NEW INTERNATIONAL TRENDS IN LIGHTNING AND SURGE PROTECTION STANDARDS AND PRODUCTS

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Abstract: **New international standards have been published recently [1], or will be published very soon [2], [3], regarding lightning and surge protection from International Lightning Protection Committees 37A and 81. It is interesting to note a few things regarding these standards:**

- **they are mostly in line and way of speaking of similar things are done with same names and concepts**
- **the lightning protection standard series 62305 is an international (IEC) and CENELEC standards showing broad acceptance**
- **same for the surge protective device standards 61643 series**
- **the 62305 series is showing that consistency prevails in lightning protection approach and that global approach is needed to address the phenomenon in a correct and comprehensive way**

Based on these standards, some standards are also developed at CENELEC level regarding photovoltaic applications or wind turbine or even storm detectors.

Purpose of this paper is to present the new documents and how all of them are interconnected. This paper mainly focuses on 62305 series (lightning protection system) and CENELEC standards and should be read in conjunction with Tony Surtees paper named "Surge Protective Devices And The all-important "SPD Disconnector" mainly related to SPD standard and UL documents, given a complete picture [4].

I. INTRODUCTION

The structure of the paper is as follows :

Risk assessement : use of storm detectors, explosive zones, environemental risk …

Storm detection : CENELEC standard

Earthing and earthing improvers

CENELEC standards : SPDs for special applications : wind turbine and photovoltaic

II. RISK ASSESSEMENT : USE OF STORM DETECTORS, EXPLOSIVE ZONES, AND ENVIRONEMENTAL RISK

Regarding, 62305-2 the main modifications are listed below:

- risk is now split in two risks one for environment impact and one for the facility risk. As a matter of fact should you deal with a chemical plant for example it is needed to study the impact of a lightning not only for the facility itself but also for the surroundings. Today this was done by a multiplication factor but if the risk of the facility was very low (for example due to limited number of people inside the facility) the resulting risk was still very low. This was not sound and the new approach is more related to reality. $L_{XT} = L_X + L_E$
- The loss calculation has been deeply changed with ratio of person in the zone divided by total number of persons. This will avoid to make too many assumptions
- The tolerable risk for national heritage is now 10^{-4} instead of 10^{-3}
- The collection areas have been refined (1 kV is now considered) :
- The explosive zones 1, 2 and 21, 22 are now used for risk evaluation
- The part dealing with services has been removed

It is then clear that introduction of all explosives areas including zones 2 and zones 22 may lead to a higher risk than before. [5] But on the other hand, the new method leads to sensibly lower risk than before when we consider only zone 0 and 20. The fact of splitting risk in environmental risk and human will also help to make a better appreciation of the real risk even if a bit to early to conclude based on a significant volume of cases addressed by this new method.

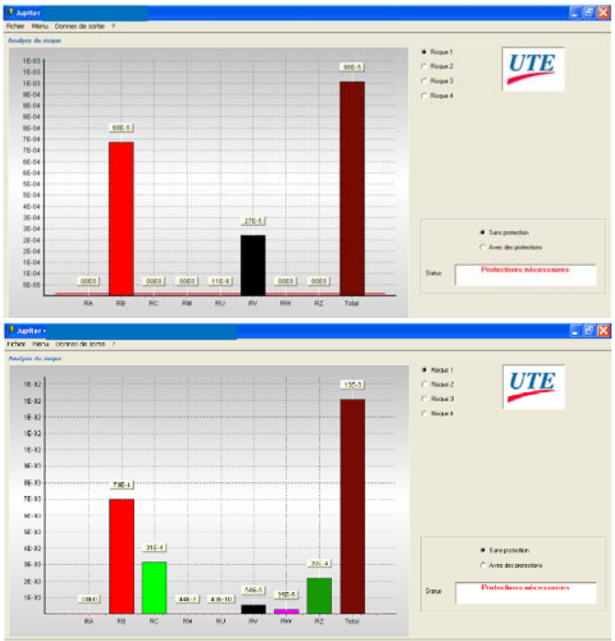

Figure : comparison or risk calculated on a chemical site when considering only zones 0 (above) and zones 1 and 2 (below)

Currently the working group is dealing with an enhanced table for Lf losses as well as the possibility to derate the risk based on mean value of flash ground density of a country. As a matter of fact, risk with actual calculation may be over evaluated for countries with higher keraunic level when it is the reverse for countries with low keraunic levels.

Storm detectors have been also proposed inside the working group as an option to reduce the risk (see below).

Recently, application of the risk method has been developed [6] to calculate risk on period of time shorter than 1 year. This is especially important for events that have a short duration compared to a year (fair, storage of products …). This is quite promising. In addition, it shows that the risk calculated over a period of a year by making the sum of the monthly risk is of course the same that the one calculated by the usual yearly method but it also shows that the yearly level of protection could be different of what is really needed is the lighting pattern over the months is clearly uneven. This need to be addressed for the critical sites such a chemical or petroleum industry.

III. STORM DETECTION

This standard 50536 is not published yet [7] but is already approved and should be published very soon. It gives a lot of definitions and concepts regarding the local storm detectors. A new part should deal in future with tests (lab, open air …) and detection networks. For the time being the only way to select such a local storm detector is to perform test over a long duration in real conditions or in dedicated open air laboratories.

It is important to be able to use storm detectors in risk calculation. The following method has been proposed and is under discussions.

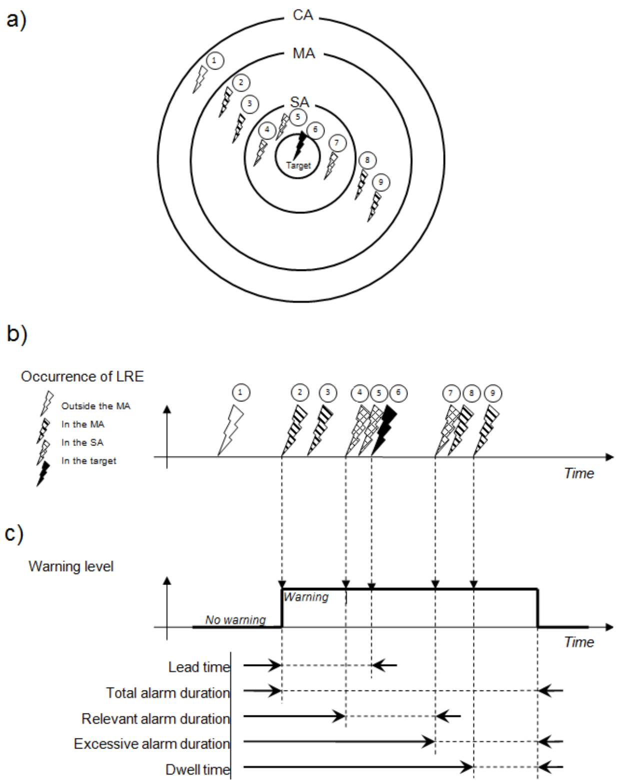

Figure : Example of an alarm. a) Locations of the lightning related events in the defined areas (coverage area CA, monitoring area MA, surrounding area SA, and target); b) temporal occurrence of the lightning related events and c) timing of the alarm according to the occurrence of the lightning related events

The reduction of the time of presence tz may be reduced by the mean of a storm detector provided that a procedure is defined and applied to reduce the time of presence based on information given by the storm detector. The storm detector should be according to Cenelec standard(under consideration) or any equivalent national standard until an IEC standard is developed for such a device. The storm detector and the related procedure become then part of the protection plan and should be included in the data file for the project/site including the maintenance program.

The relevant parameter to reduce the time tz is named Failure to Warn Ratio (FTWR) and is defined as the ratio of failure to warn with respect to the total number of situations with lightning related events in target. As a matter of fact, if there is no indication the risk remains and cannot be reduced.

In the calculations the time tz can be reduced to obtained a time t'z by using the following formula : t'z = tz * FTWR. During the time of presence tz a certain number n of lightning events can occur. Amongst these n events n1 will be detected and n2 = n - n1 will not be detected. We have FTWR = n2 / n so n2 = n * FTWR. Assuming, that the distribution of lightning events over the time of presence tz is constant (this is the basis for the risk calculation), we have n events during the time tz. The time tz can be divided into two periods of time :

- t1 where people were evacuated from the dangerous area or the danger stopped (for example stopping a dangerous or explosive process by using storm detector indication)

- t2 where people should have been evacuated but due to failure to warn, they have not been evacuated or the process stopped

We have tz = tz1 + tz2 and tz/n = tz1/n1 = tz2/n2

The reduced time of presence t'z is equal to tz2 = n2 tz /n = n * FTWR * tz /n = FTWR * tz

In risk equations tz can then be replaced by t'z should a storm detector complying with the above requirements is used.

IV. EARTHING AND EARTHING IMPROVERS

Earth improvers will be standardized in a new standard from series EN 50164 as well as for its equivalent at IEC level. However, test in laboratory may not be sufficient and it was needed to perform real tests in field in order to show earth improvers efficiency at lightning frequencies and also to serve as a base for the future standard.

High frequency measurements of earthings were then performed [8]. It allows to measure in an entirely automatic process, by means of an integrated processor, the impedance of earthing system, within a range of frequencies from 10 Hz to 1 MHz. It uses the regular three points measurements : one injection rod (Z) and one measuring rod (Y) located at 66% of the distance between measured earth electrode (X) and injection rod. The only difference is the cables being of coaxial type and also the frequencies used for measurement. The coaxial cables limits the length of Z cable and Y cable to respectively 15 m and 10 m. low frequecny regular measurement of the earthing resistance have also been performed with a regular earth meter.

The results have been interpreted according to the result directly given by the device in terms of quality of the high frequency earthing impedance and also based on the curve Z(frequency) and especially the highest values (greater or equal to 63 kHz) and their mean value (average impedance) from 63 kHz and 1 MHz.

Measurements have been done on galvanized steel tape conductors 10 m long in various trenches with our without earthing compounds. Three trenches have been made named A, B and C. A is back filled with the regular soil of the area. B is made in such a way that a compound available on the market (C1) is used around the tape and then the trench is back filled the regular soil of the area. C is made in such a way that another compound available on the market (C2) is used around the tape and then the trench is back filled the regular soil of the area.

The results obtained at low frequency with the high frequency device are consistent with those obtained with a regular earth meter (called DC value in the table).

The resistance improvement is 64% for C1 and 72% for C2.

The average impedance with compound C1 is improved by 26% and by 33% for compound C2.

Figure : Tape testing place.

We can see from the curves the inductive effect of the tape. Basically the combined effect of the compound to reduce resistance and increase capacitive coupling, improves the average impedance.

Table data obtained in 2009 for the trenches.

Electrode	10 m galvanized steel	10 m galvanized steel	10 m galvanized steel. Center connection	10 m galvanized steel
Trench	A	B	B	C
Compound	none	C1	C1	C2
Measurement N°	10	16	17	18
DC value (Ω)	29,2	10,65	10,62	8,31
High frequency device	Impedance (Ω)			
79 Hz	31	11	11	9
63 kHz	22	12	11	10
1 MHz	60	59	54	52
Average value of Z (63 kHz-1MHz)	42	31	28	28
Criterion	Bad	Acceptable	Good	Good

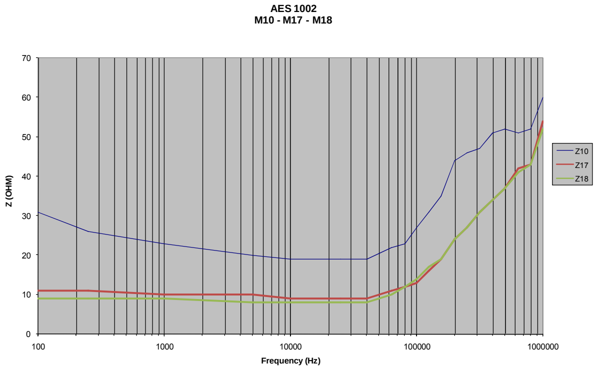

Figure : M10, M17 and M18 Z .vs. frequency curve.

One of the main conclusion obtained from same type of measurements made on rods, is that the concrete is one of the best earth improver. These data will be send to the involved working group.

More generally, use of high frequency earthing tester can be used to validate an earthing design , solved difficult cases or facilitate the maintenance especially on earthing system where measurement point are not existing or meaningless (buried loop for example) and even in harsh environment [9].

V. SPDS FOR SPECIAL APPLICATIONS : WIND TURBINE AND PHOTOVOLTAIC

CENELEC has published recently 2 guides defining what should the installation rules regarding SPD for theses specific applications. These documents also give some details on what should be the appropriate test to perform. The testing standards are still under preparation.

The main parameters for wind turbine are related to vibration and to quasi permanent impulse superimposed to 750 V which may age the SPDs.

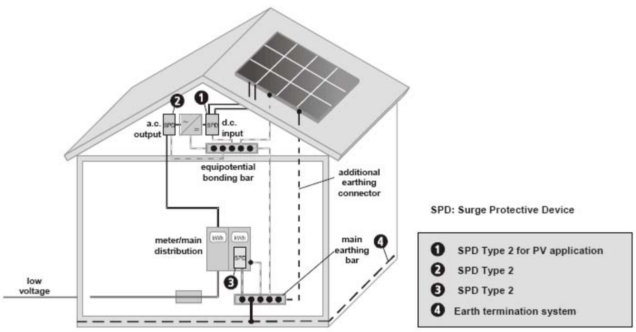

Figure : installation of various SPDs on photovoltaic application

For photovoltaic applications the main parameters are the possible aging of SPD under dc permanent voltage and the tests to validate the end of life in order to show that these SPDs cannot create a fire hazard.

VI. CONCLUSIONS

Most of the IEC and CENELEC standards dealing with Lightning Protection Systems and Surge Protective Devices are under revision and their new editions should be published by the end of the year. They introduce a lot of changes and refinements on testing especially for an enhanced safety.

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