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ERÚ Energetický regulační úřad

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SESSION 1 – NETWORK COMPONENTS

Guarantee: Karel Kohout, ČEZ Distribuční služby, s.r.o.

INTERRUPTED BREAKING ISSUES IN DISTRIBUTION SYSTEMS

Vladimír Vajnar, Zdeněk Vostracký, Katedra elektroenergetiky a ekologie, FEL ZČU v Plzni

This paper describes the breaking capacity issues of gas operated circuit breakers and the possibility of interrupted breaking caused by so called defer zero in power system. This is a new and up to date topic, combining calculations of short circuit conditions and description of critical time and place intervals of tripping process in both common distribution and generators applications. There is a discussion of different kinds of circuit breaker mechanical stress during both symmetrical and asymmetrical short circuits along with the differences near the turbo- and hydro-alternator. The paper provides the analysis of generator circuit breakers breaking capacity under generator short circuit conditions.

EUROPEAN PARLIAMENT REGULATION 517/2014 – SF6 GASS

Václav Straka, "TMV SS" spol. s r.o.

Information about European Parliament and Council (EU) Regulation 517/2014 from 16.04.2014 related to fluorated greenhouse gasses and about the abolition of Regulation 842/2006 of European parliament 517/2014 concerning the consequences related to this regulation.

FURAN DERIVATIVES IN OIL – TOOL USED FOR PRECAUTIONARY MAINTENANCE OF OIL TRANSFORMERS

Jaroslav Černý, EGÚ Brno, a. s.

The service life of oil transformer under the normal operational conditions is determined by its insulation system service life, particularly its cellulose insulation. The favourable way of assessing the ageing process is to measure its polymerization level (PPS). There is a need to open the transformer and take a relevant number of samples for PPS determination. These issues could be solved by the analysis of selected furan derivatives contained in transformer oil.

MEASURES AGAINST INCREASING THE FAULT RATE OF MIDDLE VOLTAGE VT CAUSED BY FERRORESONANCE

Jiří Horák, ČEZ Distribuční služby, s.r.o.

The paper refers to the last year conference topic the "Increase VT fault rate in MV, its causes and possible ways of its early detection". Based on our experience with power substation operations and on information from VT manufacturers, we made decision to apply different types of protection equipment to prevent the destruction of voltage transformers caused by ferroresonance in selected substations.

Consequently, we'll determine the eligibility of each measure and suggest the general solution for rest of the MV substations to DSO.

SDO - SMART DIGITAL OPTICS

Stanislav Návoj, EL-INSTA ENERGO s.r.o.

Digital current transformers are the future technology. Solution provided by one of main manufacturers of measuring transformers – key SDO technology features, Faraday's effect and its implementation, features and advantages of these instruments and their use.

POSSIBLE IMPACT OF SPECIFIC FACTORS ON DECISION MAKING PROCESS OF OVERHEAD LINE RECONSTRUCTION

Petr Lehký, Hugo Thiel, EGÚ Brno, a.s.

This paper deals with possible impact of specific factors, that can significantly affect the way of approach to decision making process related to the extent of overhead line renewal and how to make it from the point of view of future operational reliability and security.

CONCRETE POLES EVALUATION

Kamil Čihák, ČEZ Distribuce, a. s.

The paper describes briefly the history of concrete poles usage, their main vendors – producers and the design of these poles used in power industry. The paper focal point is to integrate the results of studies of first and second phase of concrete poles mechanical stress tests for practical use in CEZ Distribuce Inc. into the document establishing measures related to status and age. This document will supersede and improve the current document “Concrete poles replacement”.

2 X 110 KV ŽILINA – ČADCA LINE – HISTORY AND PRESENT

Marián Ondrejkovič, Igor Košík, SSE DISTRIBUCIA, a.s.

This paper deals with history and present of 110 kV Žilina – Čadca line, built up between 1928 and 1930. Most of the line framework is the original one, so it is 85 years old. There were performed some more detailed analysis of supports status evaluation particularly from the point of view of mechanical bearing-capacity regarding to the line replacement. According to the results, the final mechanical carrying-capacity can be affected by changing characteristics of steel used to construction as well as by known factors.

SESSION 2 – POWER QUALITY AND EMC

Guarantee: Pavel Santarius, VŠB-TU Ostrava

COMPARISON OF ACTIVE AND PASIVE FILTERS OF HARMONICS FOR HIGH POWER DC MOTORS

Miroslav Dubovský, Stredoslovenská energetika

Deployment of static harmonics compensation would be clearly unsuitable in the operation because it changes specific load parameters (power and harmonic components of voltage and current) of high power DC motors, which could interfere with sensitive equipment fed from the same source. Although this fact was proven by exact methods of measurement, the static compensation of harmonics is used for its lower costs. This paper compares the results of harmonics spectrum analysis for static and dynamic harmonics compensation of comparable DC motors from the same area.

POWER QUALITY MEASUREMENTS IN DT

František Rajský, Jaroslav Kloud, ČEZ Distribuce, a.s.

This article deals with permanent measuring of electrical energy, load, events and other parameters necessary for comprehensive view on distribution system characteristics. ČEZ Distribuce Inc. began with measurements of selected PQ parameters in distribution substations in 2004. This process continues gradually till now, incorporating almost 20 % of all distribution substations nowadays. Most of these instruments have no communication unit. Different version of instruments communicating via LAN, 3G and BPL are under the test for last two years. Nowadays we are finishing the pilot deployment of several new technologies, which are described in this paper. Planned vision of distribution network monitoring and control is outlined in the conclusion.

VOLTAGE QUALITY IN LV DISTRIBUTION NETWORK WITH HIGH PENETRATION OF RENEWABLES

Martin Kašpírek, David Mezera, David Šimáček, E.ON Česká republika, s.r.o.

This paper analyses impact of distributed generation on voltage quality parameters in LV distribution network. The impact on the voltage variation is described in both theoretical and practical way, as there were 30 different representative LV networks with photovoltaic plants selected in whole E.ON Distribuce area. The one week voltage quality was measured in these networks in 2014, always simultaneously in the distribution substations and at theconnection points of distributed generation to the LV network, that means two voltage quality measurements for each network. These 60 measurements were subsequently evaluated according to the standard ČSN EN 50 160 and the impact on voltage variations, flicker, THD, unbalance and selected harmonics voltage was analyzed. This measurement was repeated in 2015 and results of both campaigns were compared. Analysis of operational impact of so called “wattrouter” on power network when this type of equipment is used at delivery point with embedded generation for generation/consumption optimization is mentioned in the conclusion.

PROBLEMS OF ASSESSING CONNECTION AND OPERATION OF SMALL HYDRO POWERPLANT WITH ASYNCHRONOUS GENERATOR

Martin Kašpírek, David Šimáček, Jan Jiřička, E.ON Česká republika, s.r.o.

This paper summarizes legislation requirements for connection of generation to the distribution network regarding to its influence on supply net. Assessing of voltage swell and deviations during switching is made for asynchronous generator, typically used in small hydro-power generation. Field measurement values are entered to calculating model for theoretical evaluation. There is a

comparison between operational states with various power factors in plant. The attention is paid also to the parameters inducing flicker through transient phenomena caused by connection of asynchronous generators under the multiple switching conditions. The paper describes also possible corrective actions. Attention is paid to problems of plant steady state regarding to maintaining plant's power factor and reactive power flow when reactive power consumption produces additional active power losses, but the voltage change caused by plant operation is smaller than e.g. under the neutral power factor conditions of the plant.

IMPACT OF MULTIPLE NON-LINEAR APPLIANCES CONNECTION ON SUPPLY NETWORK POWER QUALITY

Václav Kůs, Jan Pikous (oba ZČU v Plzni), Jiří Duspiva (ČEZ, pracoviště Plzeň)

The growth of household nonlinear appliances is enabled mostly due their low prices. The main reason is the need to use the saving lamps for lighting. This article provides the case study for simultaneous use of multiple lighting as well as other nonlinear appliances in households. The housing estate network is used as an example where the peak simultaneous use of many of these appliances could be expected as well as possible voltage distortion by high level harmonics.

According to the week measurement results performed in housing estate distribution network in Pilsen, the nonlinear appliances impact on the respective grid is not as serious as was expected. Still there is exceeding level of harmonics voltages which are multiple of 3. The objective is to discuss, if suggestion to increase the limit values for harmonics voltages of such levels should be made.

INFLUENCE OF MEASUREMENT TYPE ON ITS EVALUATION AND INFLUENCE OF RAPID VOLTAGE OR REACTIVE POWER CHANGES ON THE OPERATION OF ROTATING COMPENSATORS IN THE SUPPLY AREA OF KRASIKOV SUBSTATION

Jan Šeda, Michal Konč, ČEZ Distribuce, a.s.

Compensators connected to the tertiary winding of EHV/HV transformers were introduced as a special and unique equipment to compensate reactive power in the supply area of Krasikov substation in discussion during last years.

Two synchronous machines with the range of -50 MVAr to +100 MVAr were more often used for injection of reactive power thus the increasing both 400 kV and 100 kV voltages until the end of 2008. At the end of 2008 however, the increase of reactive power in systems occurred, hence there was a need to absorbe this reactive power and decrease the voltage in both systems. This trend continues during next years, particularly after 2010. All of this became obvious during certification tests performed in December 2014.

This paper provides information about unusual phenomena detected through the certification of compensators and theirs impact on distribution and transmission system equipment. Additionally the paper will describe different approaches how to get and store data from all voltage levels and their impact on data representation in farther usage, including trends during years in question.

VARIANT EVALUATION LV NETWORK VOLTAGE VARIATIONS

Petr Krejčí, Pavel Santarius, Velička, TU Ostrava, Brunclík, ČEZ Distribuce

The one year monitoring of voltage variations was performed on ten points in LV systems to check possible methods for evaluations of voltage variations in LV networks. The 95 % and 99 % values of variation in one and ten minutes intervals were evaluated from bulk of measurements.

RESONANCE IN LOCAL DISTRIBUTION SYSTEM OF 6 KV CAUSED BY COMPENSATION FILTERS OF CONTINUOUSLY REGULATED COMPENSATION

Jaroslav Pawlas, ELCOM a.s., Praha

This paper describes results of voltage, current power and harmonics measurements in local distribution system of 6 kV after the installation of regulated drive of mining machine with thyristor controlled rectifier, continuously regulated compensation with filters for 11^{th} and 13^{th} harmonics and blocked triggered compensation. A resonance between filters and supply network occurs under some operational states, which leads to distortion of voltage and harmonics currents. Measurements are compared with network simulation.

OPTIONS FOR OPTIMIZATION OF POWER QUALITY MEASUREMENTS DATABASE

Jan Kraus, KMB systems, s.r.o.

This paper describes the issue of quantity of power quality historical data, which a typical monitoring system tries to store from one or many measuring points. The paper mentions compression possibilities of voltage quality, powers and energies aggregated data. Details are provided for measurements, harmonics and inter-harmonics aggregation and storage issues since these occupy the most of the storage space and because the new PQ standards require monitoring of huge amount of data. Moreover, drafted standards and articles want to aggregate this band no matter whether the specific values are useful or not.

EVALUATION OF VOLTAGE EVENTS IN E.ON DISTRIBUCE DISTRIBUTION SYSTEM

Miloslava Tesařová, ZČU v Plzni; Martin Kašpírek, E.ON Česká republika, s.r.o

This article summarizes long-term monitoring of short-term voltage dips, interruptions and swells, performed on the E.ON supply area in Czech Republic on each voltage level of the distribution system. Monitoring results provide information about the number and classification of voltage dips, interruptions and swells on each voltage level during several years. Furthermore, the article discusses up-to-date problems associated with assessing and guaranteeing the frequency of voltage dips, interruptions and swells, e.g. the specification of informative or mandatory occurrence based on recorded data, the settings of thresholds for voltage events recording regarding to voltage variations specified in ČSN EN 50 160 standard. According to the recorded voltage dips, the average MAIFI index value is determined, providing an auxiliary index to SAIDI and SAIFI supply continuity parameters. In conclusion the paper analyzes problems of evaluation of voltage dips spread within distribution system based on records of simultaneous measurements on 110 kV, 22 kV and 0.4 kV levels in selected network part.

POWER QUALITY MEASUREMENTS USING THE VIRTUAL INSTRUMENTATION

Vladimír Korenc, Jaroslav Pawlas, Daniel Kaminský, Jan Šíma, Jiří Hula, ELCOM a.s., Praha

Power quality measurement requirements arose in first IEEE standards related to harmonic limits regarding the power disturbance. This standardization was accelerated by the wide introduction of semiconductor devices and their quick deployment in industrial and household areas. Energy market liberalization is another milestone closely related to this problem as well as introduction of distributed energy resources during last years. ELCOM Inc. provides innovative approaches in this area for last 25 years. The principle of virtual instrumentation is used in the measurement domain during all these years, facilitating the integration of science and engineering developments and enabling new

approaches deployment by their use in power measurements. This paper summarizes the development and trends in measurements in the context of power quality measurements including use cases of applications from single instruments to distribution system solutions.

SESSION 3: OPERATION, CONTROL AND PROTECTION OF NETWORKS

Guarantee: Petr Toman, VUT Brno

USAGE OF WIDE AREA MONITORING SYSTEM TO ELIMINATE NEGATIVE IMPACT ON CUSTOMERS DURING SWITCHING DIFFERENT 22 KV NETS

Jan Jiřička, Jan Chromý, Vratislav Štěpka, E.ON Česká republika, s.r.o.
Miloslava Tesařová, Roman Vykuka, Západočeská univerzita v Plzni

Wide Area Monitoring System (WAMS), known particularly from its usage in transmission systems, are becoming widely used even in the distribution system (DS) operation. Typical usage is to support secure meshing of different 110 kV or 22 kV areas. Nowadays, wide area monitoring units are installed as standard equipment into the 110 kV/MV transformer stations on both primary and secondary side. The voltage phase shift is caused by the power transfer by individual system elements (TS/DS transformers, 110 kV lines, 110 kV/MV transformers, MV lines). There is a higher load diversification between individual MV feeders or 110 kV/MV transformers as more distributed generation is connected to the MV system. In practice, no exceptions are 110 kV/MV transformers and MV feeders with opposite active power flow. Despite these facts, the biggest problem is represented by meshing MV networks supplied from different HV systems. Distribution system operator tries to make switching in MV network with the least impact on each consumer. Thus the objective is to minimalize operations leading to short supply interruptions.
For that purpose, calculations of balancing currents were made to define the limit conditions of secure operation in MV network from the point of view of both protection and limited breaking capacity of typically used components. Calculated values were then checked in real operation by the measurement of balancing currents with known phase difference..

INNOVATIVE SMART AUTOMATION CONTROL OF DISTRIBUTION SYSTEMS

Petr Neuman, NEUREG, s.r.o., Praha

Many articles and documents, focusing on numerical models and analysis of extensive power systems, were written in last years. But most of them are related to models and analysis of interconnected transmissions systems. Only relative minority of them were focused on distribution systems and its principal components. As a result, the distribution engineer has not enough tools for distribution system analysis, e.g. under the steady state conditions (energy flows) and during the faults (short circuits), as the transmission system engineer has. The distribution system engineer is left “in the dark” (has not enough information) without these simulation and analysis tools for distribution system operation. Smart Grids introduction complicates the whole issue even more.
For this reason the presentation deals with problems of distribution system (DS) dynamic models and approaches to their “Smart” automated controls. The synchrophasors or Phasor Measurement Units (PMU) and Wide Area Monitoring, Protection and Control are promising components for the future distribution system operation. This presentation will specify the application function PMU for DS, partly overlapping application functions for transmission system (TS). Several successful European applications (Smart Grids, PMU/WAMPaC) will be pointed out, as well as options and approaches for application of automated control algorithms.

DEPLOYMENT OF MEASURES FOR CYBER SECURITY WITHIN TRANSMISSION SYSTEM SUBSTATION CONTROL SYSTEM

Michal Andrejčák, ABB

The cyber security becomes a topical problem also in the power industry. Unification of HW, SW and communication platforms of automation equipment and systems together with the requirement for lowering operational costs and fast fault clearance leads to the opening of the previously closed systems. This causes the growth of security risk for the control systems of transmission system substations. For increasing the system security, several steps need to be done – from the state evaluation, through necessary steps specification to their realization. Additionally there is a need to ensure the cooperation between the control system vendor and different organizational units of operator. This is what ČEPS Inc. is doing within the pilot project called "Implementation of measures increasing control system information security".
This paper describes all aspects of project development from the status evaluation to the implementation of first measures.

REQUIREMENTS ON SCADA AS A PART OF POWER UTILITY INFORMATION SYSTEM

Václav Král, Karel Procházka, Petr Pražák, EGC - EnerGoConsult ČB

This paper is based on standardization requirements of European Committee M/441 EN for CEN, CENELEC and ETSI for development of smart measurement equipment open architecture as well as ENISA (European Network and Information Security Agency) recommendations on compatibility, interoperability and cyber security.
This paper informs about existing and future SCADA standards, based on the aforementioned requirements.

COMMUNICATION TECHNOLOGIES AND SUPPORT OF REDUNDANCY NETWORK STRUCTURE PROTOCOLS

Jaroslav Šach, Zbyněk Bělina, Stanislav Bureš, Jana Jiřičková
Siemens s.r.o., Západočeská Univerzita v Plzni FEL

This paper deals with redundancy network communication technologies that increase the data availability in network and increase immunity against interruptions. The article analyses selected technologies, methods and specific parameters for data exchange. Focus is aimed on Redundant Network Access (RNA) technology, including the hardware and software components that support the ways of PRP (Parallel Redundancy Protocol) as well as HSR (High Availability Seamless Redundancy Protocol). In conclusion there is a problem summary, providing recommendations related to particular technology eligibility for specific power network parts.

Key words: communication protocols, communication technology, RNA, PRP, HSR

UNCONVENTIONAL CURRENT AND VOLTAGE SENSORS FOR MV DISTRIBUTION NETWORK AUTOMIZATION

Pavel Glac, Siemens s.r.o

The discussion regarding to unconventional sensors use in protection and control MV network is held for last five years but their mass use has not come yet. This technology gains new impulse due to deployment of measurements, short circuit indicators and monitoring of power quality on distribution transformers. Space requirements of existing installations need to be taken into account as well as requirement for low cost due to the huge numbers of potential measuring points and minimal numbers of variants etc. On the other hand these connected devices are not used directly for protections and tripping of affected feeders .

This paper summarizes principles of these sensors and their usage area. Additionally the effort is made to find possible disadvantages of these sensors that could complicate the future investments in distribution network .

DISTANCE PROTECTIONS OF BIG TRANSFORMERS

Jiří Bermann, ABB s.r.o.

The electric networks in Czech and Slovak Republic use distance protections of big three-winding (EHV/HV/MV or EHV/EHV/MV) power transformers (or autotransformers with tertiary delta) on the secondary transformer winding. Main objective of this article is not the missing distance protection on primary winding but the possibility of short circuit seeing (especially in transformer) by the above mentioned protection on secondary winding (110 kV or 220 kV) and consequently provides the guide to protection setting.

SHUNTING IN ČEZ DISTRIBUCE MV NETWORKS

Roman Vaněk, ČEZ Distribuce, a.s..

Network with earth fault may be operated, if the fault location is immediately started. Operation of cable with earth fault in compensated network is safe since the fault current flows back through metal shielding of cable and represents no strain for surroundings.

Operation of overhead lines with earth fault is not secure due the touch and step voltage in the point of fault. MV conductor on ground is considered as a live part even if there is not enough protection against the touch on live part. Thus it needs to be worked on. One of possible solutions is shunting.

I-PROTECT – SMART PROTECTIONS AND POWER NETWORKS CONTROL BASED ON FUTURE ICTS (INFORMATION AND COMMUNICATION TECHNOLOGIES) AND AUTOMATION ARCHITECTURES

Elmar Stachorra, KoCoS Power Grid Services GmbH

This article describes the research, development and tests of new system architecture used for protection and control systems that comply with future requirements. It defines the objective, requirements, application and process interconnection. It proposes unified data format for planning, configuration and documentation. It deals with creation of fault records, protection parametrization and binary values acquisition and control using IEC 61850 communication, GOOSE protocol and COMTRADE files.

MV/LV TRANSFORMER PROTECTION

Jaroslav Pospíšil, Josef Toušek, PROTECTION & CONSULTING, s.r.o.

There were several MV/LV transformer (particularly dry ones) crashes recently. The reasons of these crashes are analyzed from the aspect of switching overvoltages, transformer installation in their rooms and their ventilation, operational states of renewable sources and MV network in given area.

Transformer fault causes including incorrect projects are listed, especially electrical parts relating to protective functions. Important cause of transformer damage is e.g. earth fault in MV network, its indication and elimination.

Authors of this paper try to make an innovative approach to MV/LV transformer protection by combining the MV fuse system, breakers or fuses on LV side, backup protection on MV side and early earth fault indication and high harmonics identification in operational currents.

COORDINATION OF PROTECTIONS SETTINGS AND PARAMETERS OF SYNCHRONOUS GENERATOR EXCITATION REGULATOR

Jaroslav Pospíšil, Tomáš Effenberger, PROTECTION & CONSULTING, s.r.o.

This article deals with coordination of synchronous generators (SG) protection and control system under emergency conditions such as overload and underexcitation when both excitation regulators and some of protections are working simultaneously.

Overloads happen when SG is operating in the 1-st quadrant of PQ diagram, underexcited SG is working in the 2-nd quadrant and is limited by static stability, stator warming and minimal voltage on the self-consumption busbars.

SG operation under the overload and underexciting condition needs reliable excitation regulator, protection system and coordination of their settings. Regarding to characteristics of excitation limiter and protection it is reasonable to determine the SG load limiting curves in impedance and admittance plane. The permitted operational conditions are provided for generator block – transformer without and with on-load tap changer.

VERIFICATION OF METHODS FOR EARTH FAULT LOCALIZATION EVALUATING VOLTAGE DIPS ON THE DISTRIBUTION TRANSFORMERS LV SIDE

David Topolánek, Petr Toman, VUT v Brně

Objective of the paper is assessing new methods for earth fault localization that evaluates voltage dips on secondary windings of distribution transformers, caused by auxiliary resistor connection during the earth fault, to localize the point of fault. This paper evaluates the suggested method based on fault records of real compensated distribution system.

LV LINES FAULT INDICATORS DATA EVALUATION

Drahomír Pernica, Jiří Babka, František Ženožička, MEgA - Měřící Energetické Aparáty, a.s.

This paper deals with the earth fault and short circuit indications on MV lines as well as long-term recording and evaluation of monitored values. As an example are used the measurements on real distribution system with different voltage levels recorded during 2015.

MEASUREMENTS OF GROUD POTENCIAL DISLOCATION FOR GROUNDING NETWORK OF MV/LV TRANSFORMER STATIONS AND MEASUREMENT OF TOUCH VOLTAGE IN THE STATION NEIGHBOURHOOD

Marek Kopička, Jaroslava Orságová, David Topolánek, VUT Brno
Jaromír Dvořák, E.ON Česká Republika, s.r.o.

Paper deals with measurements of ground potential dislocation and ground resistance of MV/LV transformers or MV line poles grounding equipment measurements using the method with no effect on power supply continuity. The monitoring of touch voltages in close neighborhood of selected stations was performed within the series of measurement whose results are listed in conclusion.

ASSESING THE BURN RISKS CAUSED BY ELECTRIC ARC DURING ISLAND OPERATION OF THE DISTRIBUTION SYSTEM

Jan Pígl, Eaton Elektrotechnika s.r.o.

This paper deals with assessing the burn risks caused by electric arc during island operation of the distribution network. Paper focuses particularly on the importance of definition of each operational scenario and their impact on the short circuit current and the emitted heat that depends among others on short circuit current and protection system settings on each busbar in given power system. Another important issue is the protection system definition regarding the short circuit effects. IEC 60909 and IEC 61363 standards are discussed in this context.

PLC ROLE IN SMART METERING ROLLOUTS – COMPARISON AND METODOLOGY OF PLC PILOT IMPLEMENTATION

Petr Mlýnek, Radek Fujdiak, Pavel Šilhavý, Jiří Mišurec, Ústav Telekomunikací, VUT Brno
Lešek Franěk, ModemTec, s.r.o.
Juan J. Zamphiropolos, Jiří Pařízek, E.ON Česká republika, s.r.o.

Paper deals with the draft of evaluation methodology for Power Line Communication (PLC) implementation. Suggested methodology enables detail evaluation and comparison of each PLC technology based on precise parameters definition and the measurement method. Paper also describes application and verification of this methodology for selected PLC technologies under the real PLC pilot implementation as well as laboratory conditions.

SESSION 4 – DISTRIBUTED ENERGY RESOURCES, ELECTRICITY USAGE

Guarantee: František Kysnar, EGC ČB s.r.o.

PŘÍSPĚVEK ČEZ, A.S. – NÁZEV PŘÍSPĚVKU BUDE DOPLNĚN

Jiří Hledík, ČEZ, a.s.

CONNECTABLE POWER OF THREE- AND SINGLE-PHASE SOURCES FOR LV NETWORKS

Karel Procházka, Jan Petrásek, EGC-EnerGoConsult ČB

Paper shows the significant difference of symmetrical and single-phase source impact on the network voltage conditions thereby connectable power, caused by voltage unbalance limit. Additionally it proves the conditions deterioration in case of unbalance consumption and generation connected to the different phases of LV network as well as the risks of “zero” injection into the LV network during the “compensation” of single phase consumption by three-phase generation.

ARCHITECTURE OF CENTRALIZED SYSTEMS OF AUTOMATIC SECONDARY VOLTAGE REGULATION USED IN 110 KV DS IN CZECH REPUBLIC.

Richard Habrych, ORGREZ, a.s.

CERTIFICATION OF ROTARY COMPENSATORS USED TO PROVIDE THE U/Q – VOLTAGE STABILIZATION IN THE SUPPLY AREA OF KRASÍKOV STATION

Ing. Jan Šeda, Ing. Michal Konč, ČEZ Distribuce, a.s.
Doc. Ing. Radovan Doleček, Ph. D., DFJP, Univerzita Pardubice

Synchronous compensators connected to tertiary winding of EHV/HV transformers in Krasikov station area were introduced at conferences in last years as special and unique equipment for reactive power correction.

Two synchronous machines with the range of -50 MVAr to +100 MVAr were used more often for reactive power injection until the end of 2008 in order to increase the voltage on both 400 kV and 110 kV levels. But since the end of 2008 it’s necessary to consume excessive reactive power and thus decrease the voltage in both systems. This tendency continued in the next years especially after 2010. All of this became obvious during tests performed in December 2014.

This paper provides information about compensators and their options. Additionally the description of certification test itself is provided, that differs from the regular test required for other devices providing U/Q services.

PŘÍSPĚVEK ČEPS, A.S. – NÁZEV PŘÍSPĚVKU BUDE DOPLNĚN

Martin Pistora, ČEPS, a.s.

RECONFIGURATION OF SOLAR PLANTS FREQUENCY PROTECTION

František Kysnar, Karel Procházka, Josef Hrouda, EGC-EnerGoConsult ČB s.r.o.

Installed power of Solar plant has increased from less than 2 GW in 2005 to more than 80 GW in whole Europe nowadays (installed power is 2 040 MW in Czech Republic). Frequency protection setting of most solar sources responds to frequency range 49.5 Hz to 50.2 Hz according to the rules applicable when they were installed. ENTSO-E analysis show that the maximum disconnected power in this source type, due to system stability, shall not be higher than 4 500 MW at 50.2 Hz in European wide range. That means 6 000 MW of the installed power. These conditions are even more strict in case of underfrequency, where the disconnected power should not be higher than 2 350 MW which means 3 000 MW of installed power at 49.2 Hz. Thus distribution system operators defined new requirements on frequency protection settings not only for the new connected generation but to existing generation too (so called “retrofitting”). This paper provides the reason for frequency protection reconfiguration, generation settings requirements including the impact on the connected generation in Czech Republic.

ISLAND OPERATIONS

František Žák, EGE, spol. s r.o.

As the society dependency on electricity increases, so increases the need to secure reliable power supply. Despite of this there is still possibility of blackouts in big network parts caused by serious faults. These blackouts can affect many consumers. When the interruption on supply line lasts several hours or days, automatic creation of controlled island operation could solve the problem of power supply in such area. Creation of controlled island operations can be particularly cost-effective in industry. Automatic control allows splitting the predefined area into island operation. Automatic control ensures the synchronized reconnection of island into the power system when the fault is cleared. Controlled island operations are part of Smart Grid. The island control system can be used to active or reactive power overflow control under the normal synchronous operational conditions of network

NOTIFICATION OF ELECTRIC WORK MEASUREMENTS

Jaroslav Pospíšil, Pavel Tureček Protection & Consulting, s.r.o.

This article deals with up-to-date methods and notification of electric work measurement, active and reactive power regulation and brief evaluation of current reactive power regulation.

Initial revision is the prerequisite to successful putting electric device into operation. This revision verifies device security and proves that persons and asset are suitable protected against risks caused by electrical devices.

ČSN 33 200-6, TNI 33 2000-6, ČSN 11 1500 and parts of ČSN 33 3201 Standards deal with initial revision. Initial revision requirements provided by these standards are interconnected and support each other. The effort is to refine this issue in the distribution Code, supplement 4.

RIPPLE CONTROL BLOCKING FILTERS AND THEIR APPLICATION

Tomáš Hanžlík, EGC-EnerGoConsult ČB s.r.o.

Among the others negative impacts, renewable generation deteriorates the ripple control signal in energy networks. The blocking filter is the most common equipment used for reducing the negative impact of such plants on ripple control signal. This paper deals with assessing the need for such equipment and consequences of its application on one of its many implementations.

DECREASING THE RISK OF BLACKOUT USING METHODICAL DATA AQUISITION

Dipl.-Ing. Elmar Stachorra, General Manager KoCoS Power Grid Services GmbH, Dipl.-Ing. Timo Wild, Product Manager Fault Recording & Power Quality, KoCoS Messtechnik AG

Impacts of blackouts on inhabitants and infrastructure, GRASP research project and conclusions of Technology Assessment Bureau of Germany Federal Parliament. Smart Grids, identifications and lowering risks of blackouts, data capacity and new requirements on measurement systems. Temperature as one of critical factors and other metrics. Communication, communication protocols and time synchronization.

PRACTICAL EXPERIENCE WITH DETECTION OF PID AND OTHER PV FAULTS

P. Mastný a J. Morávek (VUT), M. Vavera (Sunlux).

This paper provides the description of functional options to PID detection directly in the operated PV without any laboratory measurements. Results of operational measurements are analyzed and discussed in context of this issue and then will be used to operational efficiency optimization.

OPERATIONAL ANALYSIS OF SELECTED RENEWABLE SOURCES

Jaroslav Pospíšil, Josef Toušek, Tomáš Effenberger / Pa C /, Aleš Procházka / EON /

This article deals with identification of reasons leading to the voltage transformers damage in PV plant Turany (5 MW) connected to substation Sokolnice 22 kV that seriously hurt the power generation. The reason of damage of voltage transformers (VT) on VN 1384 feeder should be specified based on the long-term measurements in AJA 16 bay in VN 1684 feeder. The detailed protection analysis of 7SJ63 function and/or setting in MV feeder was made, as well as so called notification of electric work measurement.

The paper presents the results of “long-term” voltage/overvoltage measurement on the MV side in the Sokolnice substation, tripping test simulation under the different PV load conditions, function of Siemens type 7SJ63 protection including the fault records in monitoring period.

A project of PV plant protection and control improvements was realized as well as corresponding voltage condition measurements in case of relocating the decomposition point on plant’s LV side.

SEKCE 5: PLANNING OF POWER DISTRIBUTION SYSTEMS

Guarantee: Jaroslav Šabata, EGÚ Brno, a.s.

N-1 CRITERION – APPLICATION AND IMPACT ON WORKS PREPARATION IN ČEZ DISTRIBUCE INC.

Martin Mach, ČEZ Distribuce, a. s.

This document deals with application of N-1 criterion not only in works preparation. The objective is to find a balance between distribution system security, reliability, safety, impact on customers and necessary interruptions during maintenance, upgrade or development of distribution equipment.

OPERATIONAL EVALUATION OF MV/LV TRANSFORMES WITH ON-LOAD VOLTAGE REGULATION ACCORDING TO THE REGULATION METHODS

Jan Jiřička, Martin Kašpírek, Jan Vrzal, Libor Kolář, Josef Novotný; E.ON Česká republika, s.r.o., Martin Plchút, Siemens, s.r.o.

This paper deals with LV distribution network voltage stabilization using the MV/LV transformers with on-load voltage regulation. Methods of regulation differ from one vendor to another. E.ON uses two types of Siemens machines (FITformer 1.0 REG and FITformer 2.0 REG) with the LV side regulation. Two ways of operational solutions are compared where regulation can be performed either according to the voltage in LV distribution station switchgear only or the voltage values in embedded LV generation / the ends of LV feeders participate on the calculation. Beside this E.ON performs the operational tests of SGB transformer with GRIDCON tap changer manufactured by Maschinenfabrik Reinhausen using similar way of transformer parameter setting as used by 110/23 kV transformers. Among others this paper describes the impact on voltage deviation and transformers parameter optimization as well as detailed documentation of installation progress and operational experience, including measurement data transmission and SCADA transformer control.

INSTALLATION OF MEASUREMENTS IN GRID NETWORK OF ČEZ DISTRIBUCE UTILITY IN ŠUMPERK FOR OPERATIONAL MONITORING AND ANALYSIS

Taťána Macečková, Vlastimil Novotný, ČEZ Distribuce, a.s., Jan Souček, Martin Paar, MEgA - Měřící Energetické Aparáty, a.s.

Today's vision of LV distribution network future development is focused on acquiring the information on current status of network operation. Network monitoring is based on measurement installation

opening new possibilities of network operation. One such approach is grid networkoperation. Development of distribution networks monitoring remedies some disadvantages of grid operation and makes it more attractive.

This article briefly describes the size and operation of grid operated network in Šumperk. This article further deals with the measurements installation into this part of low voltage distribution network. It includes use cases from the field installation in ČEZ Distribuce grid network in Šumperk as well as example of measurement values and data storage and display system.

PROCESSING AND VISUALIZATION OF LARGE MULTIPLE DATASETS

Tadeusz Sikora, Pavel Santarius, Petr Krejčí, Richard Velička VŠB-TU Ostrava

Power industry is oversaturated with measurements. Measurements are performed on as much values as possible with highest available sample frequency. Many of these measurements are not used, they are only stored on server for possible future use. This article presents one such case. Large dataset of voltage, current, active and reactive power measurements from several distribution transformer stations, obtained through many years of operation was compiled into graphics for easier use in operation evaluation of these distribution transformer stations.

GROUNDING THE PHASE WITH EARTH FAULT

František Žák, EGE, spol. s r.o.

Earth fault is one of the most common distribution network faults. It is possible to operate the network with earth fault for a limited time period, if there is a network with ground capacitance current compensation, or to disconnect this fault fast. The point of earth fault is burdened with residual current which causes burning around the point of fault and increases the damage on electric equipment. Also the electric shock hazard increases. The residual current value is growing particularly during the network reconfiguration in order to fault localization. If the earth fault phase is grounded during the network earth fault, the residual current would be split between point of earth fault and point of grounding according to the ratio of impedances. If the fault resistance is higher than 50 Ohms, the current in point of earth fault is significantly lower. In practice, the single-phase fault resistance is usually higher than 50 Ohms in most earth faults in distribution network. Significantly lower current in the point of earth fault allows operating the network with earth fault more safely. The control system for grounding the phase with earth fault requires no change in standard protection methods in distribution network and allows the standard point of earth fault localization. There are several systems for grounding the phase with earth fault in operation this year.

CAPACITANCE CURRENT ISSUE IN ČEZ DISTRIBUCE A.S.

Martin Mach, Petr Sikyta, ČEZ Distribuce, a. s.

This paper analyzes the growth of capacitance current in distribution system and its impact on investment decisions and network operation. Detailed analyses and evaluations of capacitance currents in transformer stations and supply areas were made, including future scenarios.

POWER QUALITY REGULATION

Jan Šefránek, Energetický regulační úřad

This paper deals with power quality regulation with focus on changes in next regulation period. In the context of new regulation period since 2016, new elements within quality regulation motivation were applied, based on experience obtained in the third regulation period. This paper includes the evaluation of power quality and related services in power industry in 2014.

QUALITY FACTOR – RISKS AND ISSUES ASSOCIATED WITH EVALUATION

Petr Skala, Václav Dětřich, Oto Bucholcer – EGÚ Brno, a.s.

Quality factor affected the distribution prices based on continuity of supply index from 2013 for the first time this year. Likewise in other indexes of continuity of supply, the quality factor allows to estimate its values in future (including the impact of designed measures) by means of simulation. Evaluation of such forecasts needs specific approaches since the calculation contains nonlinearities and it is affected by random values.

This paper deals with tools for quality factor evaluation, based on reliability simulation of distribution network using Monte Carlo method. Approach based on probability is chosen, enabling to respect associated risks. The quality factor calculation for each distribution network measure is discussed.

AUTOMATIC COMPENSATION IN THE CONTEXT OF QUALITY STANDARDS USRO 275/2012 Z.Z.

Marián Veselka, Západoslovenská distribučná, a.s.

According to new URSO publication 275/2012 Z.z. and its basic changes associated with quality standards there is need for measures to minimize the cases of quality standard violations stated by the publication. This paper deals with quality standard fulfilment in fault management and work schedule in theory and practice. Additional it illustrates the results, the system support and the measures taken with respect to the future.

UPDATED RESULTS OF 110 KV LINE RESTORATION METHODOLOGY

Vít Houdek, Stanislav Rusek, Radomír Goňo, VŠB-TU Ostrava

This article works out the restoration methodology of 110 kV distribution line. The methodology uses the principles of reliability centered maintenance (RCM). This kind of maintenance depends on technical conditions and importance of given distribution network equipment. Methodology uses the common available data from distribution network operation thus no new measurements and diagnostics are needed. This methodology results in quantity called restoration priority, according to which the order of maintenance section can be determined. This paper also provides up to date results from one distribution area.

UTILIZATION OF SYSTEM TOOLS FOR FAULT MANAGEMENT AND COMMERCIAL USE

Andrej Valo, Západoslovenská distribučná, a.s.

This paper deals with possibilities of using system tools for fault management on all voltage levels in distribution network. It shows areas affecting SAIDI and SAIFI reliability indexes such as interconnected schemes, fault management on LV voltage level, recording of fast and slow reclosing. Additionally the article deals with approaches how to use the system functions to commercial usage – sending SMS to village mayors, distribution system faults publication on web, ZSDID banners on village's web pages.

INPUT IMPROVEMENTS FOR FORECASTING THE INFLUENCE OF RESTORATION ON SAIFI AND SAIDI INDEXES WITH RESPECT TO AGEING PROCESS

Stanislav Votruba, Lukáš Křivanec – PREdistribuce, a.s., Petr Skala – EGÚ Brno, a.s.

Asset Strategy Planning (ASP) provides the tool for effective management of power equipment in distribution system that determine the right time to its restoration, based on input parameters of each equipment. PREdistribuce Inc. let calculate the analysis of ageing impact on fault rate, based on topology and history of faults and HV/MV distribution system resources, with respect to SAIDI and SAIFI contribution. The resulting dependence of fault rate on age can be then used to improve the ASP input data, in order to find the optimal period of power equipment restoration in distribution system.

SEKCE 6: CONTROL, ORGANIZATION, QUALIFICATION

Guarantee: Martin Schneider, PREměření, a.s.

EXPLOIT OF OUTPUTS FROM SMART GRID'S PILOT PROJECT

Stanislav Votruba, Petr Lžičař, PREdistribuce, a.s.

CHANGES IN ELECTRICITY INDUSTRY CAUSED BY CHANGING THE ENERGY LAW AND LAW OF SUPPORTED ENERGY SOURCES

Pavel Círek, Energetický regulační úřad

The amendment of energy law and law of supported energy sources changes heavily the power industry. These amendments call for need of wide change within Energy Regulatory Office's orders. Likewise, there is additional energy legislation affecting the legal regulations of electricity industry approved by European Committee. This paper familiarizes with the most important changes in electric industry, affecting its daily decisions.

GUIDE TO DISTRIBUTION SYSTEM OPERATION IMPROVEMENTS AFTER APROVAL OF ENERGY LAW AMENDMENT

Karel Procházka, Pavel Bürger, EGC-EnerGoConsult ČB

The paper briefly describes the parts of Guide to distribution system operation and its amendments with expected completions and changes due to the Energy Law Amendment. The final version comes after approval of orders on measurement, connection and the market.

VERIFICATION RESULTS OF LOCAL CONSUMPTION VS GENERATION OPTIMIZATION

František Mülller, ČEZ Distribuce, a. s

CALCULATIONS FOR ASSET MANAGEMENT SUPPORT

Zbyněk Brettschneider, Radek Hanuš, PREdistribuce, a.s.

This paper illustrates the methodology for including distribution system lines to scheduled reconstruction. Methodology is based on severity of voltage limit violation at each distribution system node. The methodology takes into account the voltage limit variations, number of customers affected by non-standard voltage in given node and important customers connected to given node. The purpose is to calculate weighted factors for line reconstruction, evaluating the contribution of each distribution line to power quality at all nodes with respect to the number and importance of affected customers.

THE CYBER SECURITY LAW IMPACTS ON DSO

Petr Denemark, PREdistribuce, a.s.

This paper briefly describes basic terms and principles of new law and associated directives. The paper explains basic terms and then the requirements resulting from the cyber security law and rule, including their impacts on the electricity industry area.

CYBER SECURITY

Michal Andrejčák

NEW APPROACH TO PRICE SETTING FOR GENERATION AND CONSUMPTION OF REACTIVE POWER BY WHOLESALE CUSTOMERS AND ELECTRIC ENERGY PRODUCERS, COMPARISON OF CURRENT METHODOLOGY WITH NEW MODELING OPTIONS

Pavel Bürger, EGC – EnerGoConsult ČB s.r.o.

Reactive power flow through the distribution network affects both distribution capacity and power quality, eventually deteriorates the stability of both distribution and transmission system. Wholesale customers as well as electric energy producers significantly contribute to this status. Appropriate penalty setting for breaking agreement can effectively change the course of action of wholesale customers and producers. This paper offers specific approaches to price setting of reactive power consumption/supply, so that the rules would be simple and general while retaining comparable yet applicable penalty system according to the NRA price rule.

REACTIVE POWER CONSUMPTION OF MV/LV DISTRIBUTION TRANFORMERS AND ITS IMPACT ON REACTIVE POWER FOLW IN DISTRIBUTION SYSTEM

Pavel Bürger, EGC – EnerGoConsult ČB s.r.o.

The quality of MV/LV distribution transformers was improved in last several decades. New distributions transformers have multiple times lower consumption of reactive power required to establish transformer magnetic field. This paper compares the reactive consumption of distribution transformers under no load condition listed in NRA Price decision with current practice and it proposes the parameter improvements.

DAMAGE COMPENSATION ACCORDING TO THE NEW PUBLIC LAW (89/2012 SB.)

Pavel Kraják, ČEZ Distribuce, a.s.

Two ways of approach are in conflict at damage compensation – legal and technical. According to the common sense, these two approaches should come together. Contrary is the case. New public law amendment and energy law amendment (131/2015) make the situation more complicated and improved the situation for “lawyers” only, regardless of principles of distribution system service in context of energy law amendment. This paper tries to make the reasonable conclusion. According to

last several cases, mistakes can be found on both sides. There is a “part of truth” on both sides and there is no optimal solution without the common agreement. Regional distribution system operators try to find the solution. This paper tries to show the way of common sense.

COMPARISON OF DIFFERENT APPROACHES TO SAIFI AND SAIDI PARAMETERS IMPROVMENTS IN MEDIUM VOLTAGE DISTRIBUTION NEWORK

Martin Čerňan, Josef Tlustý, Zdeněk Müller, ČVUT v Praze, FEL

This paper aims on analysis of automation equipment benefits in medium voltage distribution networks. As measures for reliability improvement, the reclosers, remotely controlled pole-top smart switches and FPIs (Fault passage Indicators) were considered. SAIFI, SAIDI and supply interruptions were selected as main indicators of evaluation. Gains of each element were analyzed on simplified networks in two cases. Difference between variants is the presence of backup supply. Required inputs are the average number of annual permanent faults, number of branches longer than 1 km, overall number of customers, average annual number of interruptions and non-delivered energy, localization and fault clearance times for each feeder. In conclusion the different solutions for different types of MV feeder are provided.