

## SYSTEMS OF MEASURING, EVALUATING AND ARCHIVING THE PARAMETERS OF THE POWER QUALITY IN THE DISTRIBUTION SYSTEMS IN THE CZECH REPUBLIC

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### ABSTRACT

*The paper informs about the system of evaluating and archiving the parameters of the power quality (PQ) used in power utilities in the Czech Republic. After the observed parameters have been chosen, the output values of various types of PQ analysers (PQAs) are converted into a unique form and, after the evaluation, they are made available to various types of users within and outside the distribution system, and are archived together with the identification of the point of measurement and of the network state at the time of measurement.*

*Second part of the paper informs about preliminary results of evaluation of obtained data, esp. about fluctuating of PQ parameters during the measurements.*

### INTRODUCTION

Distribution Code [1] in response to [2] and [3] imposed the obligation on distribution system operators (DSO) till 1.1.2006 to equip all 110 kV points of delivery between transmission system (TS) and distribution systems (DS) by permanently installed power quality analysers (PQA) of class A according to [7] and to evaluate and archive the monitored quality parameters (PQ) following [4], [5] and [6].

With an exception of transient overvoltages, interharmonics and mains signalling voltages, all so called binding and indicative parameters according [8] shall be monitored, as well as magnitude of currents, active and reactive power, negative phase sequence component of the current and its angular relation, as well as harmonic currents and their angular relations.

The measurement of currents and of quantities derived therefrom was considered to be important for determination the source of disturbing the voltage quality, i. e. to find out whether it originates in the transmission or in the distribution system.

Since 1.1.2007, the characteristics of voltage (VQ) of permanently installed PQA of class B at the supply points 110 kV shall be monitored, evaluated and archived in the same extent. Permanent monitoring of binding characteristics VQ is not necessary on condition that the preliminary one week measurement (repeated each 2 years)

proves, that evaluated values of flicker, of THD and of voltage unbalance will not exceed 50 % of limit value for given point.

Permanent monitoring of VQ characteristics (including indicative ones) is also not necessary when DNO is able to prove the level of VQ using measured values of other near supply points or points of delivery TS/DS.

Analogical rules with the term 1.1.2008 are valid for output voltages of 110kV/MV substations. In these cases the monitoring of rapid voltage changes acc. [6] is not required. In MV and LV networks the monitoring of VQ, with following evaluating and archiving is mainly a reaction on users complain or a decision of the DNO.

“Open” system of measuring, evaluating and archiving of the PQ parameters has been proposed and adopted after the discussion among the regional distribution utilities and the Regulator Authority (ERÚ) aimed at accomplishment of above mentioned requirements. The system enabled the use of permanently installed and portable PQAs of different suppliers as well as their consecutive supplement, identification of measurement sites and of network configuration during the time of measurement. Results are presented to technical work places of the distributor, in range according [1] to DS users and stored.

### STRUCTURE OF THE SYSTEM

The system is composed from the following main functional blocks:

- Power quality analyser
- Communication and configuration work place
- Subsystem of archiving and evaluating of measurement of power quality

#### Power quality analyser

The basic requirements on VQ characteristics to be measured and evaluated have the origin in [7]. In case of points of delivery TS/DS PQA shall comply with the requirements for class A, in other cases i.e. supply points from DS at the level of voltage 110kV and the measurement in MV and LV networks, PQA shall comply with the requirements of class B. It is also possible to use the data from other devices with defined output protocols (electric meters, protections, etc.)

Internally recommended desegregation of system and data

flow is shown in the Fig. 1.

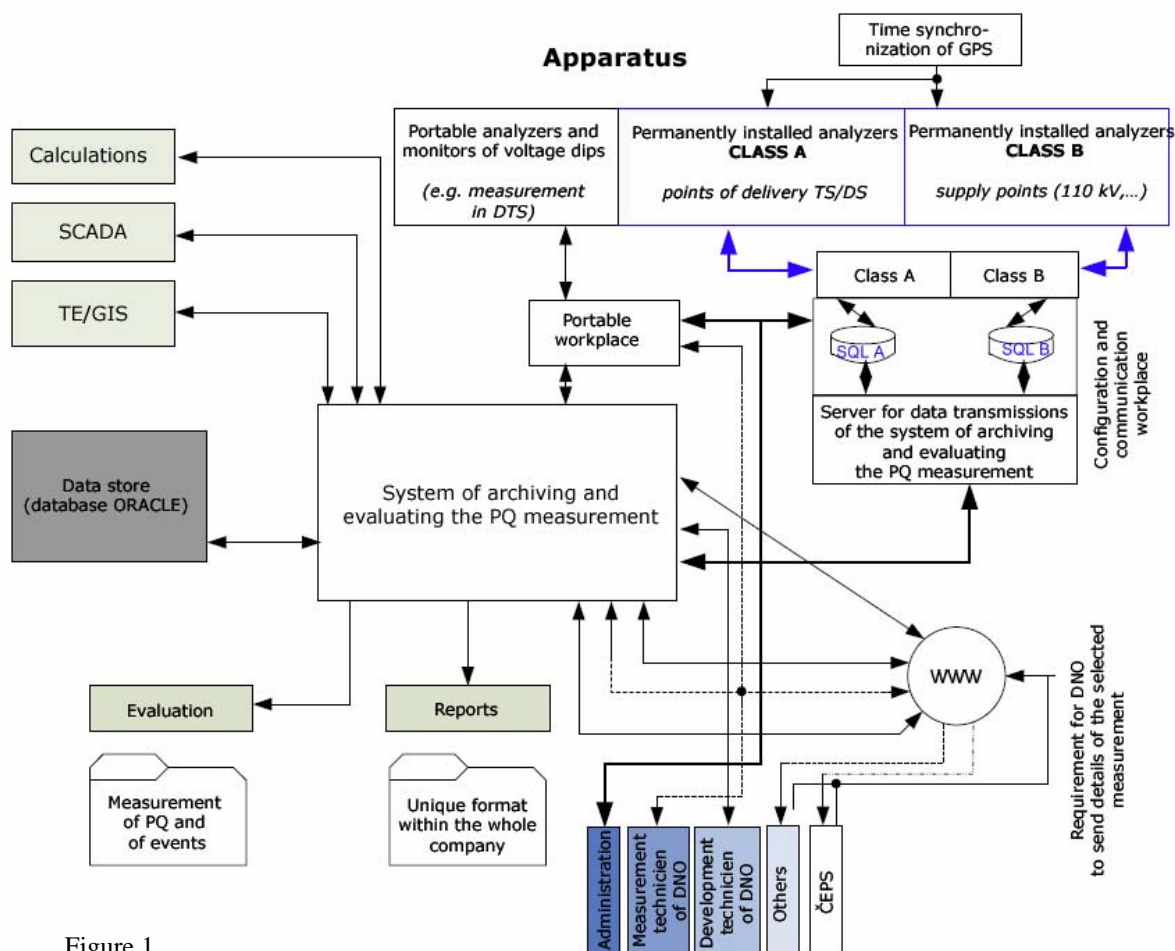


Figure 1

**Measured values and data flow**

Measured values with the range and structure according to the tables defined in [1] are transferred from permanently installed PQA to the communication and configuration workplace (as well as from PQA of class B in networks of 110kV and output voltage 110kV/MV substations). From the portable PQA are data transferred directly to the subsystem of archiving and evaluating of PQ measurement.

**Output values from Power quality analyser**

Distribution Code [1] defines required VQ characteristics for each type of PQ measurement, i.e. points of delivery TS/DS, other points of measurement in networks of 110kV, MV and LV networks. The required characteristics of VQ will be measured by PQA and transferred to further process. In addition to VQ parameters in all points of delivery TS/DS, phase currents will be measured and from them other needed values will be derived. In other cases, short termed measurements of current are performed on the points where it is necessary to determine the origin of deterioration

of voltage quality, the responsibility for it and choice of correcting measures.

The measured values will enter in specified range into the subsystem of archiving and evaluating of PQ measurements, where they will be filtered at first and then transferred into unique form to be archived, evaluated in the reports of power quality. In such form they will be available for other analyses and usage.

**Communication and configuration workplace**

Communication and configuration workplace is used for communication and remote configuration of permanently installed PQA in the DNO network. It contains communication and configuration SW of all suppliers of permanently installed PQA of the class A and B. It is used for data transfer in pre-programmed period and on request, as well as for remote programming of PQA.

It also archives all measured values for the short-time period of at least 40 days (required by [1]).

The communication and configuration workstation also transmits the full range of measured data into the archiving system for further processing and permanent archiving of results.

### Archiving and evaluation of measured values

Measured data from permanently installed power quality analysers - class A and class B are processed by the Subsystem of archiving and evaluation of PQ measurements from communication and configuration workplace. Evaluation and archiving follow. All measured data are accepted and then selection of defined subset for further evaluation and permanent archiving is realized.

As a result of PQ measurement the subsystem of archiving and evaluation of PQ generates and stores the protocol.

The subsystem for archiving and evaluating the PQ measurements also processes and archives the data from the quality measurements performed by portable PQ analysers. For these types of PQ analysers, the subsystem for archiving and evaluating the PQ measurements includes necessary conversion interfaces for receiving the data and for their conversion into a common format.

Technicians of measurement import the measured data from their workplaces.

This subsystem is also interconnected with utility internal systems TE/GIS and SCADA (and/or other computation systems) in order to ensure a unique identification of the points of measurement and of the network state at the time of measurement, as well as to present the results for evaluating the operation and for planning of the future network development .

Based on request of an authorised person (administrator, measurement technician) the subsystem provides the results and/or the archived measured data to other subsystems for analyzing, which are beyond the scope of the archiving system.

### Users

In the frame of DNO the users of the system with defined access rights are:

- Administrator
- Technicians of measurement
- Technicians of development of DS
- Other workers of DNO (chief workers etc.)

Other users can have an access through Internet.

## **RESULTS FROM PERMANENT MONITORING OF PQ IN POINTS OF DELIVERY TS/DS**

All data from measured points TS/DS was not to disposal yet, however some results and trends are beyond doubt.

### Flicker and its fluctuation

95 % of values in case of Pst and Plt have been evaluated and compared with permitted limits.

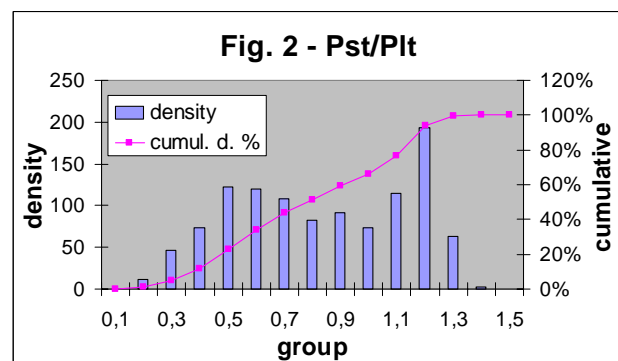
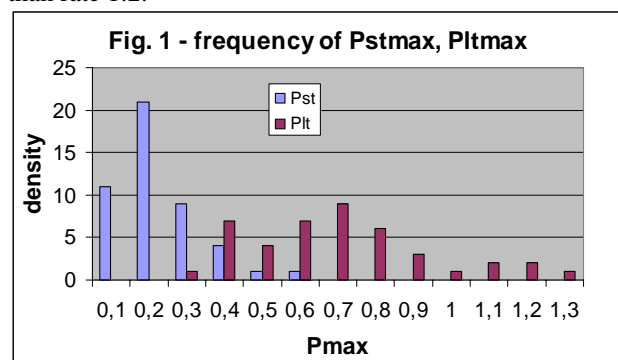
In contradiction with permitted values of  $Pst \leq 0,8$  and  $Plt \leq 0,6$  are measured data of Plt distinctively higher than the

data of Pst. While the limit of 0,8 for Pst is exceeded in case of only 5 % of observed weeks, the limit of 0,6 % for Plt is exceeded in 55 % of weeks. Pst was higher than Plt only in 34 % of week measurements, especially in case of networks supplying steel works.

Measured values of flicker in different weeks vary distinctively. Concerning values of Pst in particular measuring points it is 1:5,5, concerning values of Plt it is even 1:13 (see Fig. 2 and Fig.3).

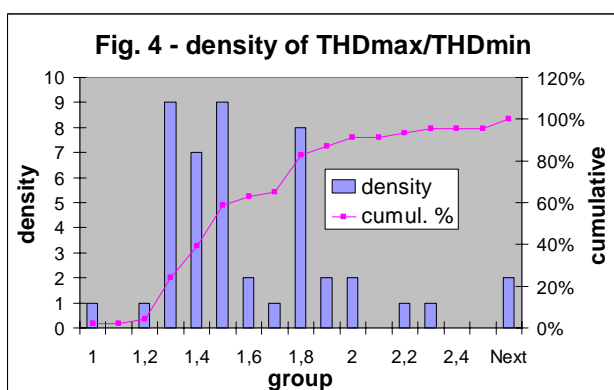
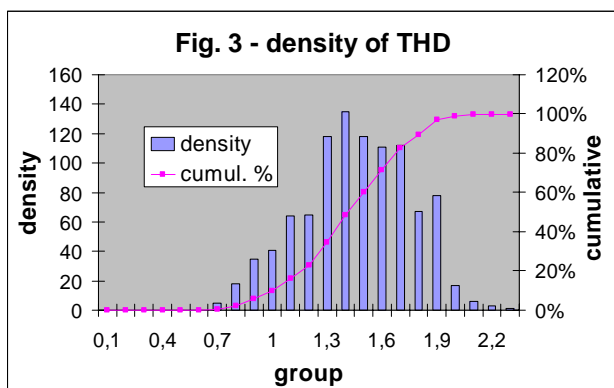
### Total harmonic distortion

Fig. 4 and 5 show frequency of values THD and rate of fluctuation of THD95 % in different 47 points of measurement in all week periods. Permitted limit for THD of 2.5 % has not been exceeded in any case of measurement, in case of 9 % of points THD fluctuated more than rate 1:2.



### Voltage unbalance

Measured values in points of delivery PS/DS didn't exceed the value 0.8 %. Also here the fluctuation has appeared during different weeks, to the limit of about 0.5 %.



## CONCLUSIONS

The report presents accepted and realized conception of measurement, evaluating and archiving systems of main characteristics of voltage quality in regional distribution systems in the Czech Republic. These systems include monitoring by permanently installed power quality analysers, as well as portable ones of different producers, ensure the unique access to quality evaluating, archiving of measured values as well as quality judging. The systems also comprehend the competent coupling used for identification of measurement sites and the network configuration during the period of measurement and for results delivery to other organizations and users of distribution networks.

Results of PQ monitoring of output voltages 110kV at 47 stations of 400/110kV and 220/110kV during the period of 9 months of the year 2006 are as follows:

In case of flicker the limit of 0.6 in case of Plt was exceeded in more than 50 % of monitored weeks, while in case of Pst the limit 0.8 in 5% of monitored weeks. From this point of view, the currently set limit for Plt at 110 kV level (lower than Pst) is not properly defined and this with regard to the fact, that in networks of 110 kV, eventually MV the problems with flicker are only there, where local disturbing loads are.

It is also characteristic a strong fluctuation for measured values of Pst and Plt in different weeks of measurement. In

case of Pst the ratio is 1:5.5 and in case of Plt the ratio is even 1:13. From this point of view, it is not correct to consider one week of flicker monitoring in the points of delivery TS/DS as sufficient for the determination of its level.

The results of THD monitoring have shown that only at the minimum of points TS/DS the level is approaching to allowable limit. The fluctuation of THD values in measured points exceeds the value 2 only in two cases.

In case of the voltage unbalance the values are substantially below the allowable limit, fluctuation within of observed weeks didn't exceed 0.5 %.

## REFERENCES

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