directive of the Minister of Infrastructure of February 15, 2055 concerning the technical certificates for railway vehicles based on art. 24 paragraph 5 of an act of March 28, 2003 concerning railway transport (Journal of Laws no. 86, item 789 as amended)
- [7] Cr-2 (R2) manual "Manual for Goods Wagon Management"
- [8] ISO18000-6: Information technology -- Radio frequency identification for item management