



FORMING RECOMMENDATIONS OF DIGITAL RECORDING DEVICES

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Abstract

The tachograph is the oldest recording device, which belongs to the Group of ORD (On Board Recording Devices). It was introduced in the USA in 1939. Digital tachograph, the new advanced type of recording device in road transport, was introduced by Council Regulation No 2135/98 of 24 September 1998 with the beginning of May 2006, in the area of the European Union. "In contrast to its analogue predecessors the digital tachograph was introduced to facilitate the control of rest and driving times and to prevent manipulation attempt" [1]. In order to prevent abuse, it has been made the system of cryptologic keys and certificates stored in cards and devices, allowing to create an explicit laws of users and authentic data recorded in, cards and devices. Despite the usage of the most advanced keys and protection systems, it has been observed that, in relation to the elements of the digital tachograph system, there are many ways to register invalid data. The European Union has taken action to prevent them, however, they must be implemented in daily life.

Keywords: *the tachograph card, control, digital tachograph, manipulation, technical inspection.*

1. Introduction

Tachograph (from Greek *tachos* – speed and *grapho*-writes) is a device combining the functions of speed indicator and clock. Tachograph records in the function of time the distance travelled by the vehicle, speed, as well as the driver's activity, i.e. periods of work or of availability, breaks from work and daily rest periods.

Due to the safety on the roads, many countries have introduced restrictions on working time for drivers of vehicles used in road transport of goods and passengers. Vehicles and sets of vehicles with a maximum permissible total mass above 3,5 t and vehicles which are constructed or permanently adapted for carrying more than nine persons including the driver, are covered by the monitoring of the driver activity by tachographs. The second aspect of the use of recording equipment in road transport was and is currently to ensure the safety of participants in road traffic as one of the main problems of present times. Number of vehicles involved in road traffic continuously increases. Despite the actions, aimed at designing and building increasingly safer means of transport, the scale of accidents is very high.

In the current situation of the functioning of digital tachograph system there are the following constituent elements: the inclusion in the TACHOnet system, the process of issuing of tachograph cards, approving of workshop conducting inspection of digital recording equipment, preparedness of States which will introduce the system of digital tachographs (fig. 1-2).

Digital recording devices use the same type of encryption protocol of signal as electronic tachographs, but with a greater degree of speed signal encryption transmitted between the motion sensor and the on-board unit. Such devices are much more safety than the equipment used previously, i.e. analogue tachographs, because of data once written in their memory cannot be changed or deleted. However, it was discovered the opportunity of very easy recording the forged information, which are stored in very safety way. Such proceedings totally changes the concept of safety. The loss of information about speed and distance, recorded in the memory of the digital tachograph, as well as the loss of data describing places of starting and finishing driver's work are quite difficult for the services authorised to inspection of digital recording equipment.

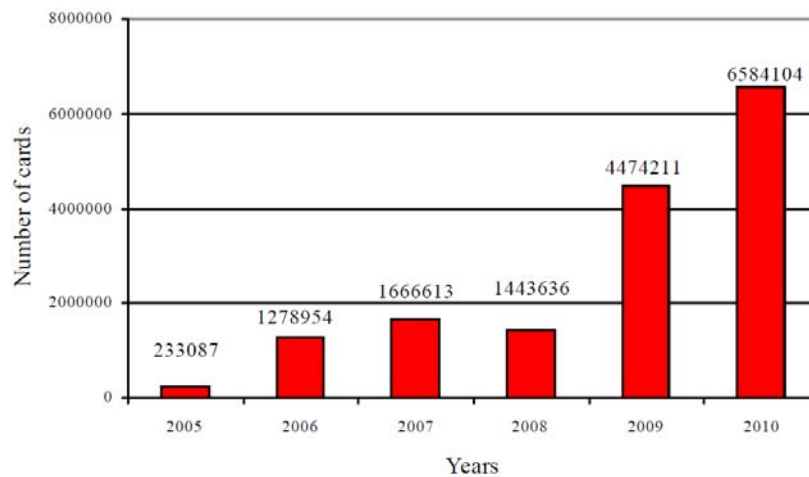


Fig. 1. Number of tachograph cards issued over the functioning of the digital tachograph system [2]

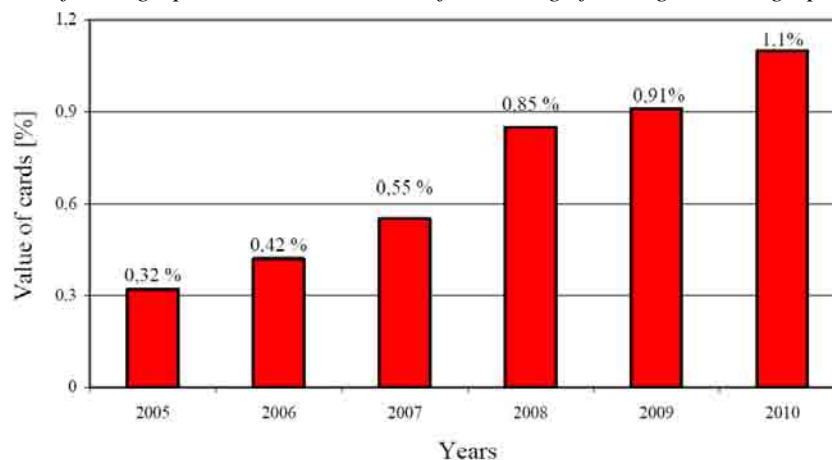


Fig. 2. Part of tachograph cards stolen and lost during the functioning of digital tachograph system [2]

2. Possibilities of manipulating the registers in recording devices.

Due to the effects of the impact, there are two types of ways to intervene in the functioning of the digital recording equipment. Invalid records may arise:

- from improper programming of on-board unit in terms of the transmission of the information concerning the vehicle speed to the vehicle unit,
- with the incorrect use of the switches of choice of the undertaken activity,
- with the adjustment of the clock or its stopping,
- with the invalid manual records,
- with the changes of recording method.

However, incomplete entries or their lack may result from:

- the possible retrospective nature of devices,
- the absence of vehicle speed signal,

- the lack of registers,
- not using the driver card,
- failure to comply with the manual entries.

Forging is not always due to performance driving in breach of the rules. Enter any kind of restrictions have created the need to hide the entries revealing their crossing. In terms of the functioning of digital recording equipment there would be no problems if the workshops carrying out checks, including calibration of digital recording equipment, implemented properly the tasks delegated to them, the drivers entered and took off the tachograph cards in good time, and the data saved in the memory cards were stored for the required period of one year, the drivers correctly used switches of changes the type of activity and correctly made records of other information and also properly stored the manual records in cases, when they do not have the possibility of creating the records by on-board unit.

Despite the benefits of greater security for the application of the digital tachographs in comparison with analogue tachographs, once saved data in the memory card as well as the on-board memory units cannot be changed. In addition, all data will be saved in the memory of the driver card and entries made on it kept manually by the driver and stored on the driver card memory, can no longer be changed. In the case of new equipment, it is very difficult to make unauthorized changes to the on-board unit, and individual driver activities are recorded by on-board unit even in the period when the driver card is left outside the on-board unit.

In the course of the functioning of the digital tachograph system it was also observed significant deficiencies in the elements concerning the safety of:

- records in the memory of the driver card and on-board units can be easily forged by saving the invalid data,
- printouts made from digital recording equipment do not contain any security (may be forged or altered),
- there is no justification for driving a vehicle, equipped with analogue tachograph without its own and valid driver card,
- although the type of the driver's work can be set without a driver card introduced to digital recording equipment, in many cases there may occur problems with the assignment to accurate driver,
- there is no obligation to make the manual records by the driver.

The data saved in the memory of driver card driver, carries large shortcomings resulting that the exact speed of the vehicle is recorded only in the on-board unit, and the record includes only last 24 hours of driving. Then, this information is deleted, and new information is written in this place. Place describing the beginning and end of each daily activity is written on driver cards until the moment of reaching the nearest city or another important place. These places, in conjunction with the written proceedings of the speed of the vehicle on the driver card, are used regularly by persons entitled to inspection in order to confirm the correctness of the recorded activity of the driver (e.g. change the vehicle speed signal often results in that recorded distance between two points is shorter than the actual distance between these two points). In the case of analogue tachograph unusual activities of the driver are written on the sheets and are stored together with other information about the driver. However, in the case of digital recording equipment, it is possible to write it on the printouts.

Digital recording devices use the encoded signal between the motion sensor and the on-board unit. The use of the encoded signal may not be treated as the improvement introduced with digital recording equipment, because these solutions have been already used in analogue tachographs. During the functioning of digital recording equipment it was observed the methods of avoiding the signal coding by using magnet or electromagnet on motion sensor, allowing to forge the signal sent to the on-board unit, so that the digital tachograph cannot record the driving activity (fig 3).

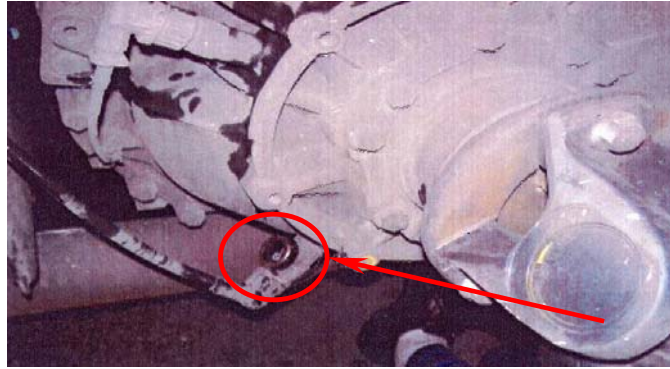


Fig. 3. Magnet on a motion sensor placed to manipulate the records of digital recording equipment

Magnets or electromagnets with different strength may cause reduction of vehicle speed signal strength by 10, 20 or 50% (figure 4–5). An additional element is the use of the plugs ("jack" type), causing grounding of the signal transmitted to the digital tachograph (fig. 6).



Fig. 4. The location of the magnet used to manipulate the indications of digital recording equipment



Fig. 5. The size of the magnet used for counterfeiting the indications of digital recording equipment

Manipulating of the records of digital recording equipment may also be made by changing the size of the wheels; its increase can cause the change about 8-10 km/h. Solutions can be checked on the basis of:

- installation table, which should be placed on the vehicle after the periodic inspection of digital recording equipment,
- the information saved in the memory of the digital recording equipment concerning the last calibration,
- technical data printout, in which the size of the wheels fixed in the car during the calibration was written.

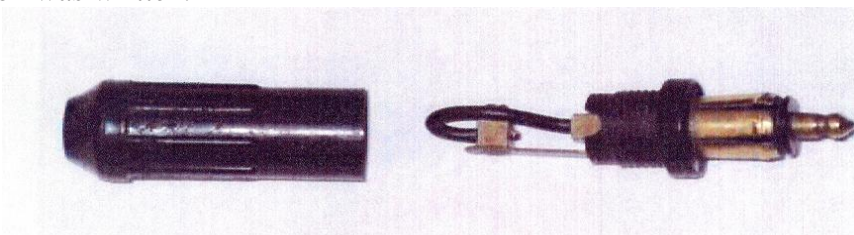


Fig. 6. Plug ("jack" type) acting on the indications of the digital tachograph

System of recording equipment may be exposed, due to its nature, to manipulation. All systems of tachograph cards, despite their numerous security equipment, are and will be exposed on

different types of manipulation to falsehood of data logged in their memory.

The use of recording equipment in road transport is necessary due to recording the driving and rest periods of drivers, and also to ensure the possibility to carry out by the competent authorities the effective inspections checking if the social rules are respected. To ensure the correct and reliable operation of these devices, and also to guarantee the possibility of recording and storing data, it is required to carry out periodic road checks and technical inspections, concerning the installed devices. Any attempt of the manipulation on records of digital recording equipment constitute a serious danger to road safety. They have also a negative impact on fair competition and the working conditions of road transport drivers, and also may cause unfair competition. In addition, they create a serious threat to the security of the system of digital tachographs.

Authorities of the Member States should develop and implement procedures, together with the methods of research based on technological *know-how* that may contribute to the increase of the detection of the different way of manipulation of the digital recording equipment.

In addition, the drivers and companies who respect the social provisions in road transport should have the opportunity to trust the indication of digital recording equipment, and national control authorities throughout the European Union should have certainty as to the credibility and integrity of the data recorded and stored by the device, regardless of whether they come from the memory on-board unit or memory of the driver card. In order to guarantee the reliability of the data, it is necessary to keep equipment periodic inspections to ensure proper operation and use.

Member States are required to ensure that the checks were carried out in such a way as to ensure the effective implementation of community social legislation relating to road transport, however, this type of periodic checks cannot guarantee that devices for manipulation will not be installed and applied after finishing the inspection. Observations and experience demonstrate that possible detection of such devices is much greater during carrying out roadside checks, if a vehicle can be more precisely inspected.

3. Control of digital recording devices

Introduction of the digital tachograph in road transport had undeniably ensured:

- improving the efficiency and effectiveness of control of road haulage companies in road transport,
- the relevant standards in the field of social legislation and its harmonization in all the Member States of the European Union,
- strengthening the principles of fair competition,
- improving safety in road traffic.

The digital tachograph is a very important on-board device, used in road transport, due to control possibilities and enforcement of compliance with the legal provisions concerning the conditions of transport and social rules for drivers. Control of the road carriage (road transport and non-commercial carriage by road) it is the statutory task of the Road Transport Inspection (Article 50 of the Act of 6 September 2001 on road transport, Law Journal 2007, No 125, position 874, with changes). Additionally, police officers, Customs officers, border police inspectors and inspectors of the National Labour Inspection are also entitled to conduct the control of road haulage in area of the installation of tachographs in vehicles and the registration of the working time of drivers. The procedure of control on compliance with the provisions on periods of driving, minimum breaks and rest periods in road transport (both during roadside checks and checks in undertaking premises), as well as the required standard equipment of controllers and the list of basic elements which must be checked are determined by the regulation of Minister of Infrastructure of 2 September 2009 on the control of the carriage of goods by road (Law Journal No 145, position 1184). This regulation implements the directive 2006/22/EC of the European Parliament and of the Council of 15 March 2006 on minimum conditions for the implementation

of Council Regulations (EEC) No 3820/85 and (EEC) No 3821/85 concerning social legislation relating to road transport activities and repealing Council Directive 88/599/EEC (*Official Journal L 102*, 11/04/2006, p. 0035 – 0044).

According to these acts checks must be organized in such a way that:

- at least 3% of days worked by drivers of vehicles falling within the scope of Regulation (EEC) No 3821/85 and Regulation (EC) No 561/2006 are checked,
- not less than 30% of the total number of working days shall be checked at the roadside and not less than 50% of the total number of working days shall be checked at the premises of undertakings.

When performing inspection operations regarding compliance with the rules on periods of driving, minimum breaks and rest periods, the inspectors shall be equipped with the following devices able to:

- copy data from the digital tachograph installed in the vehicle and the driver card,
- read the downloaded data and its analysis or transmit the results of reading data to the office to make the analysis,
- make checks and detailed analysis of the confirmation of the digital signature attached to the data,
- analyze in order to determine the specific profile of the speed before the inspection of the registered equipment,
- check the sheets.

Optional equipment of the inspector includes especially devices able to make photocopies and photographic documentation.

The list of basic points which should be covered by roadside checks was defined in annex 5 to the mentioned above regulation of the Minister of Infrastructure on the control of road carriage and it includes the following elements:

- daily driving periods, breaks and daily rest periods,
- weekly driving periods and weekly rest periods,
- sheets from previous days, which should be in the vehicle in accordance with article 15, paragraph 7 of Council Regulation (EEC) No 3821/85 or data from the same period on the driver card, in memory of the digital tachograph or print with this device,
- cases exceeded the permitted speed of the vehicle,
- instantaneous speed reached by the vehicle, saved by the digital tachograph by not more than the previous 24 hours of use of the vehicle,
- correctness of operation and use of analogue equipment and digital recording equipment or record sheets or driver card.

In addition to elements during roadside check, at the premises of undertakings should be checked:

- weekly rest periods and driving times between these rest periods;
- observance of the two-weekly limitation of driving times;
- record sheets, vehicle unit and driver card data and printouts.

Nevertheless, to the control of vehicle unit, driver card data and printouts of the digital tachograph shall apply the provisions of § 10 of the regulation of the Minister of Internal Affairs and Administration of 18 July 2008 on the control of road traffic (*Official Journal* No 132, position 84, with changes). Inspector should check data in the memory of the digital tachograph and driver card through the insertion of the control card to the digital tachograph, and then display and viewing them, print or download using devices for copy the information. If the driver does not have a driver card or it is unable to use due to the damage, the inspector checks the data contained in the memory of the digital tachograph on the basis of the printout. The driver is required for writing on copy of printout, made by the inspector, his name and surname, driver card or driving licence number and signature (tab. 1).

Tab. 1. The catalog of infringements dealt with digital tachograph according to Polish Act on road transport (part I)

Position	Infringement	Penalty [PLN]
1	2	3
6.1.1	Performing carriage by road using vehicle that does not have the digital recording equipment	3.000
6.1.2.	Performing carriage by road using vehicle with a digital recording device, which does not register all required elements	2.000
6.1.3.	Performing carriage by road using vehicle with digital recording device, which does not register, at the same time, data dealt with periods of activities of all drivers who drive the vehicle in checked period	1.000
6.1.4.	Performing carriage by road using vehicle with digital recording equipment without the required periodical check, control check or calibration	1.000
6.1.5.	Performing carriage by road vehicle with digital recording equipment, by the driver without his own, valid card	1.000
6.1.6.	Performing carriage by road by driver without the required printouts of the tachograph driver card in case of damage, failure or its lack-for each missing printouts	100
6.2.1.	The digital tachograph does not register on driver card speed of vehicle, activity of driver and distance of travel	5.000
6.3.4.	Using the same driver card by more than one driver	3.000
6.3.5	Using the same driver card by more than one driver in the same time	1.000
6.3.7.	Showing during check in premises of undertaking data from driver card, digital tachograph or document confirming the fact of not driving the vehicle – for each day	500
6.3.9.	Showing during check in premises of undertaking incomplete data on the periods of driver activity – for each day	300
6.3.11.	Not making a copy of data from driver card – for each driver	500
6.3.12.	Not making a copy of data from digital tachograph – for each vehicle	500
6.3.13	Not showing during check in premises of undertaking data copied from digital tachograph and driver card, stored in undertaking – for each day	300
6.3.14.	Interference with the data written in digital recording equipment, driver card and undertaking card	5.000

Transport undertaking is liable for infringement dealt with obligation of installation and usage of digital tachograph, found by inspections. The penalty is imposed on the transport undertaking by administrative decision. Amount of fines for such infringement are set out in the annex no 3 to the Act on road transport. Part 6 of annex no 3 specifies 15 infringements dealt with digital tachograph and assigned them a penalty ranging from 100 to 5.000 PLN. Below there is a modified extract from the annex no 3 to the Act on road transport for infringements of the provisions on the use of the digital tachograph.

It must be underlined that the driver is also liable for infringement dealt with improper usage of digital tachograph. The infringements and penalties are described in annex no 1 to the Act on road transport. For instance, for performing carriage by road using vehicle with digital recording equipment with illegal additional device influenced on incorrect function of digital tachograph the driver should be punished fine of 2000 PLN.

The ratio of issued decisions on the imposition of a penalty payment to the number of checked vehicles in the year 2010 equals 15.4% (14,4% according to inspections of vehicles registered in Poland and 17,6% - vehicles registered abroad). In view of the comparison of the results of the checks carried out by the Road Transport Inspection from the beginning of its existence, it should be underlined the systematic decline in the number of checks with the imposition of the penalty by administrative decision in proportion to the number of controlled vehicles. The following chart shows the increase in compliance with the provisions of the transport by carriers, which covers the period from the beginning of activity of the Road Transport Inspection by 2010 (fig. 7).

The results of the roadside checks carried out by inspectors of the Road Transport Inspection indicate a statement of more than 172 000 infringements (in accordance with the annex to the Act on road transport). Approximately 70% of infringements were related to the provisions concerning driving and mandatory breaks and rest periods of drivers, over 15% of infringements were related to improper use of the recording equipment, while 10% constituted a violation of the requirements for the possession of the required licenses, certificates of accomplishment of the non-commercial, or documentation of drivers. Violations related to not paying by carriers the mandatory tolls on national roads is about 2% of the total number of infringements. The structure of infringements shows the fig. 8.

Of the total number of approximately 65 000 of infringements related to the non-observance of rules on social legislation for drivers in road transport, the most common is not allowed reduction of daily rest periods and driving time without required break. A detailed list of the number of infringements noted in respect of the working time of drivers shows the fig. 9.

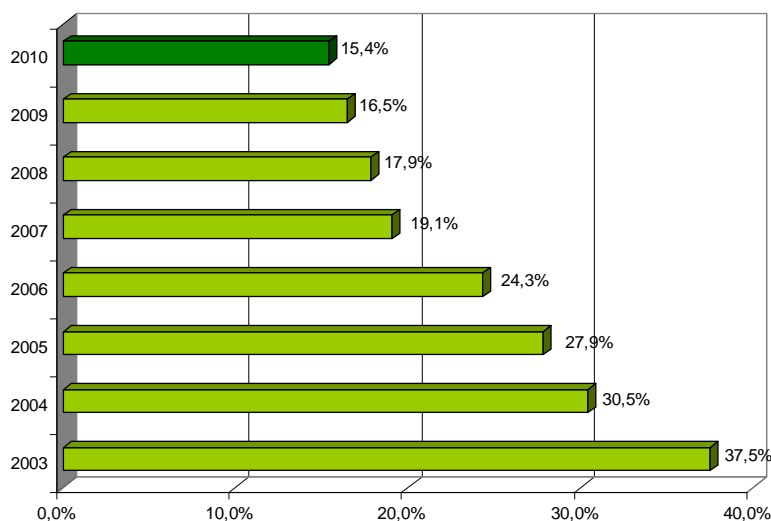


Fig. 7. The increase in compliance with the provisions of the transport

According to infringements referred to compliance by the drivers and traders with the provisions concerning the use of recording equipment cases of incorrect use of the recording equipment or the incorrect use of recorded sheets are very common. A detailed list of the number of infringements noted in the use of the recording equipment shows the fig. 10.

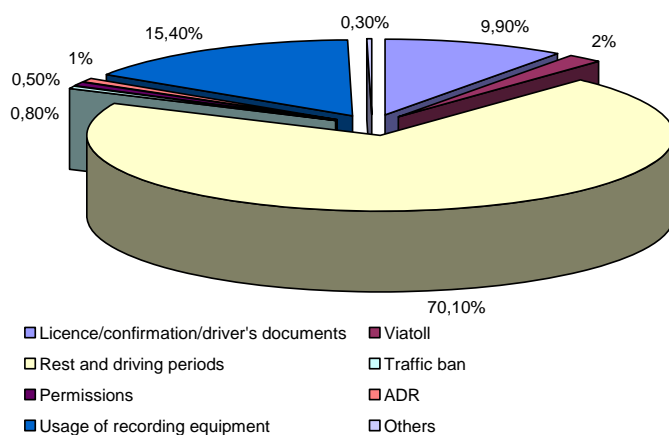


Fig. 8. The structure of infringements in road transport

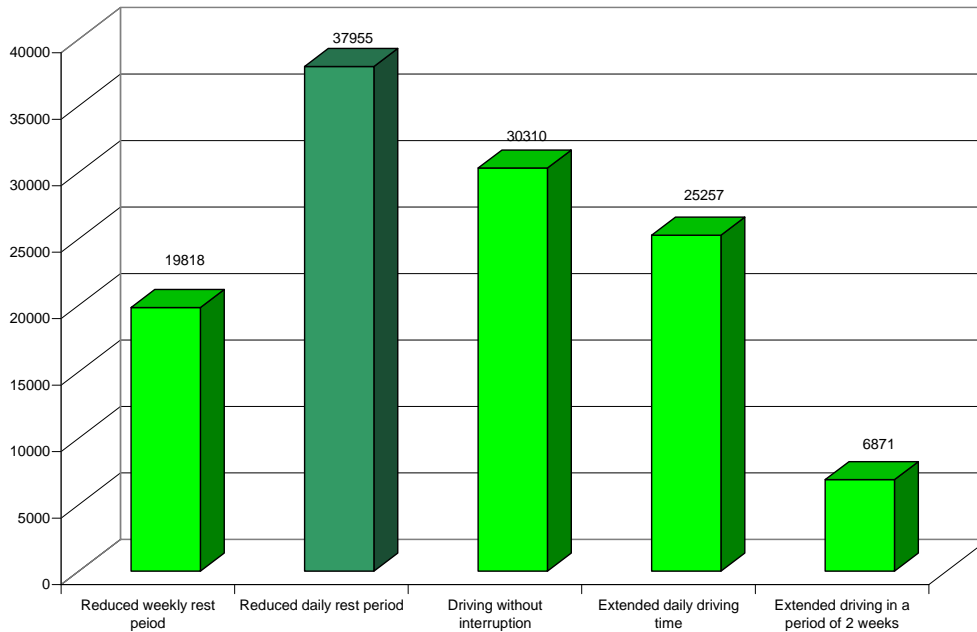


Fig.9. The number of infringements in road transport

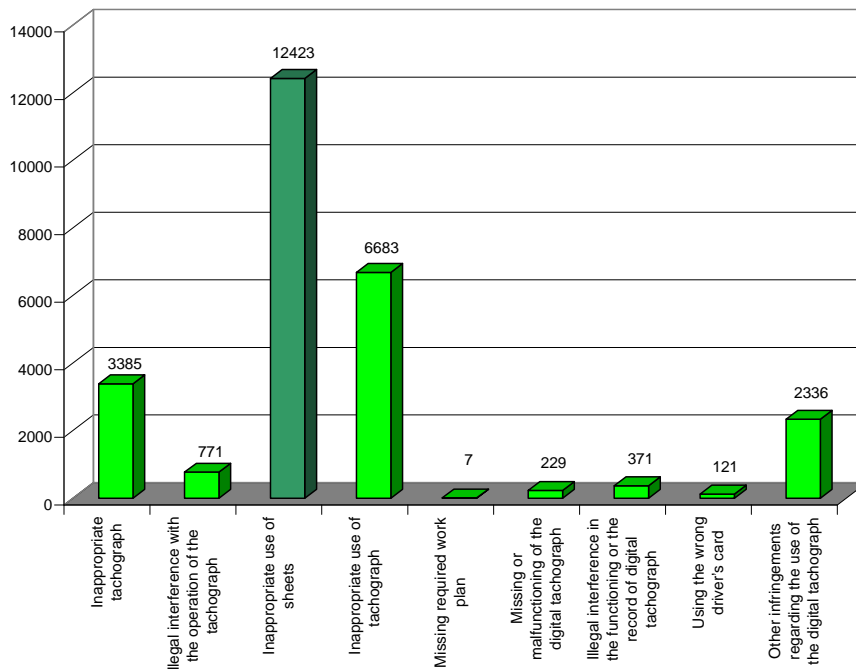


Fig. 10. The number of infringements in road transport in light of using recording equipment

Violations of the standards of the working time of drivers will also rise to the liability of the driver in the form of fines levied by the criminal mandate. This responsibility is independent of the responsibility of transport undertaking and aims to more effective compliance with the provisions concerning the standards of driving and mandatory breaks (fig. 11).

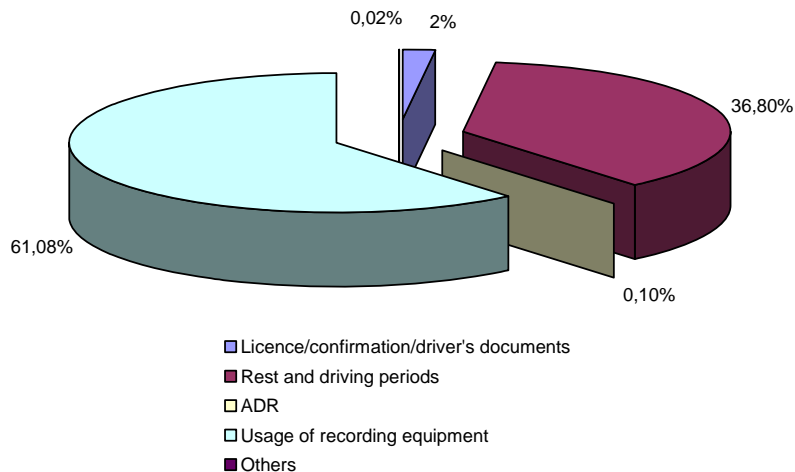


Fig. 11. The infringements number of standards of driving and mandatory breaks

As a result of the checks carried out in enterprises engaged in road transport in 2010 it was issued 2077 administrative decisions on the imposition of fines of value: 25 000 000 PLN.

As a result of checks carried out at the premises of undertakings, inspectors of the Road Transport Inspection claimed more than 243 000 infringements. More than 62% of the infringements concerned the incorrect use of the recording equipment, 36% of infringements related to the non-observance by the drivers of the provisions concerning driving and mandatory breaks and rest periods, but approximately 1% were infringements referred to the violation of the requirements for the possession of the required licenses, certificates of accomplishment of the non-commercial, or documentation of drivers.

4. Guidelines for prevention of tampering with a digital recording devices during roadside checks

One of the most important conditions of effective roadside checks is to ensure the proper training and full equipment for enforcement officers. “The digital tachograph is much like a burglar alarm in that the attacker only has to destroy confidence in it, by making it appear to be unreliable, in order to defeat it” [4] For that reason the inspectors should have a control card, and the appropriate tools to copy data from a memory on-board unit and the memory of driver card and analysis of these data or printouts, in combination with record sheets and any other documents relating to working time for drivers. Officers should also be provided with the necessary software enable quick and easy analysis of such data.

Regardless of whether the checks are carried out on the roadside, or in the premises and whether that they are related to compliance with periods of rest and driving, the roadworthiness or other aspects, officers of the control services could also be able to test the proper functioning and proper use of the equipment to detect cases of manipulation of these devices.

To achieve such tasks Member States should make the appropriate methodology and circumstances of conducting such additional checks. Therefore, the scope of these checks might be included in the national control strategy. Such methods as: method of two check points with the analysis of speed or distance, method of one check point with a detailed analysis of data or the method of one check point based on the technical inspection, increase the effectiveness of control. Ultimately, the officer could immediately order to carry out other vehicle inspection in the workshop.

The method of two check points with the analysis of the actual speed or distance. Using this method of inspection, officers could measure actual speed of the vehicle at a specific point using portable or installed in some place cameras, before stopping the vehicle. Then, they could copy file containing details of speed over the last 24 hours from on-board memory unit and compare registered speed in a given point with the speed measured several kilometres before. At the checkpoint, this method requires only the comparison of two numbers after reading a file containing details of speed over the last 24 hours.

Using the method of distance in time control, it is important to remember to select the point of inspection, located in a known distance from the specific place where officers have other means (bills of collected tolls, camera records, the protocols of border inspections) that enable to specify the moment, when a vehicle stopped in this place or not. Then, officers could copy a file containing details of the speed of vehicle for the last 24 hours from memory of on-board unit, and compare these data with the average vehicle speed, based on the known distance and time needed to reach the checkpoint.

Significant differences between read data and measured or calculated speed it is possible that the manipulation of the tachograph has been made. In that situation the vehicle could be directly checked in the workshop, without the need for additional inspection in the checkpoint.

In case of data read from the memory of on-board unit, it should be underlined that data was included with a digital signature, originally generated by the digital recording equipment or driver card in order to verify the authenticity and integrity of the data.

Method of one checkpoint with a detailed analysis of the copied data . In order to confirm the suspicions as to the presence of a device to manipulate, officers should compare data on driver's activity, copied from the memory of driver card and on-board unit with any documents in the vehicle and the driver's statement. Inconsistencies between these data could form the basis for suspicion and further action. In the next stage, it should be analyzed information about events and faults, including attempting to breach security, interruptions in power outage, move or sensor fault, especially registered within the last 5 days.

In addition, it should be analyzed the information including technical data, with particular regard to data concerning time adjustment or calibration data. The last group of data can be predominantly useful in finding too many cases of calibration, what may indicate that they have been carried out using the workshop card, which has been stolen or lost. Control officers should check the status of identified workshop cards, including their validity in days, when they have been used for the calibration of digital recording equipment.

If control officers continue to suspect irregularities after analysis of all the data, they could perform the copying file from the memory on-board unit, containing detailed data on speed for the last 24 hours and using specialized software to check whether there were unrealistic increases or decreases the acceleration of the vehicle, and whether the profile order is consistent with other documents in the vehicle, together with the statements of the driver (the number of breaks, speed in mountainous region or in urban areas).

Presented methods of inspection with obtained evidences may justify the suspicion of the use of the device in order to manipulate the indications of the digital recording equipment.

Method of one checkpoint with a special analysis of copied data requires disposal at the checkpoint an appropriate software to generate legible indications of speed changes in time, identify abnormal fluctuations in increasing speed and indicate automatically unrealistic rises or falls of the acceleration of the vehicle and any suspicious calibration of the recording equipment or any interruption of power.

Method of one checkpoint based on the technical control of seals . If it would be possible, officers should inspect the seals. If there is no seal or it is destroyed (damaged), then the driver should explain this fact. If the driver does not have a credible explanation, this may constitute the infringement and it is recommended to make directly an inspection of the vehicle in an authorised workshop.

Vehicle or data inspection in premises of undertaking. It is recommended that the competent authorities of the Member States use the possibility of controlling vehicles and on-board units, drivers with the cards drivers in the premises of transport undertaking. Data managed by the entity, must be kept for at least one year and must be available for inspection, on every request of control officers. For that reason, it could be checked any vehicle, which is located in the premises of transport undertaking. Additionally, it could be done any appropriate tests and activities, limiting to a minimum any delay, which driver could be exposed. Such controls could also cover the possibility of preparing and equipping control officers with suitable devices to enable verification of the recording equipment, in conformity with UE regulations [5] and [6].

5. Guidelines for prevention of manipulation of digital recording equipment during technical examination

If, after roadside check using the procedures of technical inspection, there is suspicion that it has been installed the device used to manipulate the indications of digital recording equipment, control officers would direct the vehicle to an authorised workshop. National authorities of the Member States may authorise to instruct the authorised workshop to make specific research to detect devices for manipulation.

In most cases, detailed examinations would enable the detection of erroneous pairing of the motion sensor and on-board units, which may indicate the presence of a device or equipment for manipulation. Such studies should include the control of seals and tablets of installation, testing a reference and an analysis of the copied data from the memory on-board unit.

In the case of detection of such devices, regardless whether they were actually used by the driver or not, the recording equipment should be removed from the vehicle and used as evidence. In addition, authorised workshops should be authorized to carry out the technical inspection for correct operation, correct recording and storage of data, and whether the calibration parameters are correctly set.

After all technical inspection and lack of detection of equipment used to manipulation of the indications, the recording equipment shall be subjected to a complete calibration and should be endorsed with a new measurement table together with the new seals, under the supervision of the regulatory authorities.

Detection of cases of the use of devices for the manipulation of the digital tachograph system and the prevention of their use is a continuous process, which requires constant engagement. With technological progress the quantity of possible interference in the system and possible risks increase. Consequently, all entities involved in ensuring the safety of the digital tachograph system, including control officers, authorized workshop, drivers and transport undertakings are very important in process of preventing the manipulation of digital tachograph.

Member States should aim to raise as much information and to develop their own strategies, threats, and also to provide a clear support in the dissemination of acquired knowledge, while a European Commission should be informed about new threats to the digital tachograph system.

Summary

Appropriate functioning of all elements of the system of digital tachographs enable to achieve the intended purpose. In general, the guarantee of security of the whole digital tachograph system is the closest cooperation of all elements of these system and the most correct functioning of each element. However, it must be underlined that in order to prevent the manipulation of the digital tachograph, first of all it is very important to provide for:

- a range of technical measures – the tachograph to be connected to a Global Navigation Satellite System device to automate the recording of the daily journey start and end location, a remote (wireless) communications function to provide a signal, only on request,

to allow an enforcement officer to assess whether to stop the vehicle for further checks and a harmonised interface to allow the use of Intelligent Transport Systems (ITS) with the tachograph;

- a requirement to ensure enforcement officers are appropriately trained, establishing the methodology for initial and continuing training.

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