EVALUATION OF TRACTION POWER CONSUMPTION CONTROL SYSTEM IN THE CZECH REPUBLIC

And its Basic Components

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Keywords: Traction, Systems Control, Telematics.

Abstract: Our work should help to the higher effectiveness of traction power consumption. The traction power for railway comes from the regional distribution companies of the electric energy in the Czech Republic. The aim is to make cost connected with given criteria of power consumption lower. For example in the Czech Republic it is a cost connected with breach of conditions given by the "Price Decision of the Czech Energetic Regulation Office (ERU) no. 10/2004". But the scale of our work should be much larger, because each state has its specific conditions of power consumption and the work can solve universal case. It could be done by means of the system, which would use the new knowledge of informatics, telematics and system engineering. This paper discusses the state at this time at this field nowadays and possible application in the territory of ex-district North Moravia and Silesia, which is a part of the Czech Republic. This area is an integrated part of the country, which electricity is separately accounted for.

1 INTRODUCTION

Power supply of the Czech Railway, joint stock company (CD) represents a complicated system, which has functioned since the half of the 20-th century. Devices of electric traction supply system must fulfil legislative enactments of the railway law and energetic law through its construction and function, satisfy a request of international transport (interoperability) and satisfy a request of cost minimization as well. All these requests are often antagonistic and it is necessary to do several compromises (Matejka, 2004).

The process of current railway corridor modernisation has been connected especially with reconstruction of the tracks of international importance. The reconstructions of the tracks partly contained the traction supply stations (TNS) as well and they enabled to replace technically old devices through the modern components. Furthermore they enabled to adapt points of supply, so that they satisfy new energetic requirements based on new energetic calculations. Finally, they enabled to apply electronics for measuring, control and information transfer in much larger scale (Matejka, 2004).

2 RESERVED CAPACITY OF POWER LINE

Traction rectifier stations, traction supply stations of the 3 kV DC system, are connected to the electric line of any distribution company with different voltage levels. These are either the voltage level HV (high voltage) 6, 10, 22 or 35 kV, or the voltage level EHV (extra high voltage) 110, 220 or 400 kV.

It is necessary to follow actual price decision of ERU no. 10/2004, which defines prices of electricity and connected services (Czech Energetic Regulation Office Price Decision, 2004). Price decision mentions among other thinks also the price for reserved capacity. The reserved capacity (in the past also "quarter an hour maximum") is the maximum value of quarter an hour electric power, which can the consumer consume in one supply point from devices of operator of the distribution network. If the supply point is connected from more voltage levels, then the prices for reserved capacity are enforced individual for every voltage level. The price for reserved capacity for consumption from regional distribution network is enforced to calendar year with a fixed month price for year reserved capacity

Sadil J., Belinova Z., Vodrazka V., Krasa J., Rajnoch J. and Bouchner P. (2005).
EVALUATION OF TRACTION POWER CONSUMPTION CONTROL SYSTEM IN THE CZECH REPUBLIC - And its Basic Components.
In *Proceedings of the Second International Conference on Informatics in Control, Automation and Robotics - Signal Processing, Systems Modeling and Control*, pages 328-331
DOI: 10.5220/0001158503280331

Table 1: Prices for reserved capacity of power line (Czech Energetic Regulation Office Price Decision, 2004)

Distribution company	Voltage level	Fixed month price for year reserved capacity in CZK/MW and month	Fixed month price for month reserved capacity in CZK/MW and month
SME	HV	59 044,- (1 944,- EUR)	69 905,- (2 302,- EUR)
	EHV	100 122,- (3 297,- EUR)	118 539,- (3 903,- EUR)

or to calendar month with a fixed month price for month reserved capacity. It is possible to combine the month price for year reserved capacity with month price for month reserved capacity for given calendar year. The price for reserved capacity is given for each operator of regional distribution system. For the territory of SME it is seen in Table 1 on the top of this page.

The prices in SME territory rose in one year about 17 percent (Czech Energetic Regulation Office Price Decision, 2003) (Czech Energetic Regulation Office Price Decision, 2004). The price for reserved capacity overload in each calendar month is equal to ten times amount of fixed month price for year reserved capacity, based on each kW of the highest overload of contracted maximal value of quarter an hour electric power.

3 TRACTION POWER CONSUMPTION CONTROL SYSTEM IN NORTH MORAVIA

Czech Railway concludes traction power consumption contracts with regional distribution companies by means of Railway Power Engineering Management (SZE), coming subsidiary company of CD. There is defined the reserved capacity of electric line in these contracts. The reserved capacity is the value of maximal consumed power [kW], consumer (CD) guaranties to consume. It is measured in points of supply through 15 minutes work [kWh].

In SME region the 3 kV DC system for traction is used. Altogether 16 supply stations are used in this region. 7 ones are connected to EHV level and 9 ones are connected to HV level. It is crucial for conclusion of reserved capacity and for penalty paying for breach of concluded value, to which voltage level is the supply station connected. SZE concludes reserved capacity for the whole voltage level together, not for each supply station individually. At the same time, network of the supply station is so distributed, that often supply stations of different voltage levels neighbor on each other.

Concluded reserved capacity overrun takes place on the part of CD in the real traffic, nowadays. This fact is back-found out, because the recovered energy measuring runs. Our work should develop a system, which would measure the recovered power in the all supply stations more often (for example each minute) and which would add the power values of the all supply stations of appropriated voltage level. The system would find out in time, that in appropriate quarter of an hour comes to concluded reserved capacity overrun (for given voltage level) and it would send a command to a switch switch-off of some supply station of that voltage level, in that it comes to limit overrun. This supply station excess would cover the neighboring supply stations of the different voltage level.

3.1 Data analysis

Present work has concentrated to discussions with SZE. The result is data for SME-region for the year 2003 sent to me (the first author). The data contained recovered work power of the all 16 supply stations of the North Moravia each 15 minutes in the year. It was mentioned the concluded reserved capacity for the year 2004 for each voltage level in SME region as well.

After data processing I found out, that if the electricity consumptions in 2004 were equal to the in 2003 ones, then would be paid a sum of 2.500.000,- CZK (82.318,-EUR) in North Moravia region in 2004. In the next year 2005 about 17 % more, because of reserved capacity price increase. In these values can be the cost saving (only in SME region) expected, after concluded values overrun reduction system implementation.

Furthermore, I found out, that overrun of the concluded values would happen only 16 times, namely in 5 days. It would suffice just 16 actions yearly. Additionally, by checking all of the 16 overruns, there was only the value of one voltage level above the limit, while the other voltage level value was deep under the limit (see Fig. 1 and 2). Supply stations are well distributed, so that the supply stations of one voltage level can substitute the supply station of other voltage level (see Fig. 3).

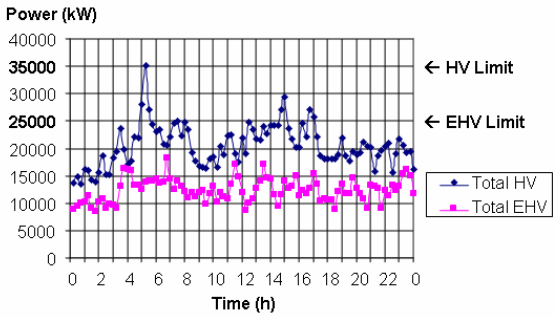

Figure 1: Example of power consumption during a day in SME region in HV and EHV voltage level

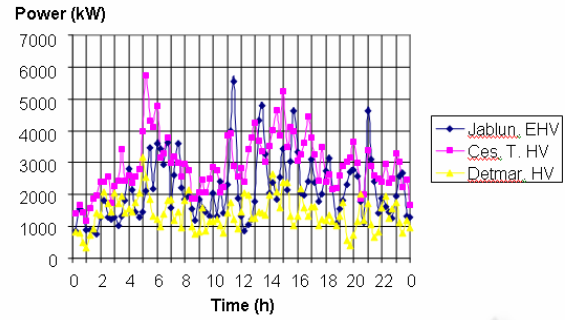

Figure 2: Example of power consumption during a day in 3 different North Moravia supply stations

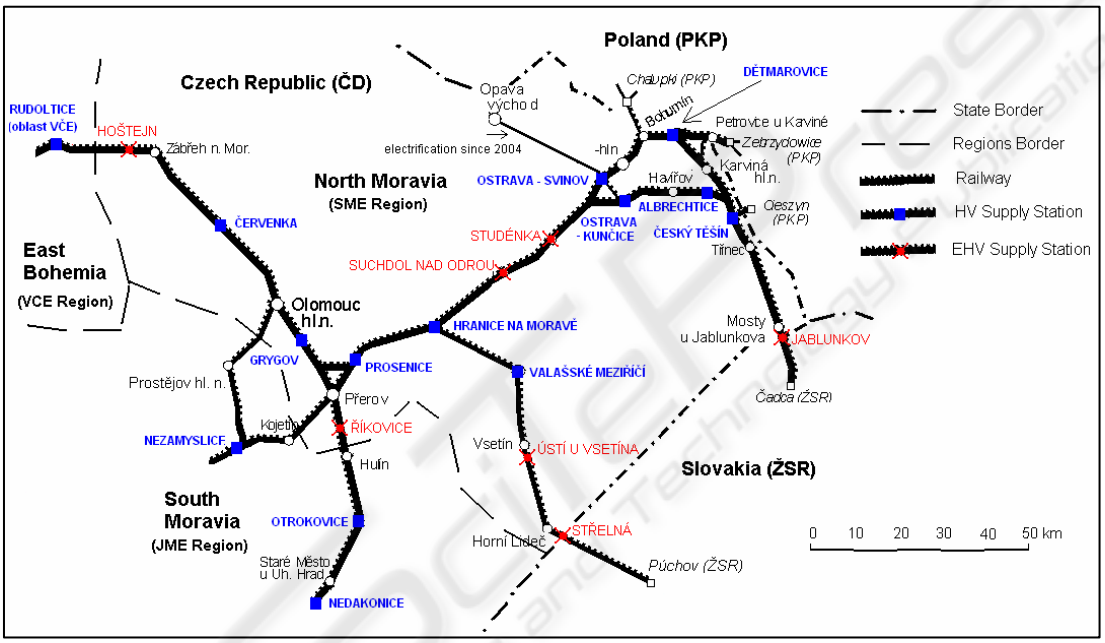

Figure 3: Traction supply stations in North Moravia region and their voltage levels, they are connected to

3.2 Control system improvement

Taking the facts mentioned above into account it is possible to consider intelligent control system application. This system would collect data in real time at first. It would send them to the control centre. The control centre would process the data. If there would be a reasonable suspicion to overrun the reserved capacity limit, the control centre would send a command back to one or more supply stations of appropriate voltage level to switch off its switch. In the beginning of the next quarter an hour it would send a command to these supply stations to switch on again. The system is outlined on the Fig. 4.

3.3 Data collection

Data collection is not complicated in modernized supply stations. The value gained from measuring devices is digitalized and transferred to data sender. This functions already at this time.

3.4 Data transmission

Important part of the problem is to provide data transmission from the supply stations to the centre, which would be fast and reliable enough. The supply stations distance from the centre is usually less than fifty kilometre but we must take into account the distance up to 150 km. The aim is to find out the solution, which would be possible to apply in a fast,

easy and cheap way. Wireless technologies are suitable, as they don't require large infrastructure building.

Currently the data transmission is realized via GPRS - involving overlaying a packet based air interface on the existing circuit switched GSM network. The advantage in using GSM is the fact that it is a global, unified system with large signal coverage. In the future, it would be possible to use GSM specially developed for the railway applications: GSM-R.

GSM-R mobile radio has been standardized in a process involving the UIC (International Union of Railways), ETSI (European Telecommunications Standards Institute) and other bodies (GSM-R website). It is operating on the frequencies 876 - 880 MHz and 921 - 925 MHz. It is part of the ERTMS (European Traffic Management System).

Main services, offered by GSM-R system, are the same as in the public networks. Unlike the public networks, where the services are for all the users provided with the same priority, the GSM-R system is based on in advance defined priorities for various user groups. The availability, quality and security of the connection are stressed.

The data could be send into the centre with pre-defined priority either directly via GSM-R (the data amount is very low) or via GPRS over GSM-R. In case of need (exceeding the reserved capacity) the centre would send the command to switch over to another supply station with high priority.

The implementation of the GSM-R in the Czech Republic has started in January 2005 by building-up first antenna masts (David, 2005). The whole pilot project should be completed in July 2005. In the first phase of the project several lines from the German border to Prague and to other locations, including international corridors, are planned and ready for implementation.

Until this time, regarding the great distances and small amount of data, GPRS remains the most convenient mean of transmission and it is also for data sending currently used.

The economical convenience of GPRS technology results from its ability to keep track of the amount of transmitted data and thus tariff-charge the user. A great advantage of the GPRS technology rests in the permanent access to the data channel even if data is not being transmitted.

3.5 Control centre

The control centre could be very easy. The only one requirement for the control centre is to add all the values of appropriate voltage level, extrapolate the value during couple of minutes to whole 15 minutes and decide if it is not going to overrun. If so, then send a command to switch off.

4 CONCLUSION

We will still attend to developing of traction power consumption control system. We will try to put particular components of the system together and to realise a pilot operation of this system.

The informatics and telematics for railway traction is just in the beginning in the Czech Republic. Relative quick applications developing, using modern knowledge of these fields with the aim of cost reduction is expected.

ACKNOWLEDGEMENT

The Project is realised with a finance support of state means by means of Czech Science Foundation (GA CR) under project registration no. 102/05/H517.

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