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Lightning Protection: Getting It Wrong

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Lightning has become a significant threat to electronics in many countries where the natural phenomenon has previously been treated only as an occasional attacker of careless living beings. Most tropical countries, several southern states of the U.S.A., Japan, and several parts of Australia, experience heavy annual lightning occurrence density [1]-[12]. These regions also record high levels of lightning related injuries and accidents. However, many European countries, far northern and southern sections of North and South America, and countries such as South Africa and New Zealand – areas that had not previously paid much attention to lightning (except South Africa where lightning research started in the early 20th century) – are now more vigilant due to increased industrial development, greater sophistication of electronics, and wide expansion of power and communication networks. The extensive dependence of society on automated systems makes countries increasingly vulnerable to lightning related hazards.

We present here information that we have obtained in several countries with respect to lightning protection through our long-term experience in operating in the Asian region as researchers, consultants, and advisors on this subject. Our findings are directly applicable and will be helpful to many other regions of the world.

Locations and Time Frame

This research was done between April 2000 and March 2010. The information was collected as a by-product of advisory and consultancy assignments and training programs in which the authors are directly involved and is authenticated by cross references. Locations for the research were India, Sri Lanka, Pakistan, Bangladesh, Bhutan, Saudi Arabia, Malaysia and Indonesia. In addition, some information was collected from Singapore, Nepal, and Iran through personal communication. The subjects include over 800 engineers and engineering administrators, about 300 non-technical administrative personnel, about 180 members of the general public, 38 agents for and dealers of lightning protection (LP) equipment–henceforth referred as "vendors," and 162 LP installations.

> Knowledge about lightning protection among the responsible parties was not very sound.

The modes of collecting information were

1) Personal observation by site inspection.
2) Data provided by knowledgable authorized personnel.
3) Questionnaires when the general public is involved.
4) Reliable documents such as authorized quotations, maintenance reports, and purchase orders.
5) Company and product promotional materials.
6) Discussions with nontechnical administrative personnel.

Each part of this study has been rejustified by additional observations during the period in which the data were collected.

Lightning Protection Requirements

In most countries, even those with frequent, intense lightning activity, knowledge about lightning protection among the responsible parties was not very sound. We observed that in South Asia the percentage of cases where lightning protection has been done after a proper risk assessment is less than 1%. In South East Asia this percentage seems to be above 50% and in the Middle East it is over 70%.

However, the number of cases investigated in South Asia is about 20 times greater than that of both the other regions. In general, knowledge of risk assessment by engineers in South Asia was poor. In all three regions, where engineering or management staff claimed that the protection system of a site has been installed after a risk assessment (by the installer or a third party consultant), the staff could not explain or provide documentation regarding the type of assessment that had been carried out. Hence, we had to guess the risk assessment procedure by studying the installer's specifications.

Informal interviews with site engineers and decision makers at the administrative level at many companies and institutions reveal that the reasons for making a decision on building and/or surge protection are as follows, in the order of decreasing degree of prominence:

1) A lightning accident has occurred at the premises.
2) A marketing representative from a LP vendor has visited and persuaded the organization to install LP.
3) A lightning accident has occurred in the neighborhood.
4) Insurance companies have insisted (imposed a higher premium for not having LP).
5) A high-ranked company representative has participated in a lightning protection program.
6) A maintenance engineer or another senior engineer has anticipated a lightning threat.

The above reasons and the priority order are common to all

Often we saw that opportunistic vendors made unnecessary or sometimes even hazardous selections.

three regions. On only a few occasions has a client demanded a risk assessment from the LP vendor.

Our informal interviews with LP vendors reveal that fewer than 50% of vendors have hired professionals able to conduct a risk assessment according to any standard. All of the earlier professional risk assessments adhered to BS 6651 (1999) [13]. However, our re-inquiry in the last few years of the investigations revealed that only three companies have the resources to conduct a risk assessment according to IEC-62305-2 (2006) [14].

The lack of correct motivation in decision-making about installing LP systems opens an opportunity for a vendor to dictate the selection of an LP scheme to a client. Without a proper risk assessment, the client allows the vendor to decide the level of protection, what is to be bought, and where it is installed.

Often we saw that opportunistic vendors made unnecessary or sometimes even hazardous selections. For example, the following erroneous installations were made by vendors.

Structural "Protection" Carried Out for No-Risk Buildings

We have come across many cases where an LP system was installed on buildings that have a very low risk index (no protection needed or only few protective components required) according to the risk assessment of either [13] or [14].

These buildings included:

a) Low-rise buildings in areas of low lightning occurrence density.
b) Totally metallic structures.
c) Buildings protected by high-rise buildings in the near vicinity (e.g., base stations underneath tall and well-grounded metal towers).

The LP systems adopted in 90% of these cases are based on early streamer emission (ESE) technology. (See discussion of ESE later in this article.) As these installations do not have any significant probability of a lightning strike even without the LP system, the vendors who provided LP are near a zero risk of failure. Such cases also contribute immensely to the no-accident statistics of installations with ESE devices, a false indication of the success of the technology.

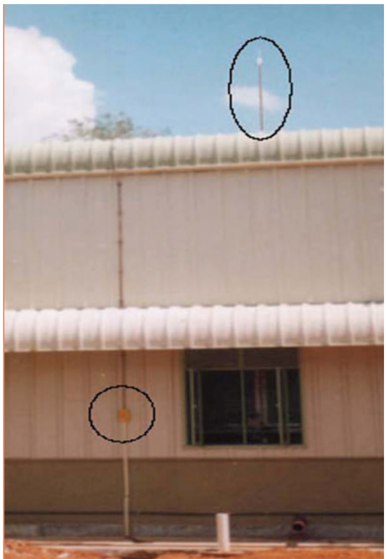

Fig. 1. An all-metal structure (supporting struts, roof, and facades) installed with ESE air terminations and bare copper down conductors in contact with the building material. The air termination and aluminum test joint box are shown highlighted with black circles.

One of the adverse effects of having copper down conductors on buildings made of steel is the rapid corrosion of steel due to the galvanic effect. In most cases, the dimensions of the roofing and supporting materials are well above the minimum values specified in IEC 62305-3 (2006) [15] for being a self-sufficient, air-termination and down conductor system.

However, the unnecessary installation of the LP system causes serious corrosion that damages the building's structure, especially in areas with high salinity and acidity in rain water. In such cases, the only structural LP requirement is a proper grounding system connected to the base of the structure. Fig.1 shows an all-metal factory, a structure made with I cross-sectioned vertical iron struts, L cross- sectioned horizontal iron struts that support the corrugated iron roofing, and sides covered with corrugated metal sheets. The structure only needs grounding of vertical struts at the base level at regular intervals as per [15]. The vendor has installed 4 ESE air-terminations grounded by bare copper tapes laid along the metal roof and facades. Note that the aluminium casing of the test joint, which is fixed to the facade by nuts and bolts, causes even worse corrosive problems due to the presence of several metals together.

Surge Protective Devices without a Proper Plan

It has been found that at a number of commercial and industrial sites' surge protective devices (SPDs) have been installed without any justification regarding the selection of location and specifications. This practice leads to overprotection of some robust equipment and to underprotection or no protection of some sophisticated equipment.

Nonconventional Air-Termination Systems

The issue of the suitability and scientific background of non-conventional air-terminations has been debated for almost two decades. The performance of such technologies has not been proven theoretically, experimentally, or statistically. Yet products based on this technology are successfully marketed in South and South East Asia, while such devices are not very popular in the Middle East.

Our visual observations reveal that in Sri Lanka, India, Malaysia, and Indonesia, the percentage of nonconventional air-termination systems (with respect to the total number of LP systems) is approximately 75%. The percentage of LP systems installed according to [15] or similar is less than 5% in Sri Lanka, about 20% in Malaysia, and about 10% in Indonesia. The rest are partial protection systems (usually single copper rod grounded by a single down conductor). Pakistan, Bangladesh, Nepal, and the Middle East are not totally infiltrated by vendors of non-conventional technology. In Singapore such technology is forcefully suppressed as a result of the dominance of few individuals.

Ninety percent of nonconventional air-termination systems are based on ESE technology, while the rest are based on lightning repelling or dissipating technology. The products based on ESE and lightning repelling/dissapating technologies have been promoted with two different marketing approaches.

ESE Technology Promotion

Manufacturers of ESE devices claim that an ESE system can intercept with a downward propagating stepped leader much earlier than conventional rods, and that thus the chances of a lightning intercepting with parts of the building is minimized. However, ESE technology has been rejected by a majority of the scientific community. Most of the reputable international standards have not included this methodology. Hence, it is of interest to explore the reasons for the success of ESE technology in most of the countries where we have conducted the investigation.

a) *Inclusion of ESE technology in French (NFC 17-102) and Spanish (UNE-21186) Standards:* Being well-developed, influential European countries, France and Spain make a considerable psychological impact on developing nations. These countries have included ESE technology in their standards, so the product gets an automatic endorsement regarding its efficiency. Even under a legal framework, a vendor will most probably be safe if his product is in compliance with a European Standard.
b) *Non-rejection of ESE technology by any standard:* Although many standards have not included ESE technology in their recommendations, none of the standards includes explicit rejection of the ESE technology. Under such circumstances, there are simply no grounds to persuade an ordinary engineer to reject a product based on ESE technology. One cannot expect a field engineer to read research papers or scientific documents as they are burdened with routine work. The situation becomes even tougher for an anti-ESE campaigner when it comes to convincing decision makers who are most often non-technical personnel.

As a team of consultants and advisors we have tried our best to address both point a) and b) during our training programs, advisory sessions, and consultancies using scientific papers and statements issued by the international scientific community. However, as the ground engineers complain, a standard issued by a well-developed country is much more recognized in the eyes of an administration or official framework than research papers or mere statements that have no legal validity.

c) *Introduction as a new technology:* The ESE technology surfaced in the late 70s but became a market force in the 1990s. Thus, compared to the 300-year-old conventional protection system, the ESE concept is a modern technology. The general public often favors such "modern" technology. ESE proponents use this human thinking pattern much to their advantage.
d) *The "handsome" look:* an ESE device is a more attractive object to the human eye than a copper rod, which is either dull plated or pale-looking due to natural oxidization of the surface. In contrast, ESE air-terminations come with various shapes and chromo plated surfaces. In many areas of Sri Lanka, for an example, having such a fancy looking device on the roof is a symbol of prestige. To compete with ESE devices, several vendors who promote conventional systems in South Asia have started manufacturing Franklin rods, which are used in conventional systems, with various attractive shapes. These rods are not sold as ESE devices, but the beautiful look attracts customers. Fig. 2 shows several such rods marketed by a Sri Lankan company.
e) Convenience for both the client and the vendor: In contrast to a LP system designed according to [15] or similar, an ESE LP system, designed according to a standard such as NFC-17-102 (1995) [16] is less laborious to install. Especially in the case of buildings that have decorated and complex

The market campaigns of ESE device vendors are much more rigorous and aggressive than those of other companies.

Fig. 2. Various designs of non-ESE-type air terminations (Courtesy SAW Engineering (Pvt), Ltd.)

shaped roofing, ESE technology is a big attraction. The single air-termination and single down conductor (in most of the buildings) cause much less disturbance to the aesthetic appearance of the building than the conventional systems do.

One of the countermeasures that can be taken by conventional LP system proponents is to promote the use of reinforcement steel structure for the purpose served by the down conductors. However, the conditions set forth in [15] for using a steel reinforcement structure for this purpose, highly restrict the adoption of this technique in practice.

f) *Powerful marketing strategies:* The marketing campaigns of vendors that sell ESE devices are much more rigorous and aggressive than those of other companies. ESE vendors can afford these campaigns because of their large profit margins.

As a remedy, we propose that those who install conventional LP systems should replace copper with galvanized steel and use the existing structural reinforcement system wherever possible to reduce the cost of materials, so that they can offer competitive prices while having good profits. However, there are several hurdles to overcome when such designs are proposed to a client: the client's doubts about the system, the architect's/civil engineer's opposition, and practical constraints in implementing the conditions set forth by [15]. In addition, most often clients decide on LP after the building is constructed, further complicating the installation of conventional LP systems.

g) *Lavish rewards to admirers:* Another strategy adopted by vendors is to heavily reward consultants who recommend ESE technology. The large profits gained by the vendors make it possible for them to offer lavish rewards to the consultants. The vendors, in turn get more business and more profits. This positive feedback loop adds new consultants and destroys the companies that are reluctant to play along. During the last five years of this investigation, most of the companies that were previously reluctant to market ESE technology were sucked in as they could not survive in the business without selling ESE technology.

h) *Client demand for ESE technology:* ESE vendors have created an atmosphere in many countries that the total solution of LP relies on the efficiency of ESE technology. Hence, clients demand ESE based LP. Most often, contracts combine installation of both SPD systems and structural protection systems. Thus, a refusal to offer ESE devices will cost the vendor the total contract. As we have observed, several LP companies in South Asia, whose main concern is SPDs, started importing ESE devices as they have lost large scale projects without them.

i) *Lightning repelling or dissipating systems:* Proponents of these systems claim that once one is installed there will be no lightning attracted to a building; the lightning will either be dissipated or diverted to an unknown destination in the neighborhood by the system. The concept is rejected by almost the entire scientific community and also not recommended by any standard. However, proponents have been successful in several occasions in the regions under investigation.

We interviewed customers of ESE systems in our study. Almost all of them stated that they were well-satisfied with the installed system. To discover the grounds of their satisfaction, we visited one of the tower sites in South Asia where a lightning eliminating/ repelling system had been installed. The location of the site is not revealed at the request of the site owner. Our observations are listed below.

a) The air-termination is a well spread metal structure (which is supposed to repel lightning) that covers the entire tower and its equipment even by an angle of vortex as low as 10°. The air termination is tightly connected (well bonded electrically) to the tower re-bars.
b) The air-termination is connected to a down conductor which is fixed (electrical bonding again) to a tower foot at regular intervals.

c) The down conductor and tower feet at the base are well integrated and connected to a well distributed grounding system (ring conductors, radials deep driven rods etc.)
d) All metallic parts of the Base Transmission Station (BTS) are properly connected to grounding system, via a well-coordinated SPD system (wherever necessary) or directly. The grounding resistance was around 0.5 Ω (measured with a KYORITSU MODEL4105A earth resistance meter on a moderately dry day).
e) According to engineers at the site, the BTS and the tower-related equipment have experienced heavy losses during the lightning seasons prior to the installation of the LP system. Since the system was installed there were zero damages for a period of about 5 years. The engineers strongly believe that the system repels the lightning.

It can easily be understood that with such a comprehensive LP system the chance of equipment damage or personal injury is extremely small, even if many lightning strikes hit the tower. Therefore, the satisfaction of the customer is well justified.

However, the issue is that the vendor has charged about 1000 times more for the so called "lightning eliminating" air-termination system than would be charged for an ordinary copper rod that could have served the same purpose. The cost of the other parts of the system (other than the air-termination) is similar to the cost of those provided by any other vendor.

Interestingly, such ESE systems are mostly installed in structures with small horizontal expansion (communication towers) and all-metal structures that can withstand lightning strikes even without air-terminations (metal oil storages that have thick walls and a thick roof). The ESE vendors also approach large-scale business enterprises with very high revenue so that the cost of their LP system will not be a sizable fraction of the annual safety budget.

There are significant problems in the installation and maintenance of wiring systems.

Erroneous Electrical Engineering Practices

In a number of cases we found that losses and damages were wrongly attributed to lightning, when the real culprit was bad electrical installation and maintenance. Most often when LP vendors are invited to forward quotations (without getting the service of a consultant), the vendors offer SPDs without asking the customer to rectify the drawbacks of their electrical system. This is done either due to lack of knowledge of the problem or fear of losing the contract. The result will be failure of the equipment even after installation of the LP scheme. Several such electrical system problems are listed below.

1) *Grounding at various points of the wiring system:* This is one of the most common LP problems in the subcontinent. About 20% of the engineers interviewed in this investigation expressed the view that the more leads from the wiring system to the earth, the better the safety. Most of the engineers who had this view are electronic/ communication engineers. We suspect that the recommendation of the manufacturers of communication equipment to have a separate (or dedicated) ground may have prompted engineers to hold this incorrect view. Interestingly, during the period of investigation, the Electronics Department of an engineering university in a South Asian country experienced serious damage to over 20 computers. A case study of the incident revealed that the department premises had more than 18 grounding points (lines connected to separate earth pits). The practice, for which maintenance engineers were responsible, was due to the belief that each computer should be given separate grounding. We have also come across 22 installations where the SPDs are connected to a grounding system different from the power ground. In all 22 cases, engineers of the site have done the installation after purchasing the SPDs from retail vendors. Fifteen of those installations, situated in high lightning density areas (over 70 thunder days per year), have records of major equipment damage before they rectified the situation on our recommendations.

Most of these misconceptions could be eradicated after pictorial demonstrations of the hazardous practices to the technical personnel concerned (current loops and dangerous voltages between ground and line/neutral due to potential differences at different ground points).

2) *Wiring system defects:* There are many malpractices in the installation and maintenance of wiring systems, as we have observed. A few of them are as follows:

There is reluctance among ground level engineering/technical staff to go beyond routine work in rectifying issues, unless there are drastic losses.

a) Selection of wrong color code: We have come across a few sites where green/yellow grounding wires are used for live or neutral at some locations of the wiring system. This can be extremely hazardous.
b) Damaged wires due to mechanical mishaps and rodent bites: In addition to the safety threat, such damaged points give rise to regular arcing, generating transients in the system. In the Middle East and some parts of South and South East Asia we also frequently observe damage to outdoor cable insulation due to due to due to extreme weather conditions.
c) Birds/squirrels make nests in panel boxes: Such animals and parts of their nests may cause sporadic arcing between bus bars.
d) Unplanned power feeds routed outdoors: One of the biggest challenges of rectifying a wiring system is to figure out and remove or re-route power lines that extend to outdoor feeds from points within the building. To make the situation worse, the extensions are most often taken from unexpected points: plug points, lamp holders, or even splitting the insulation of the wires at any place convenient to the technician. Typically these extensions are done on a temporary basis and after the purpose is served, the extension is left unattended. In most of the countries and states of Southern parts of the sub-continent, the festive season happened to be in March-May, during which decorative lamps and other displays that require power are used outdoors. Unfortunately this happens to be the period of peak lightning season as well.
e) Absence of electrical safety devices: In the entire sub-continent, it is only in Sri Lanka that the installation of both earth fault tripping and over current tripping devices are compulsory. In the Middle East and South East Asia, most industrial sites are installed with such devices, but not small-scale, out-of-city industries.
f) Unattended defective electrical appliances: Flickering florescent lamps, noise generating old UPSs, defective capacitor banks, and inductive loads are examples of transient generators within premises.
g) Irresponsible switching operations: At several locations we found that the on-off operations of some sophisticated loads were done by inappropriate means. One common example is switching on or off a large number of computers by a single circuit breaker, to save time and labor.

Erroneous Practices of LP System Installation

There are number of issues with respect to LP installations that we have observed during our investigation. Several of them were discussed earlier. Additional issues are described below.

1) *Improper installation and maintenance of down conductors:* Down conductors have been observed with twisted, crooked and loosely hanging parts, U and L bends, undetectable ground termination, fixing brackets of different metals, and parts inside cable ducts or installed close to equipment. Examples of several of these drawbacks are depicted in Fig. 3. Another issue, the installation of insulated cables in metal towers, is discussed in detail in [17].
2) *Misconceptions of grounding:* Apart from the multi-point earthing problem mentioned above, one of the most confused grounding issues, especially among junior engineers, is the maximum distance (50 cm) recommended for the grounding of SPDs. The Standards [18] clearly mention that the length of wire between the SPD and the grounding bar (which provide ground reference for the equipment to which power is supplied from the same panel) should be less than 50 cm.

   Unfortunately some technical personal understand this as a 50-cm maximum length between the SPD or grounding bar and the earth. Fig. 4 shows a ridiculous attempt made by the technical personnel of an institution in South Asia to achieve this misunderstood concept. Several other erroneous practices with regard to the same issue have been discussed in detail in [19].

3) *Use of inappropriate backfill materials:* It is a common practice among several companies and a few consultants in all three regions we investigated to use salt (sodium chloride) as a backfill material to reduce the grounding resistance of earth electrodes. Most often after the installation of a grounding system with sodium chloride and after adding several gallons of water, the ground resistance of the systems gives a reading that can be as little as one fourth of the value for the same system without such materials. These low readings allow the vendor (or contractor) to collect a payment from the customer; however, within a few months the ground resistance may increase by 4 or 5 times (even higher than that of a similar system without sodium chloride). The reality of this issue has been discussed in detail in [20]. In addition to the temporary resistance increment, sodium chloride may seriously promote corrosive effects.

Decisions on investing in infrastructure development are taken at a managerial or directorial level, where people often have no technical or scientific background.

Faking Popular Brands

South and South East Asia are plagued with fake LP devices, especially SPDs. In many other electrical products, a fake has some value, although the quality is most often less than that of the original. Hence if the price is proportionately low, people buy the fakes, sometimes knowingly, although such purchase is not strictly ethical. On the contrary, many fake SPDs have zero value (except for the plastic casing and the material filled inside to increase the weight). Fig. 5 depicts one such case observed during the investigation. The SPDs shown in the figure bear a reputed international brand name, and were installed at a bank in South Asia. During our inspection visit we noticed that one of the SPDs in the panel showed burn marks in the panel and also in the panel cover. However, the fault indicator of the SPD (the red button that should pop out in the event of SPD failure) indicated that it was in good condition. This prompted us to ask the technical personnel of the institution to remove the SPD from the panel and split it open to inspect inside. We could see only a partially melted lump of PVC-like material inside. There were no signs of any surge protective components such as MOVs, GDTs, or Zener diodes. We could not get photographs of the split-opened device as per the request of the technical staff.

Most often the fakes are identical in appearance to the genuine counterpart so that even the manufacturers could not identify the duplicated device without doing a proper test. Therefore, it is almost impossible to give guidance to the general public to distinguish

Fig. 3. Erroneous installation of down conductors. a) Right-angled bend about 3-m above ground level. b) U bend close to windows. c) Crooked and twisted down conductor. d) Loosely hanging part of a down conductor. e) Down conductor running very close to an entrance and to electrical equipment (down conductor is highlighted by a black line). f) Down conductor where the ground termination cannot be traced.

the genuine products. The only advice that we give in this regard is to buy products from authorized dealers; however, this may not be 100% foolproof.

Attitudinal and Administrative Barriers

Most of the issues discussed in the previous sections could not be rectified for several years even after the pertinent engineering/technical staff was educated about the drawbacks. In some cases, the problems were not addressed even after 7–8 years despite adverse effects due to the identified problems. There are two primary, interrelated reasons for this persistence: attitudinal problems and administrative red tape. The two factors complement each other in developing high barriers, preventing the issues from being addressed scientifically and technically.

During our interviews, it was revealed that there is considerable reluctance among ground level engineering/technical staff to go beyond routine work in rectifying these issues unless there are drastic losses. For various reasons, it was not easy to get accurate and sincere information from employees during the interviews. Hence we had to study the procedures and outcomes of a number of institutions with respect to LP concerns. As per the information we received we discuss the following factors.

1) At most institutions, the decisions on investing in infrastructure development are taken at a managerial or directorial level, where people often have no technical or scientific background. To convince nontechnical people, the technical staff needs to quantify safety and protection in terms of money. Such practice is tedious and the ordinary engineer is hardly rewarded for such efforts. Instead, it is more convenient to make a recommendation to the management asking for installing a lightning protection system. On this recommendation the authorities can request quotations from vendors. As there are, most often, no knowledgeable personnel in the staff to evaluate the quotations, the contract is given to the lowest bid, unless there are some other reason (probably nontechnical) to award it to a higher bidder. Sometimes, management rejects the request to install a surge protection system after installing a structural protection system (or vice versa), stating that an LP system has already been installed.
2) We have also been informed at several institutions that the management has asked the engineering staff to refer the request for LP system to the financial departments to check the possibility of obtaining insurance coverage against the lightning hazards instead of installing an LP scheme. Due to high competition among insurance companies and also due to their lack of knowledge about LP, most insurance companies cover the risk against lightning damage (and even the losses due to downtime) without demanding a proper protection scheme.
3) In most industrial and service sectors, administrators are reluctant to shut down a power

Fig. 4. Misunderstanding of standards. The technical personnel who designed this installation successfully achieved (as he understood) less than 50-cm tape length between the main grounding bar and the earth. The incorrect positioning of the main grounding bar makes the wire length between the SPD and the main grounding bar more than 2 m, which is a Standards violation [15]. At such a location with no space restriction the designer could have easily planned the positions of both the SPD and the main grounding bar to be well in compliance with the recommendations of [15].

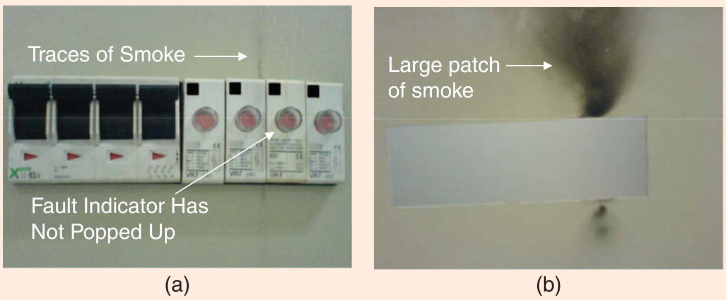

Fig. 5. a) Damaged SPD with faked brand name. Note that the fault indicator has not been popped up irrespective of arc signs. The defective SPD is discolored showing signs of internal heating, which was verified on opening the device. b) Cover of the panel with large patch of black smoke. (The smoke patch coincides with the location of the damaged SPD).

supply for the requirements of rectification or replacement. However, management overlooks the fact that in the event of transient damage, the most probable outcome is an unexpected and uncontrolled power outage.

4) Sometimes a rectification requires structural modifications, which are a burden for the maintenance engineers as they need to plan and design modifications and relocations that are outside their routine work.

Widespread Failures

We have discussed in detail the challenges that one would encounter in promoting scientifically justified and internationally accepted lightning protection technologies in several developing countries in the South, South East and Middle East Asian regions. Most of these countries are influential markets for lightning protection systems due to both industrial development and to the prevalence of lightning. The major drawbacks in designing or purchasing good lightning protection systems are the lack of scientific information at the local engineer level, technical lapses in analyzing transient conditions, the low quality of electrical networking/wiring practices, the majority of decision-makers being non-engineers, the ignorance of engineers/consultants in conducting proper risk assessment, the lack of up-to-date codes and guidelines at a national level, the flooding of the market with fake products, and the unethical perks offered by the vendors to consultants and decision makers. These shortfalls lead to dangerous grounding practices, inappropriate selection of lightning protection devices, excessively high costs for protection, unacceptable levels of system failure, and a low level of reliability.

Ignorance, lack of awareness and negative attitudes plague customers. The hunt for higher profits (overlooking scientific reality), a lack of knowledge, ignorance of standard practices, and bad engineering by vendors have resulted in the failure of many installed LP systems. These widespread failures affect the faith of the customers in LP systems in particular and in technologies as a whole (not only on singled out brands or companies in most cases). Unless the LP manufacturing and marketing communities launch a joint program to eradicate such psychological negativity among customers, the market will dwindle in this region, despite the region's growing development and industrialization.

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