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The Safety & Public Interest Concerns regarding the CVM/P998

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This document is an expanded version of Section (A) Of Mousa's Procedural Appeal of 2 March 2011. To facilitate cross-reference, the same numbering of the references has been used herein. The following materials have been added: paragraph (9.1) which describes one additional safety incident, a related photo: Fig. 4, and the related reference: [25.1].

The prohibition against issuing standards that create or entrench a hazard to humans flows from the wider obligation against issuing standards that are contrary to the public interest. That obligation is stipulated in section 4.2.1.1 (page 15) of *ANSI Essential Requirements*. Also, it is a common sense requirement that must be observed to protect the IEEE against the related liability. The potential damage to public interest that would arise from adopting the CVM (Collection Volume Method) includes both the hazard to personnel and the potential damage to the equipment in substations. In addition to the latter being important utility assets, the public at large would be negatively impacted by the consequences of blackouts and by having to pay the cost of repairing the substations through higher tariffs.

Discussion of the Safety Aspects of the CVM

1) The conventional lightning protection systems used in national and international standards rely on "passive" air terminals (lightning rods, masts or shield wires) that act as sacrificial electrodes for the termination of the lightning discharges. The underlying concept was invented by Benjamin Franklin over 250 years ago.

2) National and international standards, including NFPA Standard 780, mainly use the Electrogeometric Model (EGM) to determine the number and locations of the air terminals that are needed to provide the required level of protection. The modern EGM was first developed in 1963 [51] and it was calibrated based on field observations [50]. Refined versions were subsequently introduced including Mousa's Revised EGM [18] which was used in the 1996 edition (reaffirmed in 2002) of IEEE Standard 998.

3) The quest for improving the Franklin rod led to the invention of several types of "active" air terminals that seek to modify the behaviour of the lightning discharge. Early Streamer Emission (ESE) lightning rods is one of such systems. The claimed improvement is expressed as an increase in the protection range (also called attractive radius or protective radius). This presumably permits reducing the number of air terminals.

4) ERICO is a manufacturer of ESE devices, especially the so-called Dynasphere™. ERICO got into the lightning protection business by acquiring the Australian company named Global Lightning Technologies ("GLT"). GLT was founded by Rick Gumley.

5) The dispute regarding non-conventional lightning protection systems is not whether the related technologies increase the protection range of the air terminal, but rather by "how much"; with the vendors exaggerating as is usual in all aspects of the market place.

6) The economic viability of ESE devices rests on the claim that a single device can protect a whole building. This is because their unit cost is huge compared to that of a Franklin rod. For example, ERICO's price sheets of January 2002 list the cost of the Dynaspher as $1250 and the cost of a Franklin rod as $10. Fig. 1 is taken from an ERICO document and it shows ERICO's own comparison between its Dynasphere lightning protection system (called "System 3000") and the conventional Franklin rod system that complies with NFPA Standard 780 [45].

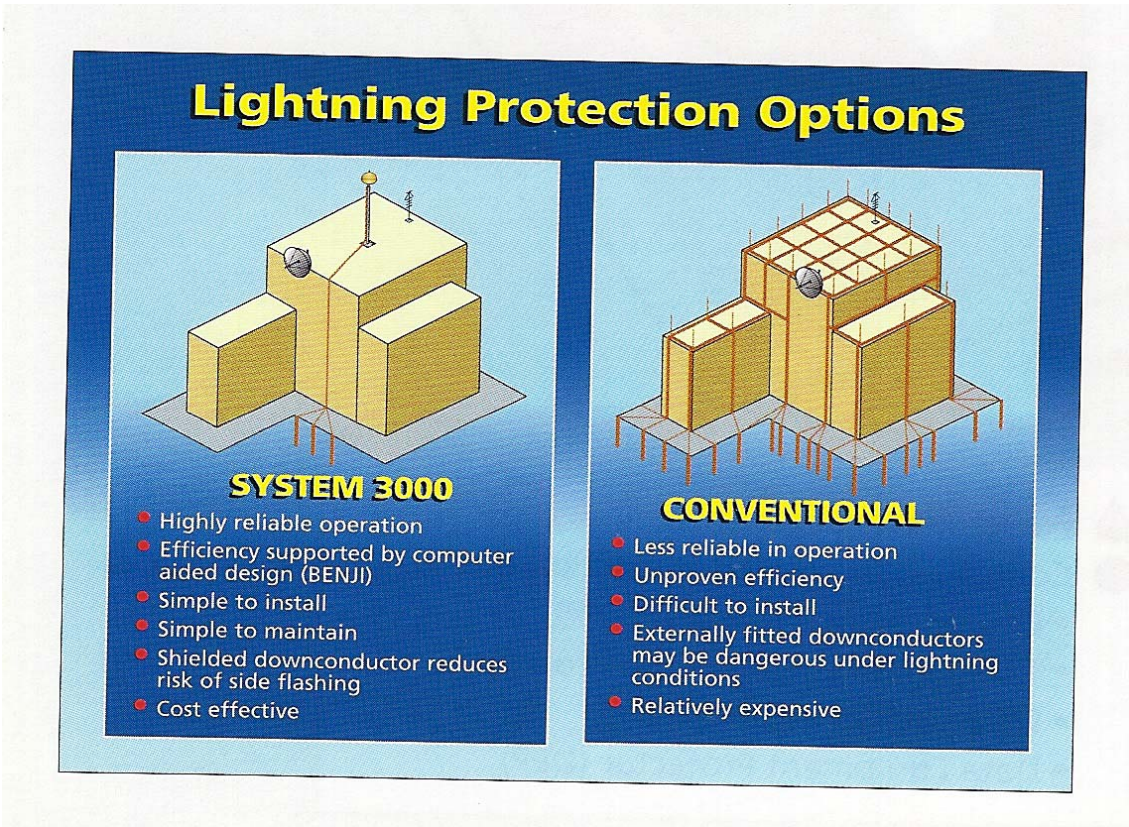

Fig. 1. ERICO's own comparison between its ESE system (left) and the conventional system (right).

7) The essence of ERICO's claim is that the huge amount of material and related installation work of the conventional Franklin rod system in Fig. 1 can be replaced by just one ESE device, one down conductor and a ground rod(s). Despite the higher unit cost of the ESE terminal, the installed cost of the whole "skinny" ESE system is less than that of a conventional system. Hence, **if the two systems in Fig. 1 indeed provided the same degree of protection against direct lightning strokes,** then ERICO and other ESE vendors would corner the whole market and all vendors of conventional lightning protection systems would be out of business. That would be O.K. as the consumer would benefit.

8) The claims of the vendors of ESE devices were initially based on ESE theory. That theory has been found to be invalid [20] and it was concluded that the ESE system in Fig, 1 only provides a small fraction of the protection that is provided by a conventional system. Hence buildings equipped with ESE systems are mostly exposed to lightning strikes, thus exposing life and property to hazards

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Fig. 2. Damage to a building within 10 m of the Dynasphere.

9) The invalidity of ESE theory has been confirmed by field observations as lightning repeatedly struck within the claimed zone of protection. Please see Fig. 2 [10]. Such failures can have serious safety implications. Fig. 3 shows an example where the falling debris caused by the lightning strike hit a car parked by the side of the building [9].

9.1) Another example of the hazards posed by ESE devices was reported in [25.1]. This concerned a lightning strike to the Mariotte Hotel at Marco Island, Florida, which occurred on 23 August 2010. In that incident, lightning struck the roof as a result of the failure of the ESE device to protect it. The strike sent a bunch of clay tiles crashing to the ground in an area near a swimming pool. Please see Fig. 4. The fallen tiles crushed a table, bounced around and broke a window. There was also electrical damage. Luckily, no one was injured.

10) ESE lightning rods were the subject of a bitter decade-long dispute when their vendors attempted to get NFPA to issue a standard for them. The battle ended when NFPA issued its final rejection of ESE systems [33]. Further, after hearing expert testimony, a US Federal Court concluded that it is illegal to advertise the claim that ESE devices have a larger protection range than that of Franklin rods [47, 22, 24].

Fig. 3. Fallen rock from struck building – hazard arising from invalid ESE/CVM theories.

Fig. 4. ESE failure incident at Maripott Hotel in Marco Island, Florida [25.1].

11) During the ESE dispute before NFPA, ESE vendors alleged that ESE technology was being unfairly treated, their grounds being that conventional lightning technology similarly lacks substantiation, and that Standard 780 should be hence withdrawn. NFPA eventually rejected that allegation upon receiving overwhelming evidence that supports conventional lightning technology and the related EGM which is used in determining the placement of Franklin rods [2, 16, 46].

12) During the early 1980's, Rick Gumley, the owner of GLT which is ERICO's predecessor, proposed using the Collection Volume Method (CVM) as an alternative means of justifying the claim that a single Dynasphere can protect a whole building. This is because the CVM exaggerates the protection range of air terminals and implies that it drastically increases with increase in height. Following the rejection of ESE theory by NFPA, the CVM became ERICO's only means of justifying its unsafe practice of using a single ESE device to protect a whole building.

[13] The CVM is based on a model that was originated by A.J. Eriksson [7, 8]. Eriksson's Model has been rejected by the scientific community at large. This is evidenced by the fact that the IEC Standard on Lightning Protection continues to use the EGM despite the passage of about 25 years since the introduction of Eriksson's Model / CVM.

[14] During 2002, ERICO previously attempted to get Standard Australia to sanction the CVM. That attempt failed when the invalidity of the CVM was confirmed by a position statement of the Scientific Committee of ICLP [42].

[15] ERICO then twice tried to get NFPA to sanction the CVM: in 2003 and in 2006, but both attempts similarly failed [34, 35]. The Scientific Committee of ICLP issued a second warning against the CVM in connection with ERICO's attack on NFPA [43].

[16] As the above clearly indicates, the objective of ERICO's attempt to get the CVM in IEEE Standard 998 is to legalize its unsafe practice of using a single ESE device to protect a whole building. In this connection, it should be noted that the CVM has NOT been previously used in designing the shielding systems of substations. This is evidenced by two IEEE industry surveys that were done in 1991 and in 2007 (copies included in appendices of draft Standard 998).

[17] The draft standard includes major changes compared to the 1996 edition. Most of those changes were written by Dr. Franco D'Alessandro, who is a consultant for ERICO and was previously employed by it. The crux of the changes made by Dr. D'Alessandro was the introduction of Eriksson's Collection Volume Method. This he did twice, apparently to maximize the related potential commercial impact: once under the heading "CVM" and once under the heading "Eriksson's EGM". The above changes and related numerical examples **occupy a staggering total of about 66 pages** of the draft standard.

[18] As stated above, the CVM exaggerates the protective range of air terminals and that buildings would be mostly exposed to direct lightning strikes if the CVM was used in designing

their shielding systems. Similarly, the equipment and switchyards of substations would be exposed to direct lightning strikes if the CVM was used in designing their shielding systems. The potential consequences are as follows:

a) Risk of injury to workers.

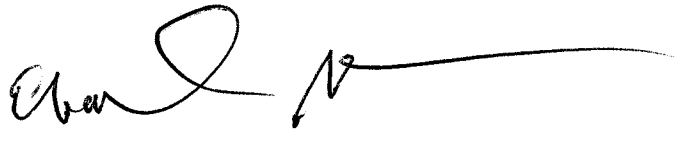
b) Damage to the non-self restoring insulation of transformers, shunt reactors, circuit breakers, etc. In addition to the high cost of repair, this may cause lengthy power outages.

c) A direct hit to a bus would cause an outage of all the lines connected to the substation. This could lead to a blackout over a wide area.

d) A lightning strike to a bus very close to the circuit breakers may cause the breakers to fail to operate and/or be damaged. The electrical fault would then have to be interrupted by the slower back-up protection via the breakers in the other substations which feed into the struck substation via the interconnecting power lines.

e) The disruption from the load shedding arising from the simultaneous shut down of several power lines, including delayed clearing of electrical fault due to reliance on back-up protection, could cause instability of the power system which may cause the blackout to extend to an even wider area. This would further lengthen the time needed to restore the power system.

All of which is respectfully submitted.



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