Benefits of Implementing An Uninterruptible Power Supply System At Data And Network Centers In Complex Operating Conditions: A Case Study

Adis Rahmanović
University of Travnik,
Faculty of Technical Studies,
Travnik, Bosnia and Herzegovina,
email: adis.r@rmub.ba

Haris Berkovac
University of Travnik, Faculty of Technical Studies,
Travnik, Bosnia and Herzegovina &
BH Telecom Sarajevo
email: haris.berkovac@gmail.com

Muharem Kozić
University Dzemal Bijedic, Faculty of Humanities,
Mostar, Bosnia and Herzegovina,
email: muharem.kozic@unmo.ba

Abstract—**Data and Network centers from the aspect of electricity quality are non-linearity generators, and on the other hand they are very sensitive to deviations from electricity quality. The aim of the article is to show how optimal working conditions for this type of IT equipment can be provided in complex operating conditions. The paper describes various parameters, conditions, as well as measures and equipment that are implemented to ensure optimal operating conditions of IT equipment, security and reliability of data, but also human lives that interact with electricity. In addition to all the above measures, care should be taken to ensure that the implemented measures are environmentally friendly and economically viable.**

Keywords- Security of Data and Network equipment; Electricity quality parameters for IT equipment; Data security and reliability;

I. Introduction

Complex operating conditions represent a great challenge for the installation of equipment in the field of information and communication technologies, especially in the field of Data and Network centers, which in addition to great value in the field of installed ICT equipment, have great value in the field of information systems and supporting databases. accompanying data. We have such conditions when such centers are located nearby or at the same substation connected to large and unpredictable consumers of electricity. energy such as Rudnik, which has surface and pit coal exploitation. If such centers are located at the same substation with such plants, they are exposed to different risks that can significantly affect the quality indicators of electricity. energy, which is shown below. Knowing how sensitive the ICT equipment and data recorded on such equipment are to changes in the quality indicators of el. energy, and how much on the other hand as consumers due to nonlinearity, negatively affect the quality of electricity. the energy was necessary to provide in complex conditions that at least the basic indicators of electricity quality. energies in the Data and Network Center are within acceptable limits. Complex conditions of exploitation are reflected primarily in the relatively frequent sudden power outages. energy, as well as in unannounced or fast switching procedures, ie. switching on the contactor under load, frequent sudden pulling of large amounts of el. energy, due to a large number of significantly different consumers, which are relatively poorly distributed in phases because they are different types of consumers located in the transformer area, from production plants, administrative centers, to households, shops, and the like.

II. Ease of Use

The term "electricity quality" has several aspects, such as:

- Frequency quality, which is related to maintaining the frequency at the prescribed value.
- Voltage quality, the measure of which is the deviation of the voltage magnitude and the shape of the voltage wave from the ideal references.
- Current quality, which is complementary to the notion of voltage quality and refers to the deviation of the current wave from the ideal reference.
- Power (or energy) quality, which is a combination of voltage and the current quality and characterizes the interaction between the system and the consumer.
- Supplier quality includes all technical and commercial aspects of frequency and voltage quality, which have an impact on the customer.
- Consumer quality, which includes all technical and commercial aspects of voltage, electricity and energy quality, from the impact on the supplier.
- The basic forms of the disorder are defined:
- Voltage dips represent a decrease in the voltage amplitude of the industrial frequency, the duration of

which ranges from 0.01 s to 1 minute. Typical values are between 10% and 90% of Uef.

- Power outages are characterized by complete voltage loss (when the voltage is below 10% of the nominal rms value) on one or more phases over a long period. Current interruptions are characterized by the duration between 0.01 s and 3 s, and temporary interruptions between 3 s and 60 s, while permanent interruptions are all those whose duration is longer than 60 s.
- Voltage shocks represent a temporary increase in voltage (or current) by more than 10% of the nominal value, and the durations are from 0.01 s to 60 s (typical values are between 1.1 r.j. and 1.8 r.j.).
- Transient changes of voltage waves are characterized by the appearance of impulse irregularities in the voltage sinusoid, which are repeated in short time intervals on the otherwise sinusoidal voltage wave of industrial frequency.
- Overvoltages and under voltages are voltage deviations greater than ± 10% of the rated voltage value, lasting more than 1 minute (typical values of overvoltage are 1.1−1.2 r.j., and under voltages 0.8−0.9
- Harmonics represent sinusoidal voltage waves (and/or currents), whose frequencies are integers or a fractional product of the fundamental frequency of an alternating voltage of industrial frequency. These waves are superimposed on the fundamental frequency wave, causing its distortion. Sources of harmonics are nonlinear consumers and devices of power electronics: static converters, inverters, cyclo converters, then arc furnaces and contactless switches and other similar devices.
- Periodic pulses appear as short-term disturbances in each half-period of the voltage wave (lasting less than 0.01 s). They are most often produced by switching devices of power electronics. Their harmonic components are usually very high frequencies.
- Voltage fluctuations are characterized by systematic variations in the envelope amplitude of the voltage wave, normally in the range of 90% to 110%. Such voltage variations are inherent in flickers. i. Frequency deviation is also manifested in the change of the voltage wave period.
- Telephone interference factors.

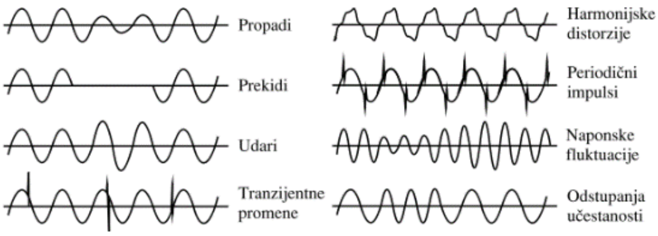

Figure 1. Overview of basic forms of electrical signal disturbances

Electronic devices are nonlinear and generate certain negative phenomena in the system, and on the other hand, they are extremely sensitive to small changes in voltage quality. Mitigation of consequences is most often done through the following measures:

- Install filters,
- Stabilizers,
- UPS,
- Try to balance consumers in stages ...

III. Description Of The Uninterruptible Power Supply System On The Example Of Data And Network Center In "RMU Banovići"

The uninterruptible power supply system includes a 10kVA / 10kW uninterruptible power supply device (UPS1), a 5kVA / 4.5kW uninterruptible power supply device (UPS2), and a STS "static transfer switch" device for automatic switching of consumers from one power supply to another (STS) [5]. and other equipment required for installation) for the needs of uninterrupted power supply of critical equipment server rooms located in two IT rack cabinets in the administrative building RMU Banovići which are integrated into the power supply system according to the scheme given below:

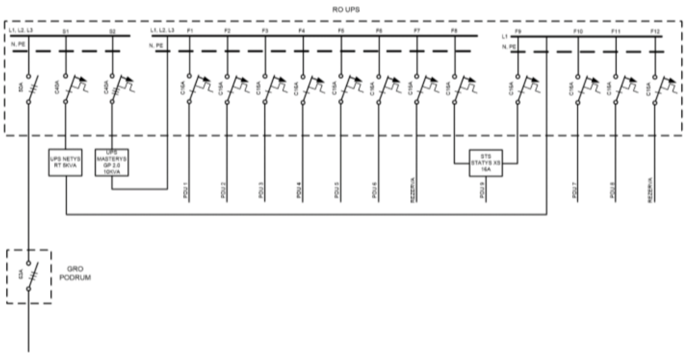

Figure 2. One-pole UPS power supply cabinet scheme

Legend:

- RO UPS - Distribution cabinet UPS Data Center system;
- GRO Basement - The main distribution cabinet in the Basement;
- UPS NetyS RT 5kVA - alternative UPS;
- UPS Masterys GP 2.0 10 kVA - main UPS
- STS STATYS XS 16A - module for optimizing the use of UPSs individually;
- Other: Electrical cables and fuses.

For the needs of the implementation of such an uninterruptible power supply system, a special cable has been installed for adequate standard insulation, appropriate crosssection, as well as the appropriate number of fuses, optimally distributed, to take into account the load in the form of server and network infrastructure. ICT devices are evenly connected to the different phases with their installed power, to have a minimum equalization current flow. When choosing UPS devices, care was taken to have the characteristics of stabilizers, filters, to be In-line interactive, to have the maximum power factor, due to energy efficiency parameters, to have the ability to monitor the load balance by phases, as well as greater autonomy. power supply in case of power failure energy, where for this way of realization with such devices and current load can be provided autonomy of ICT devices and over 8 hours in the initial year, and on average until the battery replacement period which is provided in 4 years to be autonomy at 7 hours with a connected optimal load of ICT devices, which satisfies most of the anticipated power outages, and even in cases of reconstruction or regular alarms.

Only the risks of the negative impact of a Force Majeure or a catastrophe have not fully received their answers. We also procured most of the network equipment to support the power supply. energy via Ethernet or PoE adapter, so on that side, connecting all network infrastructure to this type of protection, we have ensured that the power supply in the domain of reverse power supply is also provided via Power over Ethernet (PoE). All ICT devices that did not have two power supply units, this system is provided with an additional power supply unit, so that all devices have a double power supply. energy.

IV. Installation Of Uninterruptible Power Supply System Data And Network Center In „Rmu Banovići“

To connect the complete uninterruptible power supply system (UPS1, UPS2, STS, power strips, and consumers), a new distribution cabinet (RO - UPS) has been installed in the IT room. The RO-UPS contains all the protective and other elements for connecting the UPS and the consumer according to the above scheme. Each fuse is marked with an ordinal number corresponding to the ordinal number of the supply rail. A new cabinet with 63A fuses for the entire system has been installed in the basement, from where a new 5x6mm2 power cable has been laid to the disconnector with 50A fuses in the RO-UPS. In the RO UPS cabinet, in addition to the main disconnector, there is also a power fuse UPS - 1 (C40A3p), a power fuse UPS - 2 (C40A1p) and fuses for 9 power strips (C16A1p) and 2 power fuses STS (C16A1p) and one (C16A1p) for reserve. Power strips are mounted in rack 1 and rack2 cable 3x2,5mm2 (personal) and marked with the appropriate fuse mark according to the above scheme. All works were performed following standards and electrical regulations. The operation of the uninterruptible power supply system was tested by switching off the main supply disconnector in the basement of the building next to the GRO, without load and then with a load. A simulation of the failure of each power supply was performed by switching off the corresponding fuse in the RO-UPS [1].

Uninterruptible power supply (UPS1) 10kVA / 10kW – Socomec Masters Green Power 2.0 is a stand-alone UPS in "VFI - double conversion" design, defined by EN62040-3 standards and standards EN62040-1, EN62040-2, EN62040-3, CE, Seismic compliance with UBC - 1997 Zone 4. The UPS1 has a dual input network to separate AC power from the bypass power and features a three-phase rectifier, batteries, three-phase inverter, static switch, manual maintenance bypass, built-in LAN interface and two additional slots for communication options, graphic display (with information on UPS parameters (instruction management, measurements, alarms, settings, event overview ...) [6]

The UPS has a system for remote monitoring and control of room temperature measurement via LAN, SNMP agent, automatic system shutdown for operating systems Windows and Linux built into one of two additional slots for communication options. Batteries are integrated into the UPS cabinet housing in 4 rows. In each row, there are 36 12V9Ah batteries connected in series and all four rows in parallel thus providing autonomy of over 135 minutes at a load of 3500W.

Uninterruptible power supply (UPS2) 5kVA/4,5kW– Socomec Netys RT je UPS „rack&tower“, „VFI-on line double conversion“ versions defined according to EN62040-3 standard and standards EN62040-1, EN62040-2, CE. The UPS is compact, maximum height 4U with batteries, and contains a rectifier, batteries, inverter, automatic bypass, built-in LAN interface, RS232, USB, and an additional slot for communication option, display (with information about UPS parameters (measurements, alarms, settings, ...). UPS has a system for remote monitoring and control via LAN, SNMP agent, automatic system shutdown for Windows and Linux operating systems. The batteries are located in a special 2U battery cabinet and with the UPS cabinet, it forms a 4U unit. The battery cabinet consists of 16 12V9Ah batteries connected in series, which provides autonomy from over 15 minutes at a load of 3500W.

Device for switching consumers from one power source to another (STS) 16A – Socomec Statys XS 16A is a "rack" version, defined by standards IEC60950-1, EN62310-2, CE. STS is compact (1U), with a slot for communication option, LCD (with information on STS parameters) (measurements, alarms, ...) All devices that are important for the work process and do not have a double power supply are connected to the STS When commissioned and set up by professionals, the STS operates completely independently. Any consumers in the two IT racks of the server room are powered directly via UPS 1 and UPS 2, primarily via UPS-1 a UPS2 will serve as a “back-up.” As a parallel / redundant connection between UPS devices of different power and model is not possible, redundancy of server power units is used and STS is used to power all other equipment that does not have its redundant power supply. and rack 2 are powered by UPS - 1 with three power strips (9 schucko slots) per rack, and with one power strip (9 schucko slots) with UPS - 2. Consumers who do not have a redundant power supply unit will be powered from the STS output directly in one rack with an attic power strip (9 schucko plugs) connected to the IEC C19 (16A) output terminal for powering the consumer in the second rack. All power strips are powered from the cabinet with c16A1p fuses to disperse the risks according to the above scheme [2].

V. Benefits Of Using A Standardized Uninterruptible Power Supply System Installed In Complex Operating Conditions

After the implementation of a standardized uninterruptible power supply system that will be used in complex operating conditions, the above already described solved most of the existing and already addressed problems and risks, provided normal operation of ICT equipment, greater reliability and availability, and minimized risks in the domain damage to electronic and personal data, at least in the domain of risks arising from el. power supply [3,4].

All components have been selected, installed and configured to work according to the prescribed standards, and in this domain, in addition to adequately protecting ICT equipment, software and data, we have ensured their availability and reliability, provided operation under optimal voltage conditions, respecting legal regulations, professional standards, which was a demanding task to achieve under complex operating conditions, which are most pronounced due to the location and connection to a common substation with different consumers, several which are unpredictable with occasional activation of large consumers, as well as consumers with high nonlinearity and reactive energy. Other benefits of using such a system in conditions of complex exploitation:

- Filtration and voltage stabilization, el. currents, frequencies, powers.
- Providing conditions for the more reliable and long-lasting operation of ICT equipment.
- Greater security and reliability of data from undesirable effects on the quality of electrical energy.
- Greater security and reliability of information, operating systems, various software platforms.
- Greater security and reliability of Internet access and related services.
- Compliance with laws, bylaws, standards and rules of the profession.
- Reducing the impact and number of risks associated with fires or damage to data, software and ICT equipment.
- Ability to secure ICT equipment, software and data.
- Ensuring the autonomy of the ICT infrastructure, information systems and other IT services, data availability, in case of cessation of electricity supply. energy.
- Minimization of negative impacts of nonlinear elements by sources/inputs and consumers/outputs.
- Provide preconditions for optimal operation of ICT equipment under the conditions of the warranty for the same, ie. by quality standards.
- Mitigation of negative effects on the quality of electricity. energy and security of electricity supply energy generated as a reflection of the influence of a Force Majeure or other consumers that are powered from the same transformer or cable outlet on the secondary.
- Increasing the reliability and safety of people and ICT equipment, electricity from the negative effects of electricity. energy for human health and life and reliable and longer-lasting operation of ICT equipment.
- Assumptions are provided for approximate balancing of consumer loads by phases.
- Protection of people and ICT equipment from short-circuit currents is provided.
- Significant electricity savings energy, through the installation of a new system of UPS, greater than 33.5%, through the application of more energy-efficient devices and their optimal use, load distribution and balancing by phases.
- Activation of by-pass mode for UPS maintenance purposes.

For setting up and accessing devices, there is the possibility of setting up and controlling on the spot, ie in the Data and Network center or remotely via a web browser. We ensured the same by installing an adequate card. The card allows direct connection of the UPS to the network, LAN (RJ45 Ethernet) and remote monitoring of the UPS via TCP / IP protocol using the web browser WEB. In the following figure, we have shown some of the possibilities of the software environment that serves for review, settings, certain reports, monitoring of certain parameters, where several parameters can be set to automatically monitor and information about their movement outside the given frames. address, in charge of tracking them in real-time [7].

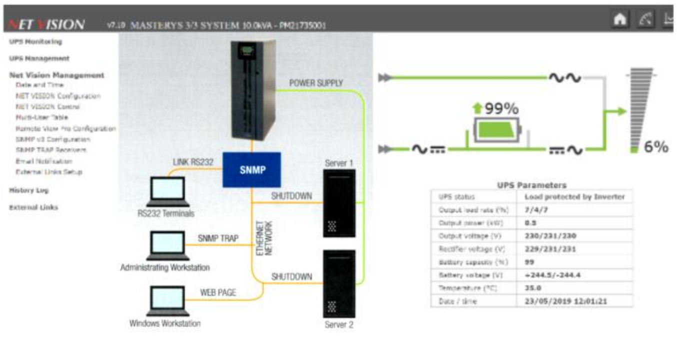

Figure 3. Display of part of the system shown through SNMP network access

The following figures show the possibilities of monitoring the appropriate parameters in real-time or subsequently through the creation of reports, which are used for the analysis and creation of plans related to the quality of electricity. energy as a vital service for Data and network centers, especially in complex operating conditions. The following figure shows us tracking a series of parameters in real-time, which are shown in the legend, which shows that the parameters are balanced and move within the given frames and that they have almost the desired values.

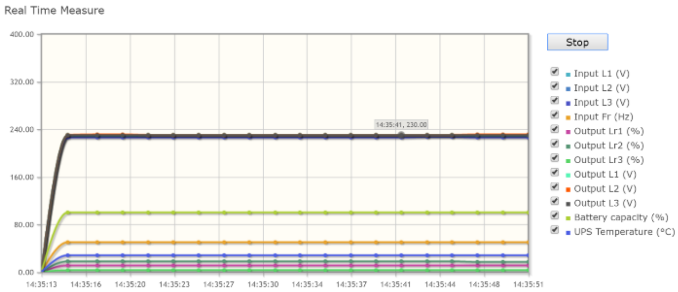

Figure 4. Display of monitoring of standard parameters after system installation

The following figure, which was created as a report in 24 hours, shows that the voltage changes by phases were in defined intervals of +/- 10% of the nominal value, as well as that the voltages by phases in time changed approximately with negligible differences, which can indirectly mean that the load was symmetrical in phases and approximately that the phases were loaded. The set voltage value was about 230 V, and the minimum value was 214 V, while the maximum value did not exceed 240 V. It is evident that the voltage at some points was less than the nominal and up to 6.9%, as well as higher than the nominal maximum 4.9%, which is significantly better than the set framework limits for the quality of electricity. energy is viewed through voltage values per phase in volts.

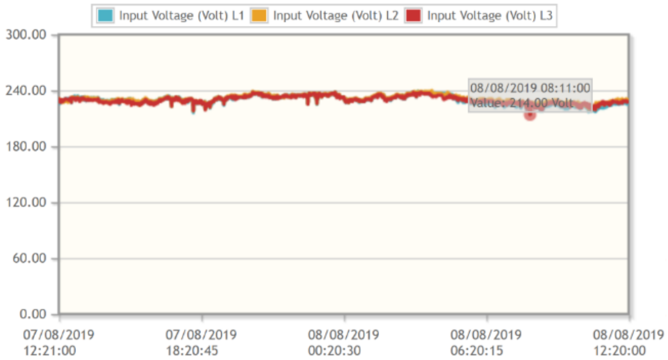

Figure 5. Display of system voltage changes by phases through a report in 24 hours

The following figure shows the temperature movement in 24 hours of one of the UPS, of which there are two in the system located in the Data and network center, which shows the number of UPS systems, for various reasons, whether due to power outage, which would probably be represented by a longer interval of switching on the UPS system or due to the quality of the connected electricity. energy, because the UPS itself, as well as the system, is interactive with the power supply line. energy.

From this report, it is evident that the UPS system was turned on as many as 17 times during the day, which means that only during 24 hours, in the absence of such a system ICT equipment and data were exposed to unacceptable parameters of el. energy, which could certainly negatively affect the reliability of ICT equipment and data corruption. This picture shows us that there are loads in the transformer area that negatively affect the quality of electricity, which can be a great risk for optimal exploitation of electronic components in ICT equipment and potentially causing great damage.

Under such complex operating conditions, manufacturers do not provide guarantees for ICT equipment or reduce them, so it is important to install an adequate uninterruptible power supply system, which in addition to quality, provides power autonomy in case of lack of the same time interval, depending on the level of ICT equipment and services and their optimization.

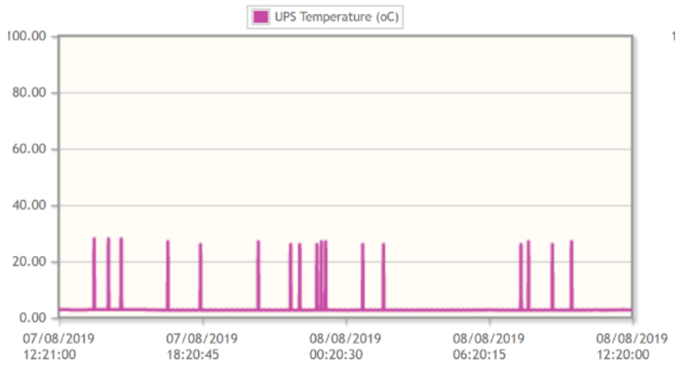

Figure 6. Display of system temperature changes depending on switching on and operation in 24 hours

Concluding Remarks

The implementation of an adequate uninterruptible power supply system, in addition to being prescribed by the relevant legislation related to data protection, as well as standards, can and should provide several benefits that are listed and processed, which have a direct or indirect impact on human security or reliability, ICT equipment, and data. In addition to providing uninterruptible power supply under certain conditions, we also have to achieve measures to combat the negative effects of risk, which is one of the assumptions that our assets in the form of ICT infrastructure and data, as well as people who have daily access to their insurance companies. The problem of ICT equipment is hypersensitivity and the requirement of high-quality el. energy, but also on the other hand the nonlinearity of electronics that generates several negative phenomena that negatively affect the power system, and which the implementation of such a system should be brought to an acceptable framework.

A special problem is the provision and adjustment of appropriate protection against overload and short circuits, the occurrence of which if such systems are not adequately implemented can endanger human life and cause great damage to ICT equipment and data. By applying the system of interactive filtering and stabilization of voltage conditions in real-time, we provide optimal conditions for the operation of ICT equipment. By providing conditions for optimal load by phases and adequate grounding measures, we minimize the equalization current, as well as static electricity, ie. negative impact in case of insulation breakdown, which protects people, ICT equipment, data, reduces electricity consumption. energy, which has a positive impact on the economy and ecology of such a system.

Taking into account all the above arguments, the implementation and adequate application of such systems offer much more benefits, compared to the costs of installing and maintaining them, so from the aspect of economic and environmental criteria should not be questioned. Of course, before the implementation, as in other projects, adequate measurements and analysis or feasibility study should be performed, so that the project solution in this area is not only safe, applying all legal guidelines and standards, but also economically and environmentally acceptable and provide appropriate the level of reliability of ICT equipment and data, but also the security of people who are infrequent interaction with such systems.

Awareness of the need to install such systems in Data and network centers, must not only be for the above reasons, but also for the immeasurable benefits in terms of increasing the safety of people who have daily contact with electricity and who without the protection system are exposed to very serious risks. they can negatively affect their lives and health in various ways.

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