QUALITY OF POWER DELIVERED BY DISTRIBUTION COMPANIES OF EPS

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Abstract: Legal requirements and the requirements of relevant standards are presented in this paper. These requirements are more and more difficult for EPS to fulfill, due to ageing equipment, enormous power consumption, lack of consumer discipline and low power rates. The paper also includes general principles of quality management system and quality management system in distribution companies of EPS, which enable power quality improvement through system approach, process quality improvement and error minimization. The presented quality plan is a strategic document for distribution companies of EPS. It is developed further via mapping of key processes in companies. The paper also presents experience of large foreign power companies as well as suggestions for improvement and monitoring quality of power delivery.

Key words: power quality in EPS, quality management systems, legal requirements, standards

1. INTRODUCTION

Following the establishment of Energy agency and other state agencies, legal acts and regulations as well as technical rules are established, which require stability and high quality of electric power supply. Requirements are becoming more stringent and thereby stipulate sistemic approach.

The consequences of low quality power supply are grave and frequently related to financial and material losses. They are manifested as technological process interruptions, computer memory losses, data corruption, voltage resonance, shortening of operational life in electric machines, cables and equipment, as well as telecommunication and data transfer interference.

Growing demand for high power regulated drives [13], induction furnaces with no dynamic compensation, increased power demand (even during summer months), implementation of various process and other computers [14], protective and measurement devices stipulate quality considerations and require sistemic solutions.

Following the critical period of sistematic erosion (1999-2000), a lot has been done in Electric Power Industry of Serbia (EPS) and its distribution companies in order to recover the electric power system (cca. 120 MEuros have been invested in distribution system in four years) with well known results.

It is still difficult to maintain high quality supply with equipment and facilities 66% written-off and insufficient construction, without improved maintenance, monitoring, control and metrology.

In order to improve the quality of supply, it is necessary to improve quality management system and to integrate processes (planing, purchasing, control, maintenance, construction, quality infrastructure, risk) systematically and with minimum error. Quality management system has been implemented in virtually all distribution companies (former ED Užice and ED Vranje are in the process of implementation). The results should be apparent with support from management and owner and with stimulation of employees.

2. LEGAL ACTS

Modern legal acts and regulations and technical rules are gradualy put to effect in Serbia. The process requires substantial financial support and time investment in order to reflect all requirements in the infrastructure of EPS and its distribution companies.

2.1 The requirements of the Energy Law [3]

The Law states the objectives energy policy and terms of its realization, organization and functioning of energy market, conditions of steady and qualitative energy supply for the buyer, as well as safe, reliable and efficient power generation, control, transmission and distribution, functioning and development of respective systems, terms and regulations of energy generation, energy efficiency and environment protection, and monitoring of compliance to the Law.

The Energy law requires qualitative supply of energy to the buyer, which was not required by previous legal acts pertaining to energy.

Energy policy includes measures and activities geared toward realization of long-term objectives in regard of energy and power, particularly safe, qualitative and reliable supply of energy and fuel, as its first objective and nine other objectives (article 4.).

Energy subject which supplies energy and energy buyer make a contract on the sale, which states the schedule and quality of supply, duties of energy subject which supplies power to tariff buyers in case of quality and continuity failure, and other important matters (article 56. and 57.).

Should any irregularity in energy supply arise, which is not caused by the buyer, the buyer has the right to demand that irregularities be resolved in due time (in 24 hours, 2 days at most) (article 60.). This article does not apply to power interruptions resulting from disturbances in energy market (article 71. and 72.).

After supplying contracted quantity of energy to tariff buyers, energy subject can sell the excess energy on the free electric power market (article 81., subpart 1 and 5). Energy subject performing the distribution of electric energy is responsible for maintenence, functioning and development of distribution system in accordance to the needs of buyers he is supplying. He is also to plan distribution system development for 5 years ahead, including construction and reconstruction of the system and facilities (article 103.).

Steady supply and quality of power supplied is monitored by electric power inspection (along with six other areas of inspection monitoring) (article 152.).

2.2 Bylaw on the terms of electric power supply [4]

This legal act stipulates detailed conditions of electric power supply, as well as measures taken when electric power supply is under threat due to disturbances in functioning of electric power system of of electric power market in Serbia.

The solution granting the right to connect to the transmission or distribution system also refers to quality of transmission and distribution, in accordance to the law, regulations and technical rules in compliance to the law (article 10. point 8).

Energy subject in transmission or distribution of electric power is required to continuously supply energy of suitable quality to the buyer, as stipulated by the law, contract of electric power sale and this legal act. Power interruptions arising from the operation of devices for the protection of electric equipment are not considered as a discontinuity in electric power supply (article 22.).

Tolerated deviation from nominal voltage at voltage levels 110, 35, 20 and 10 kV is ±10%, and at 230/400V also ±10% (with the exception of power failures which have to be resolved as soon as possible) (article 23.).

Frequency in the suppliers network should be 50Hz±0,5Hz (article 24.).

Measurement devices must comply to standards, technical and quality norms (article 44.).

Electric power supply in case of general power shortage is covered (article 20. and 21.).

Energy subject for electric power distribution is responsible for informing tariff buyers on all changes in conditions of electric power supply (article 58).

2.3. Bylaw on the conditions of establishing calibration laboratories for electricity meters [7]

The bylaw stipulates conditions which must be met by the calibration laboratories for electricity meters, regarding employee safety, equipment and workspace.

In addition to other conditions (qualification, equipment, workspace), electricity meters are to be calibrated by direct comparison to a standard (article 4.).

Other methods of calibration may be used until January 1st, 2007 (article 19).

2.4 The law on health and safety at work [6]

This law stipulates terms of enforcement and enhancement of safety and health of persons participating in work processes as well as persons who may be present near workspace, with the objective of prevention of work related injuries, professional and work-related illness.

The law also defines penal clauses. There are 52 penal clauses for the employeer, 8 penal clauses for legal entities and 2 penal clauses for the employee.

„Bylaw on general measures of protection from electric power at work“ (Sl. Gl. SRS br. 21/89) will be in effect until a new legal act is encted, pertaining to articles 15., 18., 43., 49. and 51.

It is apparent that legal acts enacted sofar contain new requirements, and other laws, by-laws and technical rules are pending. All these requirements will have to be addressed in quality

management system documents. This will require significant investment, training, monitoring, corrective and preventive measures.

3. DEFINITIONS AND REQUIREMENTS

Quality of electric power delivered is usually associated with two important quantities: voltage and frequency. Before the Serbian electric power system collapse (in the 1990.-2000. period), quality of electric power was monitored in terms of voltage control, reliability of supply and electric power system stability.

Quality of electric power is determined via the quality of the process of purchasing (control of electric power distribution system) and quality of electric power delivered, which consists of multiple processes (planning, goals, purchasing, control, maintenance, construction, measurement, reporting, internal audit, quality infrastructure, quality improvement and customer satisfaction above all else) [1].

Parameters of electric power quality are:

3.1. Continuity of supply: defined by coefficients (indexes) of reliability:

– number of hours per year when daily peaks are not covered
– generation less than demand
– expected values of undelivered power (no ring supply, weather conditions, protection device action at increased load)
– power interruptions (mulfunctions at critical points, irregular protection device action, old equipment).

3.2 Voltage and frequency deviations

Table 1 presents various voltage and frequency deviations, quality parameters and adverse effects.

Table 1. Electric power quality parameters [12]

Groups of indices		Quality indices	Deformation source	Amplitude, duration, frequency	Negative effects for consumer of type:
Basic parameters		1. Variation of voltage	Overload, maladjusted regulation transformers	>± 10%Un > 1min	All electrical equipment (in the long term)
		2. Varijaion of frequency	Electric power system Overload	> 1min >± 10%fn	Asynchronous motors, clocks, electronics
		3. Asymmetry	Large monophase load, disballance	>± 2% > 1min 5Hz	Three-phase motors, transformers
	Transients	4. Impulses	Atmospheric discharge, connection of load	<15 Un <200ms >5kHz	Computers, electronics
		5. Oscillations	Capacitor connection	<15 Un <50ms 5kHz-5MHz	Computers, electronics
Waveform Deformations	Transient regimes	6. Voltage drops	Motor start	0.1-0.9Un 10ms-1min. 50Hz	Computers, electronics
		7. Transfers	Unipolar short circuit	1,05/1,8Un 20-200ms 50Hz	Computers, electronics
		8. Short voltage interruption	Automatic reconnection	0V 20/500ms /	Computers, electronics
		9. Undervoltage	Planned (voltage reduction) Maladjusted transformers	0,8-0,9Un > 1min 50Hz	Computers, electronics Capacitors, batteries

		10. Overvoltage	maladjusted regulation transformers	1,2-1,4Un > 1min 50Hz	Light bulbs, Motors, insulation, Computers, electronics
		11. Voltage interruption	Network failure	0 > 1min /	All equipment, esp.Computers, electronics
	Steady state ot system	12. Harmonics	Power converters, Regulated drives, Saturation machines, fluorescent lighting	2-55Un 0,3 ms 150Hz-5Hz	Resonance, heating of el. Machines, protection triggering
		13. Voltage drops	Power converters	0.1-0.9Un 0,3 ms 200Hz-300Hz	Computers
		14. Flicker	Steelmills, Arc furnaces, etc.	0.3-2.5Un 0,3 ms <25Hz	Light bulbs, Computers, electronics
		15. Šum	Power converters	0.9-1.1Un 0,3 ms >5Hz	Computers

3.3. EN50160 standard – basic standard of electric power quality [10]

Recommends characteristics of distribution voltage with respect to frequency, quantity, waveform and tri-phase voltage symmetry (table 2)

Table 2. Quality characteristics of distribution voltage, according to EN50160 [10]

Characteristic	Limit values	Measurement Interval	Observation Period	Acceptance percentage
Frequency	49,5Hz-50,5 Hz 47Hz -52Hz	10 s	7 days	95%
Voltage	230V±10%	10 min	7 days	100%
Voltage drops (≤1min)	10-1000 times annualy <85%	10 ms	1 year	95%
Short interruptions (≤3min)	10-100 times annualy <1% Un	10 ms	1 year	100%
interruptions (>3min)	10-50 times annualy <1% Un	10 ms	1 year	100%
Intermittent voltage peaks	U<1,5 kV	10 ms	/	100%
Transient voltage peaks	U<6 kV	/	/	100%
Asymmetry	2% (sometimes 3%)	10 min	7 days	95%
Higher harmonics	<8%	10 min	7 days	95%

4. QUALITY MANAGEMENT SYSTEM PRINCIPLES

4.1 Electric power market opening [2]

Market opening (deregulation) has tightened quality of service requirements and requirements for efficiency improvement in quality management system (QMS) and quality infrastructure (standardization, metrology, accreditation, conformity assessment) [18,8] in electric power and other companies.

In order to attain cost-effective control of distribution companies and customer satisfaction, problems must be dealt with at the point of origin and cause of the problem must be defined and removed in order to prevent its re-occurence (self-assessment model). Corrective measure can not

only refer to problem solution, but must also address the likeliness of its re-occurence in the system by drastic error reduction and attainment of excellence model [16].

Quality management system principles are:

1. Distribution company customer orientation
2. Leadership
3. Employee envolvement
4. Process approach
5. System approach to control
6. Constant improvement
7. Fact-based decision making
8. Mutually advantageous relations with suppliers

Distribution companies improve quality individualy and collectively within EPS. We will address two quality management system principles here: distribution company customer orientation and system approach to quality control.

4.2. Distribution company customer orientation [9,16,1]

Improvements and requirements are as follows:

1. Realization of conditions for steady and qualitative supply to electric power buyers [3,4].
2. Determination of customer requirements resulting from stipulations, such as contracts, legal acts and technical rules.
3. Conducting customer requirements review prior to commiting the distribution company to fulfill them.
4. Brand creation – customer and investor view of the company after its transition from state to regional, national and european level (regional brand, national brand and european brand).
5. Understanding the spectrum of needs and expectations (new markets, new consumers).
6. Harmonizing the balance of needs and expectations of buyers (customers) and other interested parties (owner, employees, suppliers, society), optimization and relations to market regulator (high prices, low prices, interruptions).
7. Measurement of customer satisfaction with supply quality (permanent measurements), reacting in accordance to the measurements and training the employees to aquire knowledge and ability to satisfy buyers (customers).

4.3. System approach to distribution company control [9,16]

System approach is identification, understanding and control of a system comprising several related processes (control of electric power distribution system, maintenance work under high voltage, construction and reconstruction, quality control at customer location and customer satisfaction analysis) for a given aim of effectiveness improvement (ratio of results attained and resources used).

New approach directives of EU (not only directive 2003/54/EC), market position of previously monopolistic companies puts them in a position where they have to apply system approach.
This is reflected in the following:

1. Quality management system efficiency improvement of a company to apply system technology with a minimum of error (see quality plan) and tendency to attain total quality system (TQM).
2. Definition of risk of electric power quality:
    1. Technical risk (system reliability, bad quality, energy shortage)
    2. Commercial risk (high input price, high distribution costs)
    3. Weather derivatives (rain, wind, floods ...) Contracts effect protection fo electric power company of external factors.
    4. Principal supplier bankruptcy in capital object construction
    5. Recognize and designate all interested parties (customers, competition, state, employees, banks, environmentalists)
    6. Regulatory risk – electric power market is regulated (price and conditions are determined by the regulator)
    7. System complexity
3. System definition and development of processes affecting the quality of supply
4. Constant system improvement via measurement and evaluation.

4.4 Legal acts and quality of supply – QMS input

Legal acts and technical rules have not changed drastically in developed EU countries. EU directive 96/92 on electric power market opening has been put in effect in 1996. However, many EU countries have recognized national brand in their electric power companies, and so in 10 years (7 years of EU directive 96/92 and 3 years of EU directive 2003/54/EC application) they have opened only 30% to 50% of electric power market (France, Danmark, Italy, Belgium, Greece, Spain, Portugal, Check Rep., Poland, Ireland, Slovenia).

Developed electric power companies have introduced, applied and improved quality system and quality of supply at the time when first steps toward introduction have been made in Serbia in year 1995. They have had then and now still have a very highly developed quality infrastructure (well known internal standards of french EDF).

4.4.1. Energy law [3]

This law, related to the quality of supply, stipulates orderly and qualitative supply of power to the customer.

Reconstruction/revitalisation of power installations of EPS and its distribution companies has not been completed yet (distribution companies have invested 120 million Euros in four preceding years). Investments have been delayed due to low price ov electric power, and insufficient funds were available for joint investments with consumers.

Our electric power (we generate it) is of the same quality as the power of developed electric power companies. Now, insted of exporting it and realizing 378 million Euros in year 2005. (production plan and realization in 2005.), social concern and low price resulted in enormous consumption and the need for importing electric power for another 36 million Euros.

Would we become national brand with 378 million Euros and how much could be invested in electric power quality (see quality plan) ?

It would be much easier to comply with the law regarding the quality of supply and we would not have to constantly fight suggestions to dismember EPS.

We are very well aware of bad privatizations (Hungary went with fast privatization, then its state nuclear power plant leaked, Check Republic sold, then bought its companies back, Slovakia sold its electric power company for 840 million Euros, Macedonia sold its distribution for a little over 200 million Euros).

Uncontrolled privatization can not improve the quality of supply, because profit is extracted, the price hikes, nothing is invested in development, greed sets in and the collapse of electric power system follows (California – the most developed state in the world, Italy ...).

4.4.2. Bylaw on the conditions of electric power supply

Conditions of quality of supply were given in part 2.

The bylaw has been in effect since January 1st, 2006.

It is still difficult to comply with all the stipulations of the bylaw with cca. 66% written-off equipment and installations and insufficient construction of electric power installations and infrastructure.

EPS and its distribution companies have mobilized majority of their personnel (in last five years). Continuous work and dilligence have produced respectable results (with frozen salaries and minimum stimulation, with no housing policy) but still a lot of work remains to be done, to bring the voltage from 180V to 230V ± 10% (conditions of the bylaw).

Other quality parameters of supply have been included in distribution companies' quality management system and will be permanently improved.

4.4.3. Law on safety and protection at work [6]

Legislative acts in this area is very important for distribution and other companies of EPS, because of the need to work under high voltage and because of very steep fine policy (60 punishment clauses for the employer but 2 for the employed).

Work under high voltage, along with internal standards, legislative acts, equipment purchasing and training, is one of important segments of supply quality improvement, in particular for reducing interruptions of supply.

4.4.4. Bylaw on conditions for establishing calibration laboratories for electricity meters [7]

Dsistribution companies posess 25 calibration laboratories for electricity meters. None of them is acredited, and one of the reasons for that is their organisational positioning outside quality system. This also holds for measurement transformers and protection devices. It is not sound for 25 laboratories to rely on one laboratory outside the distributions or on laboratories which conduct no type tests. Apart from accuracy class, electricity meters and measurement transformers must undergo type tests.

Greek electric power company has 16 independent acredited labiratories, Kolubara Metal will soon have four acredited laboratories, TENT two laboratories and RB Kolubara one laboratory. All these laboratories conduct service and process measurements.

We look forward to faster developments in metrology (Institution for measurement and precious metals has joined European metrology organization), primarily because of supply quality and reduction of losses due to old measurement equipment.

5. QUALITY MANAGEMENT SYSTEM IN DISTRIBUTION COMPANIES OF EPS [1]

Until year 2000, quality system according to international standard ISO 9001:1994 has been introduced in Elektrovojvodina Novi Sad, Elektrodistribucija Beograd and Elektrošumadija Kragujevac. Activities have been continued, in introducing and certifying quality management system in accordance with ISO 9001:2000 and acompanying standards. Present status is presented in Table 3.

Table 3: Present status in introducing and certifying quality management system in distribution companies of EPS

company	Company division	Certified system	On-going project
EDB		QS (2001/SZS)	QMS
Centar	El.šumadija	QS (2002/SZS)	QMS
	El.morava	QMS (2005/TUV)	
Elektro-srbija	El.srbija	QMS/2006	
	ED Užice		
Jugoistok	ED Niš	QMS (2005/TUV)	
	ED Vranje		QMS
	ED Leskovac	QMS (2005/TUV)	EMS, OHSAS
	Elektrotimok	QMS (2005/TUV)	EMS ,OHSAS
Elektrovojvodina		QS (1998/SGS) QMS (2004/SZS,TUV)	EMS

Introduction, documentation, application and maintenance of supply quality is conducted within the quality management system.

5.1 Objectives for supply quality improvement are:

1. Employees focus on satisfying customer/buyer requirements
2. Implementation and application of legal acts, rules and standards
3. Improvement of existing best practise
4. Improvement of existing processes (purchasing, input/output quality control, control, maintenance, construction, informatics and telecommunications, metrology, customer satisfaction and support processes) and of the system as a whole
5. Improvement in understanding electric power quality requirements
6. Reduction or ellimination of effects of problem areas on supply quality
7. Requirements of the founder, stockholders, agencies, operators, syndicate, ...
8. Enlarging the profit of the company

5.2. Realisation phases are:

1. Electric power qualitz improvement planning
2. Education and training
3. Analysis of gap between present status and status in developed electric power companies of EU-countries
4. Process screening and documenting for quality of supply
5. Document implementation
6. Internal audit and top management review
7. Implementation of corrective and preventive measures

8. Maintenance and continuous improvement of supply quality

5.3. Some technological and business parameters indices

9. Length of distribution network – 137.923km
10. Transformer power - 25.082 MVA
11. Total number of employees – 11.418 (15.635 in year 2000.)
12. By far the lowest electric power prices in the region, up to 3,3 Ec/kWh until year 2005 for households (7,7Ec/kWh in Croatia) and the same for direct consumers
13. High indebtedness.
14. Brain drain, with very slow recovery
15. Productivity in EPS distribution companies is 1/3 to 1/2 the productivity in EU-countries
16. Steady increase in consumption (also during summer months) due to low price
17. Losses in distribution network are 14.42% (16,31% uin year 2001) whereas the expected level is 10%
18. 18. In the period between 2002. and 2005. 120 million Euros have been invested in revitalisation/reconstruction of distributive electric power facilities.
19. Planned investment in construction in year 2005.:
    - 8 transformer stations 110/x kV (between 1990. and 2000.g. 8 stations have been built)
    - 15 transformer stations 35/x kV, 360MVA
    - Cca. 1350 mid-voltage transformer stations, 540MVA (4% of existing number)
    - 32 km of power lines 110kV (526km in y. 2000)
    - Cca. 640 km of low-voltage power lines
20. The level of investing in construction between year 2000 and year 2005 was restricted with respect to distribution companies requests
21. Increase in the degree of payment to 87% (about 70% in year 2000)
22. Business operations rationalisation brought significant savings
23. Installations and equipment are 66% written-off.

6. PLAN OF QUALITY OF ELECTRIC POWER DISTRIBUTION [1]

6.1 Responsibility matrix

Responsibility matrix is very important in quality management system, as it defines responsibility for:

– management responsibility - director
– quality system – director's assistant for quality
– electric power purchasing – technical, commercial part
– electric power quality control – technical part
– supply identification and traceability – technical part
– consumption planning – technical part, investment
– construction of electric power equipment – technical part, investment
– quality testing and control – technical part
– metrology - director's assistant for quality
– electric power supply control – technical part
– supply non-conformance control – technical part, quality
– internal audit - director's assistant for quality
– corrective and preventive measures - director

6.2. Quality control of electric power supplied

For electric power delivered, values of voltage and continuity of supply are constantly measured and recorded. Modern electricity meters detect presence and measure the level of harmonic distortion, voltage peaks and drops in given time period. Measurements of this kind should be included in procedures, as in some parts of distribution network even 110kV network is "dirty" which is inadmissible.

6.3. Quality controlling at consumer's site

At present time, this is done by checking the voltage and load, but measurements of maximum and minimum voltage, power factor and network "contamination" (from the distribution side or from

consumer side) must be added. Controlling is done in accordance with the procedures, following a report or customer request.

6.4. Invoice for electric power controlling

This part is included in procedures and is in continualy used and improved.

6.5. Nonconformance appraisal

Nonconformance of calculation is superbly covered by quality system and it is successfully applied.

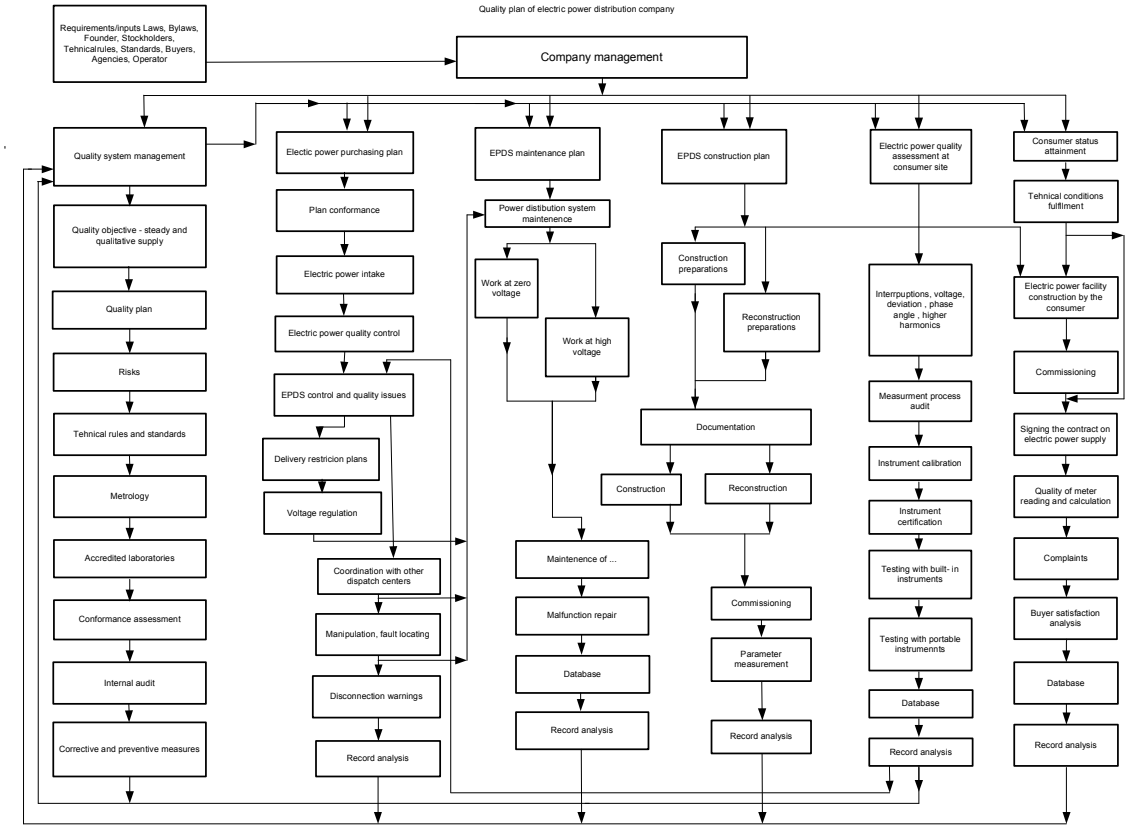
6.6. Dealing with nonconformities

This has been covered with quality procedures and requires taking action from system input point to the output.

6.7. Metrology [18]

A lot remains to be done, legislation is tight, while not one calibration laboratory of 25 owned by EPS is acredited.

Table 4. Quality plan of electric power distribution company



7. FOREIGN EXPERIENCE

7.1 Quality plans [16]

Quality control is organized as follows:

– measurement and analysis of customer satisfaction related to electric power quality

– quality control of electric power purchasing, electric power distribution system, maintenence, construction

– minimum request definition
– quality parameters application in system planning
– systemic measurements and statistic data processing on voltage and current quality
– determination of interruption in electric power supply (the number of long and short interruptions, mean time of interruption, annual undelivered electric energy)
– availability of information on measurements, metrological traceability and documentation
– taking part in the process of legislation, lobbying for optimal solutions

7.2. Supply quality improvement [16]

Before the EU-directive EC96/92:1996 became effective, new policy in network and supply quality has been realized. The planned quality level in French electric power network (Edf) in year 1995 was that no consumer at low voltage experience (or be subjected to):

a. more than 6 long interruptions
b. more than 3 hours of total interruption
c. more than 70 short interruptions (1 sec) or 30 interruptions (1 sec – 1 min)

In that period, a number of technical measures have been taken to realize the stated goals (maintenance system was improved, most critical parts were replaced, ring supply has been implemented, remote control system was upgraded, ...) which resulted in reduction of total annual down time to cca. 1,5 hours. 95% of consumers are supplied at continuity better than the stated "minimum quality level" and improvement is still demanded. Duration of total down time in supply (planned and emergency interruptions) for low- and mid-voltage is monitored.

Following electric power market opening, the requirements for supply quality have became even more stringent (especially after opening of the market in Germany and G. Britain), along with more demanding EU-directives, technical rules and quality standards, quality management systems and quality infrastructure. Attitude and satisfaction of customers is monitored and analyzed, competition is also monitored and analyzed, and optimal mesures are decided upon based on facts. Management must demonstrate its support and dedication to quality policy, quality objectives and their realization.

8. CONCLUSION

As new legal acts take effect (2,3,4,5,6,7,8), requirements for electric power quality become more stringent and EPS will find it progressively more difficult to fulfill them with old equipment, huge consumption and low price.

For quality improvement in electric energy supply systemic action is necessary, through quality management system. Improvement of all processes and comprehensive error minimization would improve quality and prepare distribution companies to enter (with other EPS companies) the stiff market competition. Quality plan is a strategic document for distribution companies of EPS and it is detailed by mapping the key processes in the company. Its responsible application and objective internal audits attain significant improvements in company's business performance and electric power supply quality.

Transition shock, restructuring and lowest price of electric power in the Balkans have not stopped EPS companies in formin national brand and enter regional electric power market. However, still a lot needs to be done in electric power supply quality improvement.

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