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„Towards Voltage Quality Regulation in Europe“

Comments by VEÖ

Part A – General Remarks on the Main Text of the Paper

1. VEÖ is open for discussion for further improvement of EN 50160 as such development has been strived for in close co-operation with the manufacturing industry during all the time since the first ratification of this standard on 5/7/94.
2. According to its given task, the actual EN 50160 does not give binding limits, but values expected not to be exceeded for a given percentage of time in normal operating conditions, at every delivery point across Europe. It would be contradictory to the nature of technology and no reason is recognizable, why the probability principle should be left.

   Further on, no contradiction is given between the application of probability parameters (whatever the values be chosen) and normal operating conditions.
3. The proposed changes in the evaluation methods for slow voltage variations and the assessment of related measurement results vs. the standardized values for the operational voltage around the nominal voltage would imply severe needs for investment in grid reinforcement and would thus cause considerable additional costs for the end customers.
4. Any specification of more constraining values in EN 50160 would result in the need for a more or less comprehensive review of the existing EMC standardization building, as the emission and immunity performance of equipment and systems is the primary basis for the PQ situation in electricity supply networks. If the efforts to realize new PQ requirements should not affect the network operators solely, that would require for a comprehensive review of the existing EMC standardization building before discussing new values for EN 50160.
5. There is no technical connection between the quality of grid maintenance and the quality of voltage (or: power quality - PQ). Therefore, besides the financial burdens due to any measures for increasing the PQ level, such measures would not be followed by any change in the level of continuity of supply – and vice verse.
6. The present document does not provide evidence of a more stringent EN 50160 resulting in any enhancement of voltage quality, security of supply or maintenance levels in the electricity grids.
7. National diversification of PQ specifications in EN 50160 – as being proposed in the document -- would be contrary to any harmonisation efforts by the EU and the manufacturing industry; it would therefore result into additional costs for the end customers.
8. Requiring for a minimum value of short circuit power at the point of connection, as proposed indirectly in the paper, would trigger severe investments and cause additional costs for the customers. Technically, this measure does not imply better PQ for all customers.
9. An EU-wide harmonised application of main continuity indices including a harmonised definition of major event days is supported by the VEÖ. However, these indices are not linked to PQ in the technical sense (see statement 1).
10. We cannot see any need for and advantage of general, permanent, and exhaustive PQ monitoring. Any tendency to monitor the PQ extensively would trigger the needs for investment into sophisticated measurement systems and their continuous maintenance that would have been available for structural grid improvements otherwise.

ad 1: VEÖ is open for discussion for further improvement of EN 50160 as such development has been strived for in close co-operation with the manufacturing industry during all the time since the first ratification of this standard on 5/7/94. The present document does not provide evidence of a more stringent EN 50160 resulting in any enhancement of voltage quality, security of supply or maintenance levels in the electricity grids.

This development of EN 50160, together with the manufacturing industry, led to a first revised edition in 1999, some further three amendments and, last actually, to a 2nd revision which has been voted by December 2006. The voting result shows broadest consensus across the 29 CENELEC Member States.

When discussing changes, any modification has to be examined concerning its economic impact on all market participants and its appropriateness for the society who would have to pay for additional costs – what is to be done before implementing modified specifications; that being conform with what is said in the ERGEG paper on p. 9, last para.

ad 2: According to its given task, the actual EN 50160 does not give binding limits, but values expected not to be exceeded for a given percentage of time in normal operating conditions, at every delivery point across Europe. It would be contradictory to the nature of technology and no reason is recognizable, why the probability principle should be left.

Further on, no contradiction is given between the application of probability parameters (whatever the values be chosen) and normal operating conditions.

The paper states that the EN 50160 limits "do not constitute a good reference for voltage quality in most European countries", implying that the quality is generally better. If that would prove true, we would not see any reason to take action.

According to its given task, EN 50160 describes the PQ situation in European electricity supply networks, specifying values for several PQ parameters which are – as also said in the ERGEG document (p. 11 & 12) – expected not to be exceeded (p. 11) respectively being very rarely exceeded in Europe for a given percentage of time in normal operating conditions; it was not the task of EN 50160 to set limits with binding character, but what has been done later on with the Un +10/-15% values for slow voltage variations. So, conform with the task having been given by the European Commission before, the EN 50160 values represent envelopes of the PQ situations per phenomenon in such a way that the described PQ level can be expected to be offered at every supply terminal throughout Europe, that with some probabilistic character per value.

Thus, a probabilistic parameter such as the discussed 95% clause in EN 50160, e. g. for slow voltage variations, is not an arbitrary value, but is rather related to the way the established electricity supply systems works. This is also the answer to question 7.b. (P. 37) "How to consider random year-by-year variations in setting limits especially for voltage dips and other events correlated to weather influence?": This variation is being considered in EN 50160.

Further on, this application of probability parameters to the EN 50160 values is based on an economic optimum consideration, as any change to more stringent specifications would result in costs for supply network measures. Attention may be drawn that any intention for setting 100%-values is realizable – with increased values compared with the recently specified ones in general. Setting more stringent values, either by reducing the averaging time, the observation period or by lowering the absolute values would in no case change the PQ reality, but imply more or less huge investments to be made by the network operators and finally to be borne by all customers. The costs, which some single specific customers with higher sensitive equipment may afford for a PQ better than such one according to EN 50160 would be socialized to be borne by all customers, what appears as not justified.

From our point of view, there is no contradiction between the application of such probability parameters and normal operating conditions. As mentioned above, the application of probability parameters results from considering the nature of technology and economic optimization; the restriction to normal operating conditions results from considering extraordinary events, as being described in the Scope – and possibly further improvable --, and therefore from impacts to the network which are out of the network operator's control. It cannot be the task of a standard like EN 50160 to set limits with a 100% status for such operating situations.

Economically, there is no possibility to exclude the case of a dip below a certain voltage value in a shared power system unless each of the customers has a separated, heavily over-dimensioned physical supply. A typical example is that any household possesses electrical equipment exceeding the installed connection capacity by far and the average load power by high factors. It is – from the economic point of view – entirely infeasible to re-dimension the entire European electricity supply system aiming at absolute security on the voltage margins.

We would like to add that the political will to bring forward the repartition of renewable sources in the distribution grids will certainly necessitate the application of probabilistic considerations on power flows and voltage bands in the future and any attempt to fix them to absolute values would be counterproductive in this respect.

ad 3. The proposed changes in the evaluation methods for slow voltage variations and the assessment of related measurement results vs. the standardized values for the operational voltage around the nominal voltage would imply severe needs for investment in grid reinforcement and would thus cause considerable additional costs for the end customers.

Concerning the voltage band, EN 50160 contains a 100%-clause (+10/-15%). The probabilistic clause for the band between +10% and -10% for 95% of the 10min-intervals of any observation period of one week introduces a margin into the calculation procedure that reflects non-standard circumstances. Grid operators cannot influence the behaviour of the customers directly and therefore at the system planning stage, probabilistic weighting of absolute values depicts stochastic behaviour of customers.

The argument in section 4.2, p.28, saying that *"according to EN 50160, for 8 hours every week, there can be severe voltage deviations in the supply voltage without exceeding the standard"* is fundamentally misleading, since it implies that this temporal repartition is typically not sectioned in separate periods, but takes place in a specific period of time.

The proposed reduction of the averaging interval from ten minutes to one minute is not consistent with other definitions, e.g. the widely used 3-minute-value for the distinction between short and long interruptions. The example in Figure 2 is quite unrealistic, however, we have identified that there is potential for measurement results increasingly being incompatible with the current voltage band when applying 1-minute-averaging periods. Related investment needs due to such a change are estimated as being in the range of several tens of some B€ only for Austria -- we suppose that in less developed countries, it would be higher in the order of magnitudes -- and probably of some hundred B€ for all Europe.

Figure 5 (p.29) is extraordinarily misleading, since it implies that within the 10-minutes – averaging interval, according to EN 50160 "everything is possible (blue shaded area)". Indeed, the measuring interval does have an impact on the maximum and minimum voltage values recorded, but this quantization error is also present if the averaging interval is one minute. Switching events and other transients would therefore also not be registered by the PQ recorders.

ad 4: Any specification of more constraining values in EN 50160 would result in the need for a more or less comprehensive review of the existing EMC standardization building, as the emission and immunity performance of equipment and systems is the primary basis for the PQ situation in electricity supply networks. If the efforts to realize new PQ requirements should not affect the network operators solely, that would require for a comprehensive review of the existing EMC standardization building before discussing new values for EN 50160.

EN 50160 has been worked out with some view to the EMC (emission, compatibility, immunity) standards published by IEC and harmonized by CENELEC as European EMC standards (IEC IS / CENELEC EN 61000 series). These EMC standards have been worked out since around three decades. They are representing a well proven standardization building, and EN 50160 is somehow relating to these standards – in particular to the compatibility standard, which itself is in close relationship to the emission and immunity standards.

Regarding the fact, that the EMC performance (emission, immunity) of electrical equipment and systems connected to the supply network

- is primarily responsible for the PQ situation in the related supply network
- is designed following to the related specification of the 61000 series

it appears as being self-evident, that any modification to EN 50160 values would need modifications to the EMC standards at the same time.

Indeed, it would be wrong to require such changes to the EMC standards at the same time than to do so some time in advance. This can be easily understood when considering the time delay between the implementation of a new EMC standard, its coming into force, new electrical equipment and systems meeting the new limits and old electrical equipment and systems disappearing from the market and users' applications.

If EN 50160 should be modified to more constraining values and the efforts to realize new PQ requirements should not affect the network operators solely, before discussing new values for EN 50160 would require for a comprehensive review of the existing EMC standardization building.

ad 5: There is no technical connection between the quality of grid maintenance and the quality of voltage (or: power quality - PQ). Therefore, besides the financial burdens due to any measures for increasing the PQ level, such measures would not be followed by any change in the level of continuity of supply – and vice verse.

On p.4, the paper states indirectly that there is potential for PQ deterioration with time. This argument is neither explained nor technically consistent. Regarding the PQ situation in EU countries as of today, we got the impression that Europe is facing a quite heterogeneous situation of PQ levels; therefore in some countries the task should be to strive for upholding the recently given level, while in other countries some improvement were to be strived for.

Market liberalisation and the activities of regulatory authorities indirectly affect long term interruptions mainly. We do not see any correlation between network maintenance and short interruptions or waveform distortions, as examples for typical PQ issues.

Continuity indices, for which harmonisation on European level is strictly supported by VEÖ, are not connected with the topic of PQ either.

ad 6. The present document does not provide evidence of a more stringent EN 50160 resulting in any enhancement of voltage quality, security of supply or maintenance levels in the electricity grids.

To be stated and to be considered together with comments 3, 4, 5, 7, 8.

ad 7. National diversification of PQ specifications in EN 50160 – as being proposed in the document -- would be contrary to any harmonisation efforts by the EU and the manufacturing industry; it would therefore result into additional costs for the end customers.

There is no evidence that any advantage might result from PQ standards, diversified across Europe except for lowering the PQ standards in some more developed countries related to PQ, such as Germany, Switzerland, The Netherlands or Austria in the long run. On the contrary, equipment manufacturers would have to raise prices due to diversified immunity levels needed for their products.

We suggest that independent measurements in randomly selected sites be executed in all member countries to check the conformity with EN 50160, especially the ones with strict regulatory PQ limits.

Consistent with the interest of ERGEG to harmonize the definition of long interruptions (p.4), we do not believe that a standardization of PQ on a national basis can be a viable option.

ad 8: Requiring for a minimum value of short circuit power at the point of connection, as proposed indirectly in the paper, would trigger severe investments and cause additional costs for the customers. Technically, this measure does not imply better PQ for all customers.

There is no direct technical connection between the power quality in a network and its short circuit power; rather it depends on the electrically surrounding customers and their (stochastic) behaviour.

Moreover, voltage disturbances are more likely to be transported to geographically distant sites in networks with low reactance. Therefore, we state that absolute values of S_k" cannot be put into a relation with the PQ to be expected at a given location in the system. A case-to-case assessment is generally more useful.

ad 9: An EU-wide harmonised application of main continuity indices including a harmonised definition of major event days is supported by VEÖ. However, these indices are not linked to PQ in the technical sense.

See statement 5.

ad 10: We cannot see any need for and advantage of general, permanent, and exhaustive PQ monitoring. Any tendency to monitor the PQ extensively would trigger the needs for investment into sophisticated measurement systems and their continuous maintenance that would have been available for structural grid improvements otherwise.

Regarding the PQ situation in EU countries as of today, we got the impression that Europe is facing some heterogeneous situation of PQ levels; therefore in some countries the task should be to strive for upholding the recently given level, while in other countries some improvement were to be strived for.

The present ERGEG document does not give any information how it is envisaged to deal with the before-mentioned heterogeneous situation when setting more constraining specifications in EN 50160.

As stated above, we support measurements checking the actual PQ situation in the grids with respect to EN 50160 in all EU countries, as a basis for possible future PQ specifications in EN 50160 -- measurements, as having been conducted e.g. in Austria since more than six years.

Part B - Answers to the Issues for Consultation, p. 37 ff.

a. General questions on the recommendations to CENELEC for revising EN 50160.

aa: Do you agree with the general messages of the 7 recommendations given in chapter 4?

ad Recommendation 4.1: *Improve definitions and measurement rules*

VEÖ generally agrees with ERGEG that more precise definitions within EN 50160 could be helpful. However, such improvement can only be done in cooperation with the grid operators. Any reconsideration of measurement procedures and parameters could only be made appropriately by adjusting IEC 61000-4_30, and in cooperation with the manufacturers of measurement equipment.

ad Rapid voltage changes

The assessment of rapid voltage changes is a complex task, especially with respect to the stochastic behaviour of consumers' equipment in distribution grids. Fig.1 shows an "ideal" voltage dip due to the variation of a single load, while Fig 2 depicts the situation, as it is frequently measured in grids. It is obvious that a suitable definition of the starting and end point of a voltage dip must be extraordinarily complex. The practical value of too complex definitions for the specific phenomenon remains unclear.

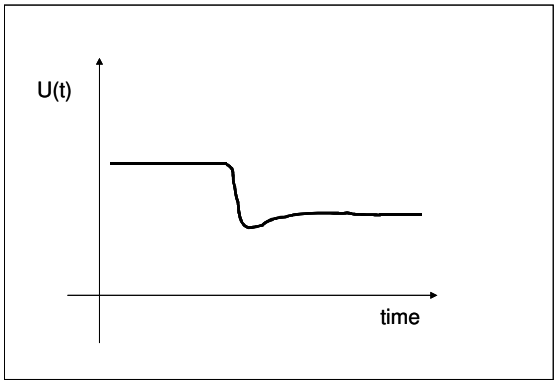

Fig. 1: Voltage dip due to the switching of a single load.

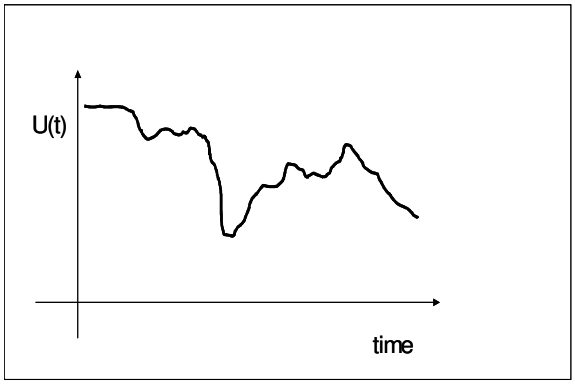

Fig. 2: Voltage dip due to stochastic switching of multiple loads.

ad Recommendation 4.2.: *Limits for voltage variations - Avoid "95%-of-time" clause and avoid long time intervals for averaging measured values*

Fig. 5 in the paper does not reflect the actual state of EN 50160, since the voltage band is defined as:

U_n +10 / -10% (95% quantile)

U_n +10 / -15% (100% quantile)

Therefore the absolute lower value of the voltage is 85% U_n and not any voltage as pretended by Fig. 5. Moreover, there is only a limited repartition of time available in the band between 90 and 85% of U_n for the averaging interval of 10 minutes, according to EN 50160.

Moreover, a 1-minute averaging interval does not in any way ensure that short transient voltages could not harm sensitive equipment. There is no reason to believe that the integrated value of the 1-minute averaging interval will depict such transient voltage peaks.

VEÖ states that a tightening of the voltage band could only be made if the measurement intervals were extended, e.g. to 15 minutes, which would be consistent with the standards used for metering equipment. If the averaging interval were changed from 10 minutes to 1 minute, the admissible voltage band would have to be loosened in order to avoid high grid investments.

ad Recommendation 4.3.: *Enlarge the scope of EN 50160 to high and extra-high voltage systems*

In contrast to distribution grids, the following features apply for transmission networks:

- (n-1) criterion
- reserve capacity must be held in evidence for balancing energy
- few PCCs with customers
- low harmonic distortion levels necessary anyway, due to the danger of resonance phenomena in low load phases
- few technical measures for the improvement of PQ on the HV side, except for the construction of new transmission corridors

Generally, we do not see any major obstacles in integrating HV and EHV into the EN 50160 framework, however, the specific technical circumstances have to be taken into account.

ad Recommendation 4.4.: *Avoid ambiguous indicative values for voltage events*

The ambiguous definitions of voltage dips and swells are mainly due to the stochastic behaviour of customers and thus widely out of the influence of a grid operator. The necessary level of equipment immunity is independent of the occurrence frequency of voltage deviations. The VEÖ agrees on a systematic classification of voltage dips, but emphasizes the necessity of a consistent classification based on the causes of the dips. It must be recognized that a grid operator cannot operate his grid without any voltage dips at all.

ad Recommendation 4.5.: *Consider duties and rights of all parties involved*

The title “Responsibility-sharing curve” in Fig. 9 is not acceptable for the general case.

In fact, a “responsibility-sharing curve” makes only sense for normal operating conditions, as in such cases responsibilities are clearly assignable. Contrary to that, the proposed curve deals with phenomena which, first and foremost, occur under abnormal operating conditions.

ad Recommendation 4.6.: *Introduce limits for voltage events according to network characteristics*

Any diversification of limits for voltage events for different classes of grids, as being proposed, appears as being undesirable due to the following reasons:

- many grids are mixed structures, are containing cables and overhead lines, and experience changes due to restructuring along time; immunity classes for customers, if adopted to grid-specific requirements, may happen to be inappropriate after several years of operation, in case of regulatory voltage event limits getting changed.
- the geography of the surrounding area is of paramount impact on the voltage event performance of a grid and cannot be influenced by the network design.
- The proposed diversification will inevitably cause a different treatment of equal customers in different network segments, which is undesirable.

ad Recommendation 4.7.: *Develop the concept for power quality contracts*

Specific PQ contracts seem to be of value only for customers requiring a PQ exceeding the specifications of EN 50160.

VEÖ states that this procedure is already mentioned in EN 50160, this kind of contracts does already exists and is being applied, as part of bilateral agreements between grid operator and customer, and cannot be further regarded in EN 50160.

ab: Are there any other major voltage quality issues missing from those that have been considered in this document ?

The issues connected to Distributed Generation are not being addressed. The presence of DG in the distribution networks implies the effective tightening of the voltage band. A reduction of the bandwidth as proposed in the paper will effectively set back the further deployment of distributed generation, which is in contradiction with the EU goals on renewable energy.

b. Specific questions on the recommendations to CENELEC for revising EN 50160

- *What is an appropriate responsibility-sharing curve between equipments and grid in the voltage-duration plan (both for voltage dips and swells)?*

  We do not agree with assigning responsibilities according to the proposed curve, see our statement to 4.5.

- *What is an appropriate way of protecting equipment against damage or failure due to short-duration overvoltages (voltage swells): limits for voltage swells (as events) or a shorter time interval (than the today's 10-min in EN 50160) for averaging continuously measured values (related to supply voltage variations)?*

  Equipment can mainly be protected against voltage swells by higher voltage immunity or fast disconnection in case of overvoltage; swells should be measured by 10ms-average values, as is the case for voltage dips.

- *Are there benefits, further than customer protection (for instance: reduction of losses), important enough to give reasons for reducing the range of voltage variations from Un ± 10 % to a narrower band?*

  The reduction of losses cannot serve as an argument since this argument implies that the voltage would be generally below the nominal value. A voltage value at the upper margin of a wide voltage band causes fewer losses than nominal voltage or a value close to a narrow margin. There is neither a technical nor an economic justification given for the reduction of the voltage tolerance band in LV supply networks, to a smaller voltage range, deviating from the values specified for the band around the European nominal voltage since about 30 years. Any change would result in severe additional financial burdens to network operators, amounting to some hundred B€ for all Europe.

  Furthermore, the integration of Distributed Generation (DG) into networks is continuously decreasing the usable voltage band and any tightening will reduce the potential penetration of DG, which is in opposition to the EU goals in the field of renewable energy and small scale generation.

- *How to consider random year-by-year variations in setting limits especially for Voltage dips and other events correlated to weather influence?*

  For steady-state conditions, steady-state extreme situations in the networks are in fact reflected by the 95% cause in EN 50160, while for events such as voltage dips etc., there is sufficient empirical knowledge to estimate the frequency of occurrence based on past years. Their statistical properties can be reflected accordingly.

- *For some topics (as for instance voltage steadiness within the tolerance band) the research made already available aggregate voltage quality indexes; should those aggregate indexes be used for regulatory purposes? Why or why not?*

  The aggregation into voltage quality indices can make sense from our point of view; however, they should thoroughly reflect the state of the European networks.

- *How can power quality contracts be defined in order to focus improvements in voltage quality levels according to customers' preferences?*

  Based on the solidarity principle and other basic network planning issues (ring structures,…), we see it fundamentally impossible to impose general different PQ specifications for customers connected to networks. The practical treatment of the connection of sensible customers will always require for a case-to-case-assessment and a financial contribution of customers in order to overfulfil EN 50160.

c. Questions on the future of voltage quality regulation

Which are the pros and cons of introducing national PQ limits and requirements by the national regulators?

We do not see any pros, since a diversification would raise costs for end-consumers anyway. From our point of view, that would no be conform with the target given by the EU for a fairly competitive internal market based on harmonised standards.