Power Quality Work
at the International Electrotechnical Commission

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Significance
Part 6: Tutorials, textbooks, and reviews

A brief historical review of how Power Quality issues were addressed in the mid-nighties, in particular the launching of a working group charged with developing a standard on the measurement of power quality parameters including instrumentation and procedures.

POWER QUALITY WORK AT THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Abstract

The paper presents an update, including a brief historical background, on the work to be undertaken at the International Electrotechnical Commission (IEC) to address power quality issues. To be useful, this work must take into consideration the three principal stakeholders, namely the producers of electric power, the manufacturers of equipment that use electric power, and the users of that equipment. Other stakeholders include manufacturers of power quality monitors, manufacturers of line conditioners, and power quality consultants. At this time there are some differences of perceptions on how the work can be accomplished to best serve the interests of all stakeholders. Nevertheless, there is no disagreement on the first goal to be reached, which is to catalyze development of compatible, comparable, and consistent results in the measurement of power quality parameters.

Introduction

In a landmark 1996 decision, the Committee of Action of the IEC approved a recommendation to undertake work on power quality issues as part of the scope of Technical Committee TC77 on Electromagnetic Compatibility (EMC). This decision, recommended by an Ad Hoc Group composed of power quality experts from ten countries, marks an expansion of the scope that will then reach beyond the purely technical issues generally addressed by the EMC community. Power quality and EMC share many concerns, to the point that each has at some time been described as being a subset of the other. In addition to this fundamental aspect, other issues permeate any discussion of power quality. It would be more accurate to draw a multi-dimension diagram with many overlaps (see Figure 1). The Ad Hoc Group considered three areas of contributions which an IEC Power Quality Group could make, complementing the work currently done by existing working groups or project teams of TC77:

- Bringing order to the present chaos of uncoordinated methods of monitoring power quality
- Proposing a classification of power quality levels describing what end-users can expect
- Building bridges among producers and users of electric power, and equipment manufacturers

Concerns have surfaced that undertaking such work might ultimately result in the development and imposition of standards on the quality of "electricity as a product" and create an adversarial relationship, where for the moment the emphasis is on cooperation. There is a need to reduce these concerns by defining more clearly the objectives and work program of this new IEC activity.

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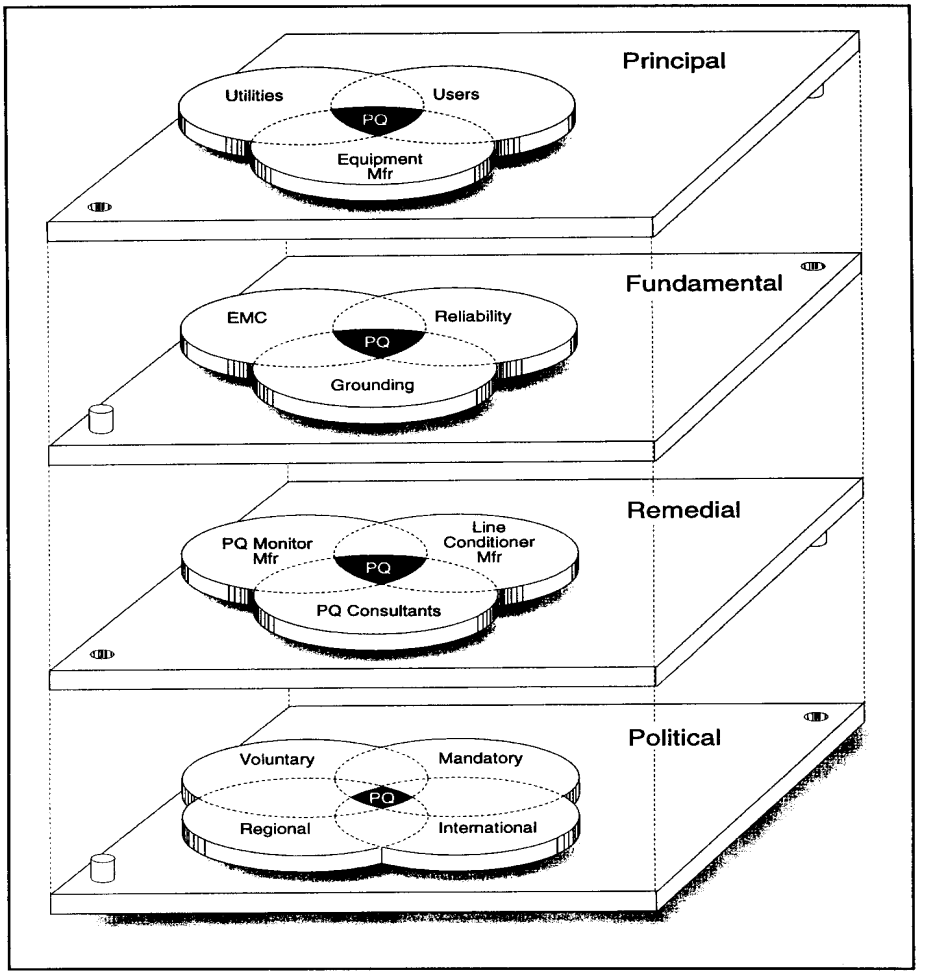

Power quality issues involve overlapping stakeholders' interests or technical aspects in many domains. In this figure, four domains are represented as planes in an exploded view, showing how for each domain, developing a Power Quality (PQ) document will involve overlapping topics and draw upon the interests and expertise of the stakeholders. A successful development will integrate all topics in each domain, and consolidate all domains into one entity. (Note how the artist has provided registration pegs on the planes so that the re-assembly will be a good fit !)

Figure 1 - The many dimensions of power quality issues

Power Quality in Other Organizations

The term "Power Quality" first appeared in the U.S. literature in the late seventies [1,2,3], used at first by the computer-user community in a somewhat negative context, as it seemed to be associated with anecdotes or complaints of malfunctions attributed — correctly or incorrectly — to "poor power quality." At the beginning, there was a tendency to look for a culprit, the users blaming the electric power being supplied to them, and the electric power supplier blaming insufficient immunity of the equipment to unavoidable disturbances.

Even when a solution was indeed in sight, there remained among some stakeholders some reluctance to assume the cost of correction, and attempt to pass it on to the other stakeholder(s). The "boundary" of the stakeholders was often defined as the revenue meter, as if electrons would change their behavior when going through the current coil of the meter.

Technically sound and economically viable solutions will depend on the cooperation of three principal stakeholders:
- Producers of electric power;
- Manufacturers of equipment that uses electric power;
- Users of equipment that uses electric power.

Perhaps not immediately obvious, but three other important stakeholders in correcting power quality problems are:
- Manufacturers of power quality monitoring instruments;
- Manufacturers of line conditioning equipment;
- Consultants called upon to solve power quality problems.

Considerable progress has been made since the early days in bringing the parties together to seek mutually satisfactory solutions rather than hunt for culprits. The PQA conferences held in the last several years are a good indication of this change of mood and mode. We now hear the word "interface" more often than the word "boundary" suggesting that disputes are being replaced by constructive dialog. The term and concept of "System Compatibility" have also become more visible [4, 5, 6, 7], with the goals of the utilities defined as making their customers satisfied and helping customers to be more competitive, rather than merely supplying them with electric power.

Many electric utilities have instituted power quality programs in their customer services, some as a defensive or reactive step, others as a proactive and marketing strategy. Engineering societies have also focused on practical, application-oriented power quality issues, while initially the standards activities were slow in reacting to the growing interest in those issues. Since then, several organizations have established power quality programs for developing standards or contributing to the development of standards, including the Canadian Electricity Association (CEA)[8], the European Committee for Electrotechnical Standardization (CENELEC)[9], the Electric Power Research Institute (EPRI)[10], the Institute of Electrical and Electronics Engineers (IEEE)[11], and the International Union of Producers and Distributors of Electrical Energy (UNIPEDE)[12]. All of these organizations have allocated substantial resources to address power quality issues.

One of these issues in particular is the incompatibility found when attempting to analyze and compare the results of power quality surveys based on different definitions or measurement methods [13, 14, 15]. This incompatibility is rooted on different definitions of disturbances, and hence different algorithms in the software of power quality monitoring instruments. Eliminating these incompatibilities is one of the prime motivations for the proposed IEC work that will first focus on measurement methods.

Power Quality vs. Voltage Quality

At the risk of oversimplification, one can identify two different approaches to addressing power quality issues on the two sides of the Atlantic Ocean. In Europe, attention seems to have focused on the "***voltage*** quality" while in North America, the concerns fell under a broader umbrella of "***power*** quality." While the difference may seem to be a mere linguistic subtlety between the U.K. English which is the official English of the IEC and the U.S. English which is the unofficial English of the IEEE, the words also reflect a difference in perspective. In French, the second official language of the IEC, one finds the label of "qualité de la tension" (tension = voltage), reflecting the emphasis on voltage. Perhaps as a result of this difference of perceptions, the few existing bilingual IEC documents on the subject have not yet provided a satisfactory equivalent in the two languages

An anecdote can best illustrate this subtle perspective difference: in what the U.S. community would recognize as a power quality pamphlet influenced by the European Community, the untranslatable caption of a cartoon from Electricité de France, "***Bien vivre avec sa tension***" (Figure 2) proposes the double-entendre of learning to live with "tension" — understood as the blood pressure of the end-user, or "tension" — understood as the system voltage. Hopefully, there will not be a triple-entendre where the word "tension" would refer to a sag, or to strained relations among the three principal stakeholders, resulting from concerns over the forthcoming IEC work on power quality issues. The caption of Figure 2 is an attempt at providing in the power quality context a culturally-equivalent rendition of the French for an English-speaking audience.

Courtesy: Electricité de France

Figure 2 - Live long and prosper with your power quality

Somewhat in contrast with the emphasis on voltage — but certainly not in conflict — the U.S. perspective has included more than just supply voltage in the power quality issues. An often-cited statement in power quality articles is "... 83% of the alleged power quality problems are actually end-user wiring problems" and one article even shows a screwdriver as "the primary tool for solving power quality problems." This broad perspective is also illustrated by an IEEE standard, part of the ***IEEE Color Books*** series, on powering and ***grounding*** for sensitive loads [11] which is clearly related to power quality issues.

Satisfactory Operation vs. Voltage Quality

During the proceedings of the IEC Ad-Hoc Group meeting held in April 1996, interesting discussions took place among the participants on their respective proposals for a definition of power quality — a necessary prerequisite to undertaking work on the subject. A compromise consensus emerged so that the group would be able to present a recommendation for action where the terms would be defined. One of the proposals had emphasized the voltage parameters, while another proposal had related power quality to satisfactory operation of the user's equipment. The resulting definition, cited below, still reflects these two points of view:

> ***Power Quality*** *- Set of parameters defining the properties of the power supply as delivered to the user in normal operating conditions in terms of continuity of supply and characteristics of voltage (symmetry, frequency, magnitude, waveform).*
>
> ***Note 1****: Power Quality expresses the users' satisfaction with the supply of electricity. Power Quality is good if electricity supply is within statutory and any contractual limits, and there are no complaints from users, and vice-versa it is bad if the power supply is outside of limits and there are complaints from users.*
>
> ***Note 2****: Power Quality depends not only on the supply but can be strongly affected by the users' selection of equipment and installation practices.*

It will be one of the tasks (challenges?) of the group working on the forthcoming documents to allocate appropriate attention to the two points of view rather than to consider them as mutually exclusive.

Forthcoming IEC Work on Power Quality

The approach now being considered by the IEC is to initially limit power quality work to measurement methods, and perhaps even to a narrower limit of characterization of voltage parameters. Starting with measurement methods certainly is a necessity to get the work under way and ensure that all parties speak the same language when discussing power quality parameters. However, stopping there, useful as it may be to catalyze compatible dialog between producer and consumer of electric energy (***power***) will not be sufficient to fulfill the expectations of equipment users. From all the fuss about power quality being addressed at the IEC, they expect that more satisfactory operation of their equipment will be facilitated by the commitment of resources now envisaged by contributors to the IEC process, and that objective and reliable guidance will be found in the new documents.

As mentioned in the Introduction, an Ad-Hoc Group of representatives from several national or international organizations and committees developed a recommendation to begin work on power quality, starting first on measurement methods. This priority is a recognition of the present uncoordinated efforts among dedicated, but isolated, organizations which have produced incompatible or contradictory results among power quality surveys conducted by different organizations. The decision by the IEC Committee of Action to accept the recommendation developed by the Ad-Hoc Group has now cleared the way for ***New Work Item Proposals (NWIP)***, the method used by the IEC to launch the development of new documents, to be submitted to the IEC National Committees for approval.

As of the writing of this paper two NWIP proposals have been circulated. One, originating from the French National Committee, has the title "Measurement Guide for Voltage Characteristics" while the other, submitted by the U.S. National Committee, has the title "Power Quality Measurements" again reflecting the difference in perspective. The French proposal somewhat mirrors the UNIPEDE [12] approach while the U.S. proposal includes all the topics listed by the Ad-Hoc Group as well as a reference to the IEEE Standard 1159 [16]. The French proposal concentrates on low-frequency disturbance characterization, including power frequency, voltage magnitude, voltage fluctuations, voltage dips, harmonic voltages, and signalling voltages, but downplays transient overvoltages (surges). It also makes several references to "Compliance with EN 50160"[11] which might be seen as leading to mandatory clauses. The U.S. proposal includes a comprehensive list of disturbances, suggests tutorial clauses on definitions and origins of disturbances, and even the possibility of providing some tutorial material on remedial or preventive actions. Both proposals follow the Committee of Action decision that Technical Committee TC77 should be the principal responsible committee for this work, in coordination with Technical Committee TC8 (Standard voltages, current ratings and frequencies).

The officers of TC77 are on record as recommending that the two proposed projects be merged into a single project since it is clear that both proposals share the same goal of developing compatible, comparable, and consistent results in the measurement of power quality parameters. The responses from the National Committees will not be compiled before late June 1997, but some responses will be known by the time of presentation of this paper. Hopefully, the responses will be positive and the paper presentation will include an update on the project planning.

Conclusions

- The first step has been taken at the IEC to start working on the development of documents addressing power quality issues.
- The challenge will now be to proceed diligently to satisfy the needs of end-users and not have the work stalled by the difficulties of reaching consensus among many stakeholders.
- The decision to start with measurement methods will enable development of a common language and build a working relationship among the participants which should promote continuing progress toward technically sound and cost effective solutions for the problems perceived — correctly or incorrectly — as power quality problems encountered by end-users in the equipment operation.

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