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# You Can't Make This Stuff Up!



## IN COMPLIANCE

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Professional Development Options for Compliance Engineers

We've queried our training contacts and resources from across the compliance industry and compiled in this article a wide range of options to help you meet your own professional development goals in 2015, including both public and custom workshops and seminars, offered in person and online.

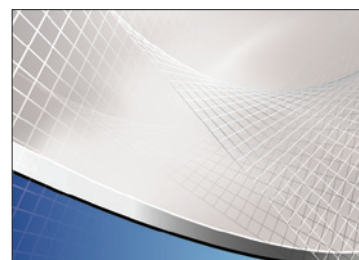
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## Letter to the Editor

*Dear Editor,*

I read with interest the article published in the October issue of In Compliance magazine. The article was “Electromagnetic Simulation Applied to Automotive EMC Testing” authored by Michel Gavião et al. The article looked very interesting as it touched two of my areas of interest, Numerical Simulations and Automotive EMC. As I continued reading

I found out that the simulations were to be compared with measurements taken at the semi-anechoic chamber at the Brazilian National Institute of Space Research. I became more interested as I was the principal RF engineer involved in the design of that chamber about 12 years ago. Not only that but I had designed all the antennas used in automotive immunity used in the measurements at that chamber below 1GHz. Not only that but some of those antennas had their performance improved as a result of analyses conducted using CST's MW Studio, the same numerical tool used by the authors. I was indeed very excited about the paper at this point, but the rest of the paper was extremely disappointing.

My disappointment began with the results section. Figure 7 showed the ETS-Lindgren model 5503-5m Vertical and Horizontal Field Generator. But in the simulation the authors simulate this field generating device as a plane wave incoming from the top. The 5503 is a standard transmission line system (TLS) like the ones described in ISO 11451 and SAE J551/11. It could have been better modeled as a plane wave incident on the front end of the vehicle and having the bottom and top boundaries as PEC while the left and right could be modeled as open boundaries. The back boundary could have been set as a port or open. Truly at those frequencies a simple model of the transmission line system could have been created without using much additional memory, given the detailed model of the vehicle. I find it really disturbing that Figure 8 shows a good agreement between measurement and simulation, given how different the two are. There is also no explanation as to how the input power for the measurement and the simulation were adjusted to be able to do the comparison. Having used CST for over 12 years to analyze antennas and absorber and antennas in the presence of test benches I find that that is a critical thing to do the comparison.





## Authors' Reply

The section about the 30 MHz to 100 MHz did not ease my disappointment. For that range an ETS-Lindgren 3159 biconical is used. The balun is your typical 50 to 200 ohms impedance Guanella balun, the antenna can be easily modeled as a solid cone (a shape available in CST's software) with a discrete port having 200 ohm input impedance. This approximation is fairly accurate as I have used it in simulations of that specific antenna inside a chamber. The authors do not show any results for that range.

The following section shows the 3112 Dual Ridge Horn as the measurement antenna. The authors do not tell us if their model is also a dual ridge horn or a standard gain horn. They state that the antenna in the simulations is scaled for different ranges so that an available antenna model from a library can be used. The comparison makes more sense but again the authors fail to explain how they adjusted the input power to do the comparison.

All these antennas are commercially available and their performance charts, and gain are found on the website of the manufacturer. It seems that there was not a lot of research done by the authors of the paper.

The final section is also disappointing. The antennas used are made by FSA in Germany, and the system was integrated by R&S. The authors state that "Since the antennas were operating with a smaller wavelength (1GHz equals 30cm) the fields generated by the antenna were considered to be a plane wave in the vehicle region."

While the authors do not state the test distance this could have been 2m as mentioned in the ISO 11451-2 standard from the reference point. Additionally these are large antennas (electrically) that will provide a high gain so that smaller power amplifiers can be used. An antenna will generate a plane wave in the far field, but I doubt very much that at 2m distance the reference point was in the far field. An antenna with a 50cm aperture will have its far field region at about 3m at 2GHz, at 1 GHz the far field will start at about 1.5m, but even then that plane wave will not cover the entire front of the vehicle.

The article could have been extremely interesting and informative, but the numerous errors and lack of information are more a detriment of the use of simulations for predictions than a support to numerical electromagnetics.

Dr. Vince Rodriguez

Thank you for the message. We are always glad to hear from people with a deep involvement in the field, and we are grateful for the advice on antenna approximation. We will attempt to answer your questions as fully as we can.

As we noted in the article, these simulations were performed alongside the EMC testing process for a newly developed vehicle and were limited in terms of resources. This meant that we had strict time limits in which to provide useful data, and only limited access to the test equipment. As a result the goal of the project was not only to model the test set-up accurately, but to do so in a way that could be set up and simulated quickly on a modest workstation. For this reason, we had to balance the accuracy gained by simulating the test chamber in full (with absorbers and antenna models) against the time saved by using approximate models.

As we did not have access to the antennas, we searched for detailed models of such antennas and also the components used to feed these antennas. Unfortunately manufacturers only provide printed data sheets that cannot be used in simulations. For simulation purposes, it is more useful for the manufacturers of EMC measurement equipment to provide simple geometries, S-parameter data, near fields and so on.

To answer the question about input power adjustment: The input power is adjusted at each frequency point so that the level measured at a reference point on the vehicle (usually, on the hood) is kept fixed, so that the results are independent of frequency band and antenna type. This is done in accordance with the CISPR 25 regulations. Every dot on the measurement plot represents a discrete frequency point where this adjustment was made.

You are correct that Figure 7 was depicted incorrectly, for which we apologize. The electric wave vector was vertical in the actual simulation.

Best regards,

Michel Gaviao,  
Marcelo B. Perotoni, and  
Alvaro B. Dietrich

## FCC's Wireless Auction Bid Total Reaches \$34 Billion

The current auction by the U.S. Federal Communications Commission (FCC) of wireless spectrum licenses may prove to be the most lucrative in the Commission's history, and provide a major windfall for taxpayers while potentially raising the cost of wireless traffic for consumers.

According to a report in the *Wall Street Journal*, bids received to date in connection with the Commission's auction already total \$34 billion, with bids submitted by at least 70 different entities. The FCC's original goal for this auction, the first major spectrum auction since 2008, was to raise at least \$10.6 billion.

The fury of activity is being attributed to the explosive growth in the use of wireless devices and the ever-increasing demand for spectrum to support consumer demand. The CTIA estimates that Americans spent 2.6 trillion minutes talking on cellphones in 2013, up 17% since 2010, but that data usage has increased by over 700% during the same period, from 388 billion megabytes to over 3.2 trillion megabytes.

More than 1600 separate licenses covering the mid-band wireless spectrum (1700 MHz and 2100 MHz) are being made available in this round, with individual bids for licenses in some of the most heavily populated areas of the U.S. already nearing \$2 billion.

## Commission Declines to Issue Forfeiture Penalties

In a highly unusual move, the U.S. Federal Communications Commission (FCC) has determined that no forfeiture penalties are due from ten wireless service providers that the Commission had previously determined to be in violation of its rules regarding hearing-aid compatible handset deployment.

In 2011, the Commission issued Notices of Apparent Liability against the wireless carriers for failing to offer consumers the requisite number of hearing-aid compatible handsets, proposing specific financial forfeiture penalties in each case. The Notices of Apparent Liability were based on information contained in mandatory filings submitted to the FCC by the carriers in January 2011 covering activity in 2010.

However, each of the ten wireless providers appealed the Commission's initial determination, averring that the documentation submitted to the FCC supported their claims of compliance with the FCC's hearing-aid compatibility requirements. Upon further review, the Commission determined that the carriers were indeed in compliance during the period in question, and that no forfeiture penalties should be imposed.

The complete text of the Commission's Order is available at [incompliancemag.com/news/1501\\_1](http://incompliancemag.com/news/1501_1)

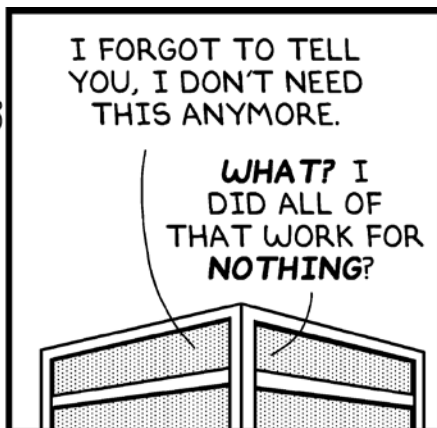
## Commission Revokes Amateur License

In another unusual action, the U.S. Federal Communications Commission (FCC) has reversed an earlier decision by a Chief Administrative Law Judge not to revoke the license of an amateur radio operator who is also a convicted sex offender.

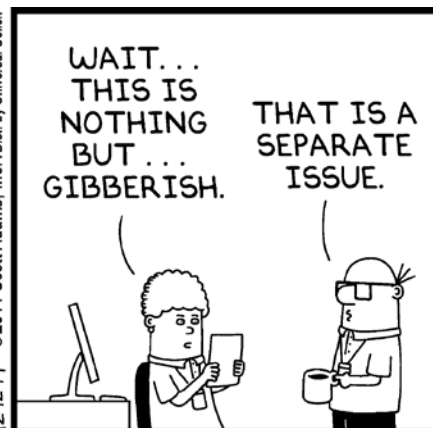
The case in question involved an Order to Show Cause issued in 2007 by the Commission's Enforcement Bureau against David L. Titus, a licensed amateur radio operator. The Enforcement Bureau issued the Show



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Cause Order based on information it had received about Titus' prior history of sexual offenses, including at least one felony sex conviction involving a child.

However, in subsequent hearings held in connection with the Enforcement Bureau's Order, the presiding Administrative Law Judge ultimately held that the Enforcement Bureau's case did not meet the required burden of proof, and that there was no credible evidence supporting the claim that Titus was a high-risk sex offender. As a result, the Judge declined to revoke Titus' amateur radio license.

Upon reviewing the case, the Commission determined that the Judge erred in his judgement regarding the

Enforcement Bureau's case by failing to consider relevant convictions for sex offenses, and by failing to give due deference to the judgment of law enforcement officials regarding the risk that Titus posed to the community. Based on this reasoning, the Commission reversed the Judge's decision, and revoked Titus' license.

The complete text of the Commission's Decision is available at [incompliancemag.com/news/1501\\_2](http://incompliancemag.com/news/1501_2).

### FCC Reaffirms Opt-Out Notice Requirements for Faxes

The U.S. Federal Communications Commission (FCC) has reaffirmed

that its requirements regarding the inclusion of opt-out notices on all fax advertising messages applies even to fax messages sent to recipients that have previously granted permission to the sender.

In an Order released in October 2014, the Commission restated its rules that opt-out notices must: 1) be clear and conspicuous and on the first page of the faxed advertisement; 2) state that recipients can request the sender not send future advertisements, and that the sender's failure to comply with the request within 30 days is unlawful; and 3) include a domestic contact phone and fax number to which the recipient can transmit their opt-out request.

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The Order also makes clear that even senders with a prior business relationship with a given recipient must include an opt-out notice that complies with the above requirements.

In issuing this clarification, the Commission acknowledges possible confusion about senders of advertising faxes as to the circumstances in which the opt-out notice requirement applies. At the same time, the Commission has also set an April 30, 2015 deadline for the filing of any waiver request from fax senders. Following that date, the Commission says it expects full compliance with the opt-out notice requirements.

The complete text of the Commission's Order in connection with its opt-out notice requirements is available at [incompliancemag.com/news/1501\\_3](http://incompliancemag.com/news/1501_3).

## FTC Settles with Certification Organization

A leading provider of privacy certifications for Internet-based companies has reached a tentative settlement with the U.S. Federal Trade Commission (FTC) in connection with charges that it failed to conduct annual audits of previously certified companies for continuing compliance.

The company TRUSTe has agreed to pay a fine of \$200,000 for knowingly misleading consumers about its recertification activities in connection with privacy policies and practices of its client companies. In addition, TRUSTe will be prohibited from making misrepresentations about its certification process, as well as misrepresenting its status as a non-profit entity. The company became a for-profit corporation in 2008, but continued to provide clients with

model language for their privacy policies that referenced TRUSTe as a non-profit.

According to the FTC complaint, sTRUSTe failed in over 1000 instances between 2006 and January 2013 to conduct the annual required recertification audits of companies authorized to display TRUSTe privacy marks on their websites and other collateral. This lack of recertification activity directly conflicted with claims on the TRUSTe website that company's displaying the TRUSTe certification mark were recertified every year.

The complete text of the FTC's draft settlement agreement with TRUSTe is available at [incompliancemag.com/news/1501\\_4](http://incompliancemag.com/news/1501_4). Public comment on the settlement was open through December 17, 2014.

## EU Commission Corrects Standards List for R&TTE Directive

The Commission of the European Union (EU) has published a corrected list of standards that can be used to demonstrate compliance with the essential requirements of Directive 1999/5/EC, covering radio equipment and telecommunications terminal equipment (R&TTE).

According to the Directive, 'radio equipment' is defined as any product capable of communication via emission and/or reception of radio waves. 'Telecommunications terminal equipment' is any device intended to be connected directly or indirectly to the public telecommunications network. The scope of the Directive also includes certain medical devices and active implantable medical devices.

The corrected list of Cenelec and ETSI standards was published in November 2014 in the *Official Journal of the European Union*, and replaces the list previously published in September 2014. The corrected list of standards can be viewed at [incompliancemag.com/news/1501\\_5](http://incompliancemag.com/news/1501_5).

The R&TTE Directive will soon be replaced with the EU's new Radio Equipment Directive (2014/53/EU), with new requirements scheduled to come into full effect in June 2016. The completed text of the Radio Equipment Directive is available at [incompliancemag.com/news/1501\\_6](http://incompliancemag.com/news/1501_6).

## Apple iPhone USB Chargers Recalled

Tectron International of Vernon, CA has announced the recall of about 55,000 3-in-1 USB phone chargers manufactured in China for use with certain models of Apple iPhones and iPad tablets.

According to the company, the USB chargers can overheat during use, posing a fire hazard. Tectron has received reports of two separate incidents in which the USB charger melted, but there have been no reports of injuries or property damage.

The recalled USB chargers were sold by a number of different distributors for school fundraisers during July and August 2014 for about \$3.50. Distributors include AGI Fundraising, The Chip Shoppe, CPK Inc., Evergreen Fundraising, Great American Opportunities and Paragon Promotions.

Additional information about this recall is available at [incompliancemag.com/news/1501\\_7](http://incompliancemag.com/news/1501_7).



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## Life Alert Personal Emergency Response Pendants Recalled

Visonic Inc. of Westford, MA has issued a voluntary recall for about 29,000 personal emergency response pendants and pendant kits manufactured in Israel and distributed to customers who subscribe to Life Alert alarm monitoring services.

According to Visonic, an accelerated circuit drain of the pendant battery can result in a decreased battery life, and a reduction in the expected “low battery” warning period from 30 days to nine days. The company says that it has not received any reports of injuries or incidents related to the recalled pendants or pendant kits, but has initiated the recall to prevent any such incidents in the future.

The recalled pendants and pendant kits were leased to Life Alert customers during the period from May 2013

through July 2014. The retail price for the pendants was about \$50, while the pendant kits retailed for between \$220 and \$240.

More details about this product recall are available at [incompliancemag.com/news/1501\\_8](http://incompliancemag.com/news/1501_8).

## Digital Audio Recorders Recalled

Olympus Imaging America, Inc. of Center Valley, PA is recalling about 500 Olympus-model digital audio recorders manufactured in China.

According to a notice issued by the U.S. Consumer Product Safety Commission (CPSC), the recalled recorders can overheat during recharging, posing a burn hazard to consumers and a risk of damage to property. Olympus says that it has received three separate reports of recorders overheating, but no reports of injuries or property damage.

The recalled recorders were sold at camera and electronics stores and mass merchandisers nationwide from February through June 2014 for about \$450.

Further details about this recall are available at [incompliancemag.com/news/1501\\_9](http://incompliancemag.com/news/1501_9).

## UL Standards Updates

**UL 536: Flexible Metallic Hose**  
New Edition dated December 5, 2014

**UL 864: Control Units and Accessories for Fire Alarm Systems**  
New Edition dated December 1, 2014

**UL 961: Electric Hobby and Sports Equipment**  
New Edition dated December 5, 2014

**UL 62368-1: Audio/video, information and communication technology equipment - Part 1: Safety requirements**  
New Edition dated December 1, 2014

## You Can't Make This Stuff Up

### Russia to Launch Wikipedia Competitor

It seems that Wikipedia, reputedly the world's most comprehensive online encyclopedia, just isn't good enough for Russia.

According to the Reuters News Service, Russia's Boris Yeltsin Presidential Library has announced plans to create its own online encyclopedia to give Russian citizens more “detailed and reliable” information about their country. According to a statement released

by the Library, at least 50,000 books and archival documents from 27 separate libraries throughout Russia have already been collected as the first step in the creation of an “alternative Wikipedia.”

“The analysis of this resource” (i.e., Wikipedia) “has shown that is not capable of providing information about the region and the life of the country in a detailed or sufficient way,” according to the Library statement. “Integration of unique materials on the regions in a single electronic encyclopedia will allow

to objectively and accurately present the country and its population, the diversity of the state, the national system of Russia.”

Russia's current President Vladimir Putin has reportedly labeled the Internet a “CIA Project,” and Russian authorities have recently been empowered to actively block certain websites without a court order. Will the advent of a Russian alternative to Wikipedia lead to blocking the real Wikipedia from Russian visitors? Stay tuned!



## UL Standards Revisions

### UL 248-2: Low-Voltage Fuses - Part 2: Class C Fuses

Revision dated November 20, 2014

### UL 248-3: Low-Voltage Fuses - Part 3: Class CA and CB Fuses

Revision dated November 20, 2014

### UL 248-4: Low-Voltage Fuses - Part 4: Class CC Fuses

Revision dated December 1, 2014

### UL 430: Waste Disposers

Revision dated December 10, 2014

### UL 471: Commercial Refrigerators and Freezers

Revision dated November 17, 2014

### UL 482: Portable Sun/Heat Lamps

Revision dated December 8, 2014

### UL 514B: Conduit, Tubing, and Cable Fittings

Revision dated November 21, 2014

### UL 514C: Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

Revision dated December 10, 2014

### UL 746D: Polymeric Materials - Fabricated Parts

Revision dated December 10, 2014

### UL 751: Vending Machines

Revision dated November 21, 2014

### UL 756: Coin and Currency Changers and Actuators

Revision dated December 5, 2014

### UL 758: Appliance Wiring Material

Revision dated December 8, 2014

### UL 852: Metallic Sprinkler Pipe for Fire Protection Service

Revision dated November 17, 2014

### UL 854: Service-Entrance Cables

Revision dated November 18, 2014

### UL 1275: Flammable Liquid Storage Cabinets

Revision dated November 24, 2014

### UL 1310: Class 2 Power Units

Revision dated December 12, 2014

### UL 1647: Motor-Operated Massage and Exercise Machines

Revision dated November 18, 2014

### UL 1703: Flat-Plate Photovoltaic Modules and Panels

Revision dated November 18, 2014

### UL 1769: Cylinder Valves

Revision dated December 3, 2014

### UL 1778: Uninterruptible Power Supply Equipment

Revision dated November 19, 2014



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## On Symbolology: This That and the King Named Cat

BY MIKE VIOLETTE

Most readers of this magazine can speak aloud the title of this piece, though they may not know who the Cat King is. The pattern of lines and curves between “This” and “That” have carved out a special place in our long-term memory—at least those that spent any time wiring logic gates (figuratively or literally).

 is an iconic symbol of the digital engineering world. Further, we can process a couple of hypothetical inputs (on the left side) in our heads, mapping the result into a Truth Table. AND is kind of like the truth gate, all inputs must be “TRUE” if the output is to be “TRUE.” Like other matters in life, such as marriage, pure harmonies, reasonable business arrangements and some philosophies, everything must be agreeable for the Boolean arrangement to be ONE.

Conversely, a simple modification to the AND system (a small circle on the ‘output’) inverts the entire truth table and we have a NAND. We dot logic diagrams with derivative symbols and create arrays that have fundamentally changed our lives.

Many notations abound in our engineering world. We can instantly recognize the symbol shown to the right when we



“read” a schematic. The symbol shortcuts the lengthy description, first described in May 28, 1948 Bell Labs Memo<sup>1</sup>, thus: “Transistor. This is an abbreviated combination of the words *transconductance* or *transfer*, and *varistor*. The device logically belongs in the varistor family, and has the transconductance or transfer impedance of a device having gain, so that this combination is descriptive.”

A simple symbol says it all.

### A CASE OF MISTAKEN SYMBOLOGY

Symbols abound in cultural identification, literature, superstition, worship, signs, warnings and cautions (especially In Compliance work). Symbols have moved millions to action. Sometimes, confusion over symbols and the connection to mythology can lead to an unkind outcome.

To wit, Captain James Cook (1728-1779) spent a couple of fine weeks

in Hawai‘i welcomed and honored, revered as a god. Apparently, the vision of the white sails floating in from the sea stirred up a local myth.



Captain Cook



On this journey aboard HMS Endeavour, (Cook's third voyage of discovery to seek the hidden Northwest Passage: hard frozen in his time but apparently open for business in ours), he managed to "discover" Hawai'i, the first Englishman to make contact on this most remote island archipelago. (He was not the first westerner, though, to chart the "Sandwich Islands" as he apparently used Spanish maps dating back to the mid-sixteenth century.)

Unfortunately, he overstayed his welcome, the Natives decided the truth didn't match their mythology; a fracas arose and the good Captain was clubbed and stabbed to death in the surf of Kealakekua Bay. In the manner of the native custom, the English explorer's body was baked

and his bones distributed as sacred relics, for although there was a misunderstanding, he still bore a god-like aura to the Natives.

A single stroke brought down a deity. Sometimes a single stroke can make a man a god.

## PERCEPTION AND MEMORY

In a recent RE we investigated the sense of smell and its impact on behavior, memory and the emotional context associated with our senses. My friend Mitchell Lazarus informs on the connection between sense and the evolution of the cerebral cortex. (*In Compliance Magazine*, November 2014), thus:

"...one bit of anatomy particularly fascinated me: mammalian cerebral cortex evolved out of reptilian olfactory tissue, with the result that, in us mammals, the sense of smell makes its first synaptic contact directly into the cortex. Every other sense first has to relay through the thalamus. You make the point that smells have a unique ability to trigger old memories and emotional associations. Some theorists speculate this is because of priority access to the cortex."

So smells go directly to our cortex—that "priority access." Imagery, however, is processed through the thalamus and set aside into long-term memory by the work of the hippocampus. This was examined just a year ago in these pages, wherein we examined learning (January 2013).

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Images, too, connect not just with cold reason like the logic gate, but with our emotional centers. For example, the use of “emoticons” in contemporary communications can convey happiness, sadness, confusion, frustration and disappointment all with a couple of letters and punctuation marks. Little shortcuts pepper our texts ; )

## DING-DONG, THE WITCH IS DEAD

Images, like emoticons in popular culture, can elicit strong reactions and memories. Just the sight of a *swastika*, for example, triggers fear, revulsion, anger and incalculable grief. They can just give you the heebie-jeebies.

Dating myself, *The Wizard of Oz* (before the access of always-on internet *series of tubes*) used to arrive via VHF signals to rabbit ears on our flickering RCA. One of the images that spooked my young mind was the curling of the stockinged legs of the Wicked Witch of the East, upon whom Dorothy’s house came to land who then received those magic Ruby Slippers.

This iconic scene of the death of the Munchkins’ tormentor (she lately somewhat sympathetically reformed in “*Wicked: The Untold Story of the Witches of Oz*”) is a powerful symbol of the end of tyranny in Oz. But, as is known, the relief is short-lived: there is still the other Wicked Witch. It’s not a little like the elimination of Bin Laden in May 2011—singing *Ding Dong*...was not the end of the story.

Symbols can represent permanence *and* evanescence.

## FREEMASONRY

The George Washington Masonic National Memorial rises on Shuters Hill in Alexandria with a powerful view of the Nation’s Capitol. The belief



Ding Dong

system of the Freemasons, a secular organization with roots in England, is replete with symbols and the very edifice is a symbol of the connection between our Earth-bound existence and the desire to thrust to heaven, a “lighthouse to Washington,”<sup>2</sup> a shrine to the “father of our country,” a practicing Mason. It is open most days to the general public.

Masons, being engineers by inference, are builders, but of stuff that is not always physical. The symbology and rites are part of the building process.

Thus, it is no surprise that the symbols are common in entry-level drafting classes (well, maybe not so much anymore, but I still have my T-Square and my dad’s drafting kit.). The elements of the principal Masonic



Freemasonry Symbol

symbol include a square, a compass or divider, and the letter “G.”

“The square is the symbol of the human soul, create “square,” perfect, though invested with freedom of choice and capacity for error.”<sup>3</sup> (Measurement uncertainty, anyone?) The compass represents the soul, “its functional energy or fire.”

To be a Mason (and I am not one, nor an expert) one must ascribe to the belief of a higher being. It is the foundation of the organization’s belief system. Thus, the letter “G” represents God or Geometry and its position in the center of the Masonic imagery illustrates its importance in the entire belief system.

“Geometry was on of the ‘seven noble arts and sciences’ of ancient philosophy. It means literally the science of earth-measurement.” But Geometry carries more than a prosaic meaning. As with proper engineering, it is not possible to build something without “first understanding the nature of the raw material the nature of the raw material to work with.” *Ibid.*

In Masonic themes, the purpose of the study and practice of the rites and importance of the symbology is for self-knowledge and self-improvement (never mind the malignment and trashing of the order by conspiracies featured in pop films and novels). The Masons aspire to be “king” of their own minds. The symbols represent the context and goals and the degrees represent progress towards those goals.

## SO, WHO IS THIS CAT KING?

Some readers of ICM know of my Far East wanderings, notably my long-ingrained Sinophilia. There is much symbology in the written “word” in the Chinese written language (and



Speaking of kings, The Cat King was born on January 8, 1935 and died on August 16, 1977, a King that Vegas--and the rest of the world--knew well. In China he is known as 猫王 (māo wáng) and is featured on karaoke menus all over the country.

its derivatives). The language is hieroglyphic, entirely non-phonetic and rich in homophones. It is also an evocative written language. The origins of written Chinese language trace back 3500 years or so, with the first characters scratched onto so-called "oracle bones," traced onto animal bones and shells. These figures are fanciful representations of common objects: animals, objects, people and actions, some of which still present their "DNA" to the modern construct. My favorite character is "fire" (huo) which looks like this:

Fire!

The character is composed of the word for "person" (ren) with two additional ticks. Looks, to me, like a guy on fire. Other words also contain emotional import: the word for "good" (hǎo) is the combination of the characters for boy and girl. The word for peace is represented by the symbol of a woman under a roof.

All of these symbols (perhaps 20,000 or more) were constructed to define the creation of human thought, societal order and philosophy. The hierarchy of the Emperors, considered near-Gods themselves, was established long ago. The various dynasties rose and ebbed (the oracle bones were first associated with the Shang Dynasty.). The language evolved. Obviously words

were necessary to describe the social and command hierarchy of the dynasty. At the highest sat the emperor. At the lowest ranks are the commoners, the workers. Thus, some of the oldest characters represent "worker" and "king."

Worker is "gong." King is "wang." These symbols are very nearly the same, with a simple horizontal slash changing the entire meaning. Sometimes a single stroke can make a man a god.

Chinese Worker

Chinese King

Speaking of kings, The Cat King was born on January 8, 1935 and died on August 16, 1977, a King that Vegas--and the rest of the world--knew well. In China he is known as 猫王 (māo wáng) and is featured on karaoke menus all over the country.

"The King of Rock and Roll." Somehow, the "cat" part of his name derived from him being known as the "Hillbilly Cat," so informs my dear friend in Beijing. Combining "Cat" with "King." Voilà!



The Cat King

Language, symbols, and graphic representations abound. In our work we use symbols all the time to convey meaning. In the broader world, symbols can be trivial; they can also be profound.

Elvis has left the building.

## NOTES

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2. <http://www.gwmemorial.org/history.php>
3. "The Meaning of Masonry" W.L. Wilmshurst. 1922. William Rider & Son. London.

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# TECHNICALLY Speaking

## Electrically-Caused Fire in Multilayer Circuit Boards

Product Safety Newsletter - November/December 1989

BY RICHARD NUTE

*A few months ago, a colleague asked whether he needed a fuse in series with the 5-volt supply on an OEM-supplied printed wiring board. The 5-volt supply to the board was rated about 40 amps. My colleague wanted assurance that the board would not compromise the safety of the product.*

I recognize that, in the case of a user-accessible board, some standards require an 8-amp inherent limit, or a 5-amp fuse, or a 240- V A limit, or a 150-watt limit. However, readers of this column will recognize that I address the hazards involved rather than the standards requirements. Standards presume certain hazards already exist in the equipment regardless of whether such hazards actually exist. The design of a product can obviate the hazards from high current or high power by means other than by making such circuits inaccessible. To do so requires that the hazard be identified, e.g., fire, and that the way the hazard arises, i.e., the fire starts, be identified.

Safeguards can then be designed into the product so as to prevent the hazard from arising. Such a process yields a safe product, but not necessarily a certifiable product. Such is the sorry state of affairs of the product safety discipline.

My colleague was dealing with a 5-volt, 40-amp, 200-watt (minimum) source. Two

hundred watts is more than enough power to start a fire if the power dissipation is not properly managed and controlled. In terms of whether the safety of the product might be compromised, we would first look at whether this power could be dissipated in such a fashion as to cause a fire.

Let's review the necessary conditions for an electrically-caused fire.

Electrically-caused fire only occurs under fault or mis-use conditions. (I believe it is obvious that fires in electronic equipment do not occur under normal or normal-use conditions.)

Electrically-caused fire occurs when electrical heating raises the temperature of a fuel material to ignition temperature. Three elements are crucial to this statement. First, virtually all materials will burn if the temperature is high enough and if heat is continuously applied to the material. (For many materials, the combustion process produces sufficient thermal energy to sustain flaming and

burning.) Second, the temperature of the heating element must be greater than the ignition temperature of the fuel material. Third, there must be sufficient electrical energy converted to thermal energy and transmitted to the fuel material to raise its temperature to ignition temperature.

The reason electric heaters don't ignite and burn is that the ignition temperature of the materials is greater than the temperature produced by the heating element. In addition, some electric heaters are built in such a fashion as to limit transmission of thermal energy to nearby external materials.

Electrical heating only occurs when electrical energy is converted to thermal energy (i.e., power dissipated in some device which produces significant heat).

Since electrically-caused fires occur only under fault conditions, the first job is to identify those parts of the circuit which, under fault conditions, would operate as heating elements and could convert a



significant amount of power to thermal energy such that:

- (1) the heating element temperature will be greater than the ignition temperature of nearby fuel materials, and
- (2) there will be sufficient electrical energy converted to thermal energy so as to raise the temperature of candidate fuel material to ignition temperature, and
- (3) there will be sufficient time to transfer the necessary thermal energy to the candidate fuel material.

To get some clues as to what parts could dissipate significant power under fault conditions, we can examine the variables which would cause power in a circuit to increase by a significant amount. Power dissipation is expressed in three ways:

- (1)  $P = E \times I$
- (2)  $P = E \times E / R$
- (3)  $P = I \times I \times R$

where  $P$  is power in watts,  
 $E$  is potential in volts,  
 $I$  is current in amperes,  
 $R$  is resistance in ohms.

Now, which parts on the circuit board can change to affect  $E$ ,  $I$ , and  $R$  in such a way as to increase power dissipation? In equations (1) and (2), if we increase

$E$ , we will increase  $P$ . Since the voltage source is external to the circuit board, no circuit board faults can increase the value of  $E$  supplied to the board. So, we need to look further.

With a constant-voltage power supply, if we decrease  $R$ , we will increase  $P$ . Let's get some idea of the values of  $P$  related to the values of  $R$ . (Table 1)

(Note that, if we were dealing with a constant-current source, increasing  $R$  would decrease  $P$ . However, in practice, the vast majority of circuits are constant-voltage.)

In equation (3), if we increase  $R$ , we will increase  $P$ . But, since  $R$  is in series with the source, if we increase  $R$  we will reduce  $I$ . Again, let's look at some values of  $R$  and  $I$ . (Table 2)

In a constant-voltage circuit, as  $R$  increases,  $I$  decreases, and, because  $I$  is squared in the equation,  $I$  dominates the total effect on  $P$ . Thus, increasing  $R$  does not increase  $P$ . Instead, the total effect is just the opposite: as  $R$  decreases,  $P$  increases!

(Note that if we were dealing with a constant-current source, increasing  $R$  would indeed increase  $P$  just as

predicted by the equation. However, in practice, the vast majority of circuits are constant-voltage.)

These data suggest that if we can identify a part failure in which the part resistance goes down to less than one ohm, then we have a candidate part or circuit for converting electric power to thermal energy. The "ideal" part failure is where the fault resistance is sufficiently low to draw maximum current from the supply.

These data dictate a second parameter for candidate parts: The part must be capable of carrying the fault current for an extended time interval without fusing.

Under normal conditions, we usually ignore the resistances inherent to wires, circuit board conductors, and connector contacts. However, when we are dealing with fault conditions where total circuit resistances are fractions of an ohm, and where currents are ten, a hundred, or even a thousand or more times normal current values, we can no longer ignore conductor resistances and connector contact resistances. So, when we are looking for candidate parts for converting electrical energy to thermal energy, we must now include

$P = E^2 \div R$			
Power	Potential	°	Resistance
Watts	Volts	$E^2$	Ohms
12.5	5	25	2
25	5	25	1
50	5	25	0.5
125	5	25	0.2
160	4	16	0.1
80	2	4	0.05
32	0.8	0.64	0.02
16	0.4	0.16	0.01

Table 1

$P = I^2 \times R$			
Power	Current	°	Resistance
Watts	Amperes	$I^2$	Ohms
12.5	2.5	6.25	2
25	5	25	1
50	10	100	0.5
125	25	625	0.2
160	40	1600	0.1
80	40	1600	0.05
32	40	1600	0.02
16	40	1600	0.01

Table 2

# TECHNICALLY Speaking

There are two broad categories of devices which have low-value resistances which maximize power dissipation from the voltage source: board-mounted components and board conductors.

printed-wiring conductor resistances and connector contact resistances.

Now we've got some bounds on what we're looking for. We're looking for that single component which is connected between a high-current voltage source and the return for that source (usually ground). The component doesn't have to dissipate the power, but it does need to carry the high current for an extended time without fusing open. As an example, this could be a bypass capacitor located near the power pin of an IC. Such capacitors can short, resulting in a very low resistance and very high current-carrying capacity -- ideal conditions for dissipating power in the fractional-ohm resistance of the conductors to and from the capacitor.

Or, we're looking for two components in series, one of which is a low resistance under normal conditions. As an example, this could be a decoupling circuit comprised of a low-value series resistor and a capacitor to ground. If the capacitor should short, then excessive power would be dissipated in the resistor. Many metal-film and carbon-film resistors initially decrease in value when subjected to heating as from over-power conditions. Again, we have ideal conditions for dissipating power in the form of thermal energy.

Finally, we're looking for candidate fuel materials and their proximity to the power dissipating components. The coatings on capacitors and resistors can be fuel, but there's not a lot of it. Such coatings, when heated to ignition temperature, will burn only for a very short time -- less than 30 seconds -- before the fuel is consumed. Because of this short burning time, not much

thermal energy will be transmitted to other near-by candidate fuels.

For a printed wiring board, the most obvious candidate fuel material is the epoxy of the printed wiring board. And, the quantity of fuel is relatively high. It is in intimate contact with board conductors, and is very near to heat dissipating components mounted on the board.

(At this point, some of you may be saying that your boards are flame-rated by UL and therefore won't burn. Recall that virtually all materials will burn if the temperature is high enough and if heat is continuously applied to the material. The flame tests in UL 94 and its clones are measures of the time of burning after removal of the source of heat. The UL 94 flame tests do not address what happens to the material in the presence of a high-temperature source of heat! V-rated boards burn very nicely in the presence of a source of heat.)

And, for a printed wiring board, the most obvious candidate power dissipating component is the conductor itself.

Now that we've reviewed the necessary conditions for an electrically-caused fire, let's look at the case for electrically-caused fire in multilayer circuit boards.

Remember, we are looking for means for dissipating power. To dissipate power from a voltage source, we are looking for low-value resistances that occur or become significant under fault conditions. The resistance value must not be so low as to cause the voltage source to go into current-source mode.

There are two broad categories of devices which have low-value resistances which maximize power dissipation from the voltage source. First are board-mounted components such as resistors, semiconductors, and connectors. (Capacitors are not included as a shorted capacitor is very-low resistance and does not itself dissipate power.)

Resistors would be limited to low-value or high-power types which, with a fault elsewhere in the circuit, could be caused to dissipate excessive power. Semiconductors would be diodes, transistors, and power ICs which, with a fault else-where in the circuit, could be caused to turn on in a fashion to continuously dissipate power in the semi-conductor forward resistance.

The second broad category are board conductors. In a multilayer board, the inner layers often are used for power distribution and return (ground). These are usually full copper sheets with holes for vias and interconnects.

Because there is so much copper, the cross-sectional area is high and the resistance is very, very low. So, there is low likelihood that the inner layer sheet conductors will overheat. The interconnects from the holes to these planes often have thermal isolation to make soldering easier. While these interconnects have a small cross-sectional area, their total resistance is not high because they are physically short in length and they are well heat-sunk to the inner planes.

With such a construction, we want to look for the longest power supply and ground-return conductors on the



top and bottom of the board. These conductors will have small cross-sectional area for the available current, and sufficient length to have enough resistance to dissipate significant power.

In the case of my colleague's board, we found such construction with a bypass capacitor at the end of a 5-volt supply conductor on the top side of the board. We shorted the capacitor, and connected the board to a 5-volt, 40-ampere power supply, and monitored both the voltage and the current.

In a few minutes, the board turned brown, and then black in the region of the capacitor. A few minutes later we had smoke. A few more minutes and we had glowing, and then burning.

For the next hour we had alternating glowing and burning as the glowing and burning followed the board conductor to its origin at the board edge connector. The current ranged between 7 and 20 amperes, dissipating from 35 to 100 watts. Then, as it reached the connector area, the current dropped to less than 4 amps, and the glowing and flaming stopped.

We examined the board in the burned area, and we found the epoxy had been burned away, the glass fiber remained, and the circuit was open at the shorted capacitor! What, then, was sustaining the current?

There are a number of possible explanations, especially when such a fire destroys insulation and could

cause additional shorts. But such shorts would need to be robust low-resistance shorts to carry the 7 to 20 amperes without fusing. In addition, the low-impedance short would need to be through the fiberglass of the board. None of these explanations is highly plausible.

The one explanation that agrees with the evidence is that the epoxy becomes conductive as it liquefies. Not only does it become conductive, it is a low-value resistance which dissipates power. This power dissipation melts more epoxy, and the process continues until the epoxy is consumed.

We tested this hypothesis by threading nichrome wire through the holes of a bare multilayer board. We connected



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# TECHNICALLY Speaking

the board power supply and ground planes to a 5-volt, 10-ampere power supply, and monitored the voltage and current. We gradually increased the power to the nichrome wire until the epoxy started to turn color and then to liquefy. Initially, the current to the board was zero.

At the moment the epoxy liquefied, the current rapidly increased. In about 10 seconds, the current was the full 10 amperes our supply could provide! A few moments later, the epoxy was glowing.

This board had numerous holes for ICs. The glowing slowly progressed among the holes for six hours before we terminated the test! We had no flame. We attribute the lack of flame to the limited power available from the power supply. The glowing appeared to be between the 5-volt plane and the ground plane in the center two layers of the 4-layer board. Sometimes the glowing was on the top of the board, sometimes on the bottom of the board. Throughout, the power input to the board remained constant.

The point is, printed wiring board epoxy is conductive when it is heated to the temperature at which it liquefies. At that temperature, and if sufficient current is available, its resistance dissipates sufficient power to heat additional epoxy which sustains the production of liquefied epoxy. Depending on the available current, the liquefied epoxy will smoke, glow, or flame.

Next, we must address the question: How can we provide protection against such fires?

To answer this question, we must review the three conditions necessary for the fire to start:

- (1) the heating element temperature will be greater than the ignition

temperature of nearby fuel materials, and

- (2) there will be sufficient electrical energy converted to thermal energy so as to raise the temperature of candidate fuel material to ignition temperature, and
- (3) there will be sufficient time to transfer the necessary thermal energy to the candidate fuel material.

We can provide protection by obviating or preventing any one of these three conditions. We'll look at these in reverse order.

The conventional means for providing protection against electrically caused fire is to control the parameter of time (3) through the use of a fuse or other automatic disconnect in the event of an overcurrent situation.

Since the current involved with this particular fire is proportional to the geometry of the supply and return conductors, a fuse will likely provide protection if the fire evolves between large-area inner layers where the volume of molten epoxy will be large and the current through the epoxy correspondingly large. But the fuse will not provide protection between small-area top or bottom conductors and the inner conductors where the volume of molten epoxy will be small and the current through the epoxy correspondingly small. This is because the differential current between normal mode and fault mode is large for a large-area conductor, and small for a small-area conductor.

Another means for providing protection against electrically caused fire is to control the parameter of conductor resistance (2) through the use of large cross-sectional-area conductors such that the conductors

will not overheat with the available fault current.

If we increase the cross-sectional area of supply and return conductors, then we have limited the dissipation of electrical energy in the form of thermal energy.

Lastly, we can heat-sink all power dissipating devices so as to limit their temperature rise (1). On printed wiring boards this is often done by using large area conductors for each of the terminals of resistors and power semiconductors.

What about two-sided and single-sided boards?


I haven't seen evidence of extensive fires for two-sided and single-sided boards as I have for multilayer boards. There is some rationale for the phenomenon not being prevalent on two-sided and single-sided boards. If we review the process by which the fire arises, it starts with melting the epoxy with some electrical source of heat. If we consider conductors on opposite sides of a two-sided board, then we have at least 1/16-inch of material to heat to melting temperature. This takes a lot more heat than the 1/32-inch or less in a multilayer board. Even if this occurs, the supply and return conductors need to be opposite each other, which is not usually the case.

If we consider the case of adjacent conductors on the same side of the board, we have a similar situation. We must heat the epoxy between the two conductors to melting temperature, which, again, takes more heat because of the greater distance and the loss of heat to the air.

Should this occur, the geometry of the conductors likely contributes to a variable distance between conductors and variable resistance of the epoxy --



which may reduce the power dissipated in the epoxy which in turn reduces the power and the heating. The fire may not be sustained.

Well... there is opportunity for more study of power dissipated in heated and liquefied printed wiring board epoxy. 

## ACKNOWLEDGMENTS

I want to acknowledge colleague Joe Thomas, Hewlett Packard, Greely, Colorado, who first demonstrated this burning phenomenon to me, and then repeated the test with identical results.

Thanks to Kevin Cyrus, HP Vancouver, who set up the test that conclusively demonstrated the conductivity of the liquefied epoxy.

Another party presented me with additional evidence of this burning process. Though the party must remain anonymous, I want to acknowledge the contribution and thank the party for providing the evidence.

(the author)

### RICHARD NUTE

is a product safety consultant engaged in safety design, safety manufacturing, safety certification, safety standards, and forensic investigations. Mr. Nute holds a B.S. in Physical Science from California State Polytechnic University in San Luis Obispo, California. He studied in the MBA curriculum at University of Oregon. He is a former Certified Fire and Explosions Investigator.



Mr. Nute is a Life Senior Member of the IEEE, a charter member of the Product Safety Engineering Society (PSES), and a Director of the IEEE PSES Board of Directors. He was technical program chairman of the first 5 PSES annual Symposia and has been a technical presenter at every Symposium. Mr. Nute's goal as an IEEE PSES Director is to change the product safety environment from being standards-driven to being engineering-driven; to enable the engineering community to design and manufacture a safe product without having to use a product safety standard; to establish safety engineering as a required course within the electrical engineering curricula.



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## Understanding Symbols

PPE and Universal Head Shape

BY GEOFFREY PECKHAM

In last year's On Your Mark columns, we discussed key elements in helping to achieve your goal of creating the most effective safety labels possible. One of these critical building blocks is symbols. This year, we'll explore symbols in more depth – how they've changed over time to become more universally recognized and standardized – by honing in each quarter on specific examples. This month's topic: the symbols for PPE and the use of a universal head shape.

As a product engineer, you know that using well-designed symbols on your safety labels help them to more universally communicate your safety messages. It's important to make sure that the symbols you use are well-designed – which means, in this day and age, that they've been developed using design principles standardized by ISO, the global standards body in charge of safety symbols. You should not reinvent the wheel. As chair of the ANSI Z535 committee in charge of the U.S. standards for safety colors, signs, symbols, labels, tags and safety information, and chair of the ISO committee in charge of international standards for safety signs, colors and symbols, I've been engaged in the process of global standardization of symbols. I'd like to share a few of those stories with you in this year's columns, to give insight on symbols you should be using on your warnings.

### PPE SYMBOLS IN FOCUS

Looking at personal protective equipment (PPE) symbols is a great place to start. As PPE is one of the ways in which people avoid hazards in a multitude of workplace settings, its use crosses all industries. The human head and face is a necessary part of many of the symbols that indicate the use of PPE. In this article, we'll concentrate on the family of symbols oriented around two templates for the human head: 1) a profile view and 2) a front view.

### EARLY BEGINNINGS

A little over ten years ago, the ISO committee in charge of safety symbols, *ISO/TC 145 – Graphical Symbols*, Subcommittee 2, met in Berlin. The committee's Asian delegation brought to the attention of the committee that the existing human head-shaped graphical symbol was not appropriate for a global audience. It was noted that, from an Asian cultural perspective, the existing safety symbols for PPE related to face shield, eye protection, ear



Figure 1: Old ISO-formatted symbols for “Wear Face Shield,” “Wear Eye Protection,” “Wear Ear Protection,” and “Wear Respiratory Protection”.



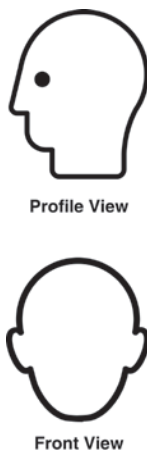
protection and respiratory protection (see Figure 1) used human head shapes that were Caucasian in nature.

What was meant by “Caucasian”? Basically it was thought that the older symbols often had a squared-off chin, an elongated (rather than round) head, and locks of hair – all of which looked Caucasian. A new human head template was proposed at that meeting. See Figure 2.

## SIMPLICITY MATTERS

The intention of ISO symbols is that they be recognized globally. This is especially important when it comes to safety. Lives may be on the line when safety messages need to be understood quickly and across all cultures. The more general, rounded nature of the new head shape corresponds better with the idea of a non-culturally specific head shape and it matches well with the human figure that has been standardized by ISO for some time. Both are simple and can be consistently used across cultures.

Extraneous detail (like hair) is not necessary to be able to identify the new head. In fact, extra detail can have the opposite effect – it can make legibility, viewing and comprehension more difficult and time-consuming. Compare the old and new “face shield” symbols shown in Figures 1 and 3. Because of its simpler, solid form shapes, the newer symbol conveys its message quicker than the older symbol.



**Figure 2: New ISO head shape templates depict a general, rounded head form.**


ISO 3864-3 is the ISO standard for the design of safety symbols. It says: “The graphical symbol should have only as much detail as is required to communicate the intended message”... it should “be simple in order to facilitate comprehension and reproduction.”

## NEXT STEPS FOR STANDARDIZATION – AND IMPROVED COMMUNICATION

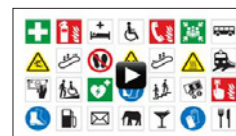
ISO/TC 145 SC2 accepted the new head shape proposals. The thought process was that they are more universal in their depiction, more simplistic in form, and are expected to have improved recognition across cultures. The PPE safety symbols using the head shape were redesigned and went through the ISO symbol registration process. In 2007, ISO standardized the universal head shape in ISO 3864-3

*Design principles for graphical symbols for use in safety signs.* See the images in Figure 3, which show the updated PPE symbols, using the standardized universal head, and compare them with the old symbols from Figure 1.

At Clarion, we use the ISO-standardized head shape templates to design PPE-related safety labels and new symbols on a regular basis – whenever a symbol needs to be used within a label to show a precautionary measure or when a new symbol needs to be created to help a client with a custom need. The benefit brought by using the latest graphical symbol design principles gives credibility to the final result and consistency to the visual communication of a company’s safety messages in line with global best practices.

Symbols do change and revisions to safety labeling standards occur. It’s important to stay up-to-date. This is true for a wide variety of product safety label messages, not just PPE. Stay tuned for the next article in this year’s *On Your Mark* series which will explore the history and progress in standardized symbols related to static electricity. 

For more information on best practices related to ISO symbols, watch a short, educational video produced by Clarion Safety Systems.



**Figure 3: Current ISO symbols for “Wear Face Shield,” “Wear Eye Protection,” “Wear Ear Protection,” and “Wear Respiratory Protection.”**

(the author)

**GEOFFREY PECKHAM**

is CEO of Clarion Safety Systems and chair of both the ANSI Z535 Committee and the U.S. Technical Advisory Group to ISO Technical Committee 145- Graphical Symbols. Over the past two decades he has played a pivotal role in the harmonization of U.S. and international standards dealing with safety signs, colors, formats and symbols. This article is courtesy of Clarion Safety Systems ©2014. All rights reserved.









# Making the Most of 2015

## Professional Development Options for Compliance Engineers

COMPILED BY THE IN COMPLIANCE MAGAZINE STAFF

*The start of a new year is a time when we usually reflect on the progress we've made during the past year and set our goals for the year ahead. More often than not, your professional development goals include training or some form of higher education to expand or refresh your technical knowledge. We've queried our training contacts and resources from across the compliance industry and compiled in this article a wide range of options to help you meet your own professional development goals in 2015, including both public and custom workshops and seminars, offered in person and online. We invite you to submit your own suggestions for additional listings as we continue to update our events section. Send your comments to us at [editor@incompliancemag.com](mailto:editor@incompliancemag.com).*

### ELECTROMAGNETIC COMPATIBILITY

**D.L.S Electronics Systems, Inc.** offers a two-day applications seminar and one day workshop. For more information, visit [www.dlsemc.com/emc-class/emc-seminar.htm](http://www.dlsemc.com/emc-class/emc-seminar.htm).

- ***EMC By Your Design: A Practical Applications Seminar and Workshop***

Using updates of the latest developments in research, standards, regulations, instrumentation and services, participants will study EMC design techniques and the calculations required to design a product to meet compliance regulations. After two days of intense study of EMC and design principles, students in the workshop will design, from start to finish, an EMC compliant product. The goal of this workshop is to help design engineers and technicians learn to apply the EMC design principles they learn in the seminar to real life products.

**ETS-Lindgren** offers hands-on training courses throughout the year. Below is a list of those courses currently scheduled through ETS-U. For more details, visit [www.ets-lindgren.com/Learning](http://www.ets-lindgren.com/Learning).

- ***Fundamentals of EMC Testing***

A three-day hands-on course designed for engineers or lab technicians who want to expand their knowledge of EMC compliance testing, or are new to the subject and want to “learn-how” quickly. Instruction is divided between class lectures and hands-on lab experience. Students are taught how to perform actual tests in a fully instrumented lab that includes a 3 meter anechoic chamber, GTEM, and a demonstration reverberation chamber. Students receive an illustrated textbook written specifically for the Fundamentals of EMC Testing course, with many of the test setups illustrated.



- **MIL-STD 461F Testing**

A three-day hands-on course designed for engineers or lab technicians who want to expand their knowledge of Military-Standard 461F testing, or are new to the subject and want to “learn-how” quickly. Instruction is divided between class lectures and hands-on lab experience. Students are taught how to perform actual tests in a fully instrumented lab that includes a semi-anechoic chamber and a conducted susceptibility test station. Students receive an illustrated textbook written specifically for the Fundamentals of EMC Testing course, with many of the test setups illustrated.

- **Overview of Radiated Immunity/Emissions Test Facilities**

A three-day hands-on course designed for engineers or lab technicians who want to expand their knowledge of Radiated Immunity and Emissions test facilities, or are new to the subject and want to “learn-how” quickly. This course will provide a basis for making informed radiated emission/immunity testing decisions. In addition this course will also cover some standards overview, test planning issues, detailed coverage of major test techniques, sources of uncertainty in test results and uncertainty propagation and impact on test results.

**Henry Ott Consultants** offers a three-day course covering the practical aspects of noise and interference control in electronic systems. More information is available on the Henry Ott Consultants website ([www.hottconsultants.com](http://www.hottconsultants.com)), both on the public and in-plant EMC courses.

- **Electromagnetic Compatibility Engineering**

This course will provide the participants with a working knowledge of electromagnetic compatibility principles. Emphasis is on cost effective EMC design for

digital systems. The commercial and industrial aspects of EMC Engineering are emphasized. The amount and complexity of mathematics will be kept to a minimum, and ideas will be illustrated with examples of actual case histories.

**Kimmel Gerke Associates** offers several public seminars throughout the year. Following are course descriptions and dates and locations of those courses currently scheduled. Design for EMC & Signal Integrity (2 days). For more information, go to [www.emiguru.com](http://www.emiguru.com).

- **EMI Troubleshooting (1 day – optional add-on)**

This very popular class has been co-hosted by Kimmel Gerke Associates and Tektronix since 1992. The focus is “inside the box” at the electronics level – components, printed circuit boards, power electronics, grounding, and shielding, with over 30 specific fixes. The class is introductory and is regularly updated to reflect the latest EMC design issues.

**MET Laboratories Compliance**

College offers seminars at various locations throughout the year. Visit [www.metlabs.com](http://www.metlabs.com) for additional details.

- **EMC & Wireless Design & Testing Seminar**

Hosted by MET Laboratories and Wurth Electronics Midcom, this one day seminar is designed by engineers and technicians, for engineers and technicians, with practical content to give you support for the development and testing of undisturbed electronics and equipment.

Silent Solutions offers a series of courses designed to expand your skills and improve job performance. Following are their course descriptions. For more information, visit [www.silent-solutions.com/education](http://www.silent-solutions.com/education).

- **Electronic Product Design and Retrofit for EMC**

This two-day class gives engineering professionals the ability to successfully recognize, solve and avoid common EMI problems. Demonstrations using working hardware illustrate concepts such as radiated emissions, high frequency antennas, radiated and conducted immunity, and crosstalk in connectors, cables and IC packages.

- **EMC – Printed Circuit Board Design**

This two-day class provides technical training intended for electrical and EMC engineers interested only in PC board design. It is an excellent follow-up class for students who have recently completed our two or three-day EMC class. Course topics include component placement, signal routing and stackup, power bus decoupling, signal theory and signal integrity, “ground” splits, and a critique of bad applications notes from IC vendors.

- **Circuit-to-Circuit Interference**

This one-day class is for electrical design engineers at all levels challenged by electrical noise problems in products containing RF (wireless), analog, switching power supply and digital electronics. Through a unique combination of lecture and hands-on experiments, class participants will master the ability to anticipate, solve and avoid electrical noise problems that can inhibit functionality in new product designs.

- **Mechanical Design for EMC**

This two-day class provides clear applications, theory and demonstrations for the successful design of mechanical enclosures for good system emissions and immunity performance. Key topics include grounding at the PCB and enclosure, system ground maps, PCB component placement and control drawings, enclosure and cable shielding, PCB device “cans”, resonant slots and enclosures, heat

sinks, unintentional antennas, as well as connector, screw, and conductive gasket spacing.

- **Grounding for EMC, Signal Integrity and Instrumentation**

Theory, applications and hardware demonstrations in this one-day class describe effective design and troubleshooting techniques. The real-time demonstrations use a spectrum analyzer, oscilloscope and signal generators to illustrate inductance, common-impedance coupling, and ground loops. Specific examples of single-point, multi-point, "good" and "bad" grounds will be discussed.

- **Mastering the Spectrum Analyzer for Electrical Noise Measurement**

SILENT's one-day class is packed with practical tips, applications, and demonstrations to help make it easy for you to pick up a spectrum analyzer and start measuring and

troubleshooting electrical noise and EMC problems. We will have a minimum of 3 different spectrum analyzers in class to help explain and demonstrate operating techniques that we have honed over the last twenty years.

**Doug Smith** is offering the following classes in 2015. For additional information, visit [www.dsmith.org](http://www.dsmith.org), or email him at [doug@emcesd.com](mailto:doug@emcesd.com).

- **Design Troubleshooting, EMC, and ESD**

This three day seminar takes the best points from Doug Smith's seminars and compresses them into three action packed days with lecture, video, and many demonstrations on live circuits. Time is allowed for attendees to operate the experiments if they want. In two days, you will learn how to make accurate measurements in the lab and then

apply those techniques to design verification and troubleshooting as well as EMC problems. The techniques and experiments are geared to the development lab and common equipment found there. During an optional third day, ESD/EMI at the system level will be covered as well as applying system level ESD stress to components, such as LEDs, in a test environment.

**Dr. Tom Van Doren** teaches participants how to diagnose and solve electromagnetic interference and signal integrity problems.

- **Grounding & Shielding of Electronic Systems**

This course treats signals and currents; explains fundamental grounding, shielding, and signal routing principles; clarifies troublesome terminology; and demonstrates many techniques for

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identifying and fixing electrical interference problems. The principles will be described as concepts rather than theoretical equations. The emphasis on concepts will make the course useful for people with technical experience ranging from beginner to advanced designer. Since many noise emission and susceptibility problems are related to the mechanical design of systems, mechanical engineers and technicians can benefit from attendance. Several interface mechanisms and shielding techniques will be demonstrated. Additional details about the course can be found: [dce.mst.edu/noncredit/facetoface/groundingandshieldingstlouis/](http://dce.mst.edu/noncredit/facetoface/groundingandshieldingstlouis/)

**Washington Laboratories Academy** will be offering a range of training opportunities in 2015, including the very popular and often sold-out MIL-STD-461 training. As always, the engineering community can take advantage of its core training offerings in EMC Design and Mitigation. Other offerings will focus on Wireless Regulatory topics, including International Approvals for RF devices, Simulation, Nuclear EMC, Shielding Design, Environmental Testing and Design and breaking topics in Engineering Reliability and Maintainability. Served up in-house, on the road and on the web and teaming with its slate of expert instructors, WLA delivers the best selection and options for engineering development. In the coming twelve months, the Academy will expand its partner opportunities to support the engineering community with the finest in professional development. Contact Mike Violette ([mikev@wll.com](mailto:mikev@wll.com)) for more information, or visit the Washington Laboratories Academy at [www.wll.com/academy](http://www.wll.com/academy).

Wyatt Technical Services offers several public seminars on EMC design and troubleshooting throughout the year. For more information, go to [www.emc-seminars.com](http://www.emc-seminars.com).

## PRODUCT SAFETY AND ENVIRONMENTAL TESTING

**AEMC Instruments** offers the following public training opportunity:

- **Understanding Ground Resistance Testing Training Seminar**  
This one-day training seminar consists of two sessions. The first session consists of classroom presentations and discussions on all aspects of soil resistivity and ground resistance testing. The second session consists of on-site field tests demonstrating the different methods of ground resistance testing discussed during the first half of the day. Participants will have the opportunity for hands-on experience and demonstrations of proper testing procedures including measurement of soil resistivity, correct placement of test rods, using the 3-Point method and proper use of the clamp-on test method. For additional details, visit [www.aemc.com/techinfo/seminars/ground\\_resistance\\_testers/ground-seminar-listings.html](http://www.aemc.com/techinfo/seminars/ground_resistance_testers/ground-seminar-listings.html).

CST of America offers the following public courses throughout the year. Additional details and a complete course schedule are available at [www.cst.com/events/trainings](http://www.cst.com/events/trainings).

- **EMC/EMI Training**  
The CST STUDIO SUITE® EMC/EMI training course consists of 2 full days. This training class is intended for Engineers involved in Electromagnetic Compatibility (EMC), Electromagnetic Interference (EMI), Electrostatic Discharge (ESD), Electromagnetic Environmental Effects (E3) and antenna integration.
- **Signal Integrity & Power Integrity Training**  
This 2-day hands-on training course is focused on modeling and solver overview and focuses on EDA/SI/PI applications. The CST MWS Signal Integrity training course consists of 2 full days. It is helpful to be familiar

with the Getting Started manual. This training course is focused on modeling and solver overview, and concentrates on SI/PI applications.

- **Training for EDA / Signal Integrity**  
This CST MWS training course consists of 2 full days. It is helpful to be familiar with the Getting Started manual. This training course is focused on modeling and solver overview, and concentrates on EDA / SI / PI applications.
- **Microwave & Antenna Training**  
This 2-day hands-on training course focuses on modeling and solver overview and concentrates on antenna simulation.
- **Antenna Placement Training**  
The training consists of one full day. It is intended for customers that are already familiar with the modeling/ solving part of CST or participated the 2 days training on antennas. This training course is focused on antenna placement simulations.
- **Multiphysics Training**  
The MPS training consists of one full day. It is intended for customers that are already familiar with the modeling/ solving part of CST or participated in a beginner training. This training course is focused on various em-thermal and mechanical coupled simulations.

**Equipment Reliability Institute** offers the following public courses throughout the year. Visit [www.equipment-reliability.com](http://www.equipment-reliability.com) for more details about each course and a detailed schedule.

- **Fundamentals of Random Vibration and Shock Testing, HALT, ESS, HASS Measurements, Analysis and Calibration**
- **Military Standard 810G Testing**
- **Understanding, Planning and Performing Climatic and Dynamic Tests Thermal & Vibration Reliability**



**O'Brien Compliance Management** offers a training course in IEC 60601, the medical electrical equipment standards for basic safety and essential performance. A brief description and dates and locations are below. For further details, please visit [www.obcompman.com](http://www.obcompman.com).

- **IEC 60601 Series, 3rd Edition Training**

This course is an intense 3 day training course. There are presentation slides, frequent references to source standards, and skill implementation work group exercises. Participants are encouraged to ask questions about the safety requirements, and how they apply to products currently under development. Our course continues to evolve to stay up to date with latest standards, interpretations and regulatory guidance.

**TÜV Rheinland Step-Ahead Educational Series** draws on the expertise and skills of TÜV Rheinland experts, including engineers and scientists from all over the world. Step-Ahead Educational Series continues in 2015 with a comprehensive selection of seminars, webinars, roundtables and lunch & learns. For more information, email TÜV Rheinland at [education@tuv.com](mailto:education@tuv.com), or go to <http://education.tuv.com/step-up-education-series>.

- **NFPA 79:2015 – Industrial Machinery**

NFPA has released its latest update to NFPA 79, the electrical standard for Industrial Machinery. Our expert staff will review the changes to the standard and discuss typical pitfalls manufacturers fall into when bringing their equipment and machines into compliance with the standard.

- **Automated Material Handling and Robotics**

TÜV Rheinland experts will review the new requirements effective January 2015 in the US and provide

guidance on the application of ISO 13849 – safety-related part of control systems, as related to systems using automated material handling and robotics.

- **3D Printing and Additive Manufacturing**

This course will review the variety of equipment types labeled as 3D printers, identify and define the associated hazards of this equipment and outline conformity assessment procedures, regulations and standards in major global markets that manufacturers are required to comply with when placing equipment into that market.

- **EVSE – Charging Stations and Components**

Electric vehicles (EV) are an emerging product market. New products (chargers, cables, plugs,

protection circuits, vehicle telematics, etc.), standards (UL/CSA, IEC/EN) and regulations (jurisdictional) are in effect and under development across the world to support the development of the EV market and the creation of entirely new infrastructures. Secondary uses of EV equipment are also emerging through the charging of the battery storage by distributed energy sources (solar, wind) and/or returning the stored energy to the power grid. This course will review mandatory requirements manufacturers face before being able to place equipment on the market.

- **Medical Device Cybersecurity Front & Center**

With the rise of wireless, Internet and networking technologies employed in medical devices, the need for effective cybersecurity to assure device functionality and patient



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information security has become essential. Find out how to meet these new market and regulatory demands with TÜV Rheinland experts specializing in cybersecurity.

- **Risk Management for Medical Devices**

“ISO 14971:2007 Medical Devices - Application of Risk Management to Medical Devices” is a standard followed by medical device manufacturers to support their risk management process. This educational series will examine the best ways to document your conformity to both ISO14971 and IEC 60601-1 3rd Edition for electro-medical devices. The changes imposed by EN ISO 14971:2012 will also be discussed.

- **EMC for Medical Devices**

With the 4th Edition of IEC 60601-1-2 published earlier in 2014, medical device manufacturers need to prepare to make design changes in order to fulfill the new standard. The educational series will cover the requirements of the new standard in detail, as well as the FDA guidance document on using RF wireless technology in medical devices.

- **Wearable Technologies**

Wearable devices contain advanced circuitry, wireless connectivity and, at least, a minimal level of independent processing capability. Wearable technology products are a relatively new product group, and manufacturers need to determine how their innovations fit into existing regulations for fixed, mobile and portable devices. This course will cover product safety, EMC and radio tests applicable to these futuristic gadgets.

- **International Approvals**

Today, companies need more than ever seamless solutions for access

to world markets with timely and accurate product certification management. Learn about the current rules and regulations for gaining market access to Argentina, China, Japan, Korea, India, Brazil, and more. The seminar will address several product categories, including medical, Information Technology, wireless, audio/video, household, and machinery.

- **Environmental Compliance**

Manufacturers of medical, consumer monitoring and control equipment, electrical and electronic equipment who export to the EU must comply with the REACH, WEEE Recast and RoHS Recast Directives, or risk losing access to market. Previously exempted medical and consumer monitoring and control equipment have had to comply since July 21, 2014, and industrial monitoring and control equipment will need to comply by July 21, 2017. Learn how to ensure your product's compliance.

- **Smart Grid & IoT**

As the number of smart grid products and services increases in the market, factors such as interoperability of devices and cybersecurity have become increasingly important. TÜV Rheinland is in the forefront of smart grid testing, so join the experts to discuss the success of Smart Grid technology, how Internet of Things (IoT) is changing the consumption of energy, and the value of alliance certifications – from ZigBee to Wi-SUN.

- **Systems Certification**

The final draft version of ISO 9001:2015 is likely to be approved in June 2015. It will have a big impact on certified organizations and those looking to get certified in the near future. This course will provide an analysis of the changes and what they will mean to your organization and

answer some of the most frequently asked questions about the upcoming revision.

- **ITE Safety Compliance**

To export to the EU, Information Technology and office equipment manufacturers will need to comply with EN 60950-1, Amendment 2 for their existing and new products from July 2016 on. Manufacturers of audio/video (A/V), information technology (IT) and communication technology products will learn about a new standard IEC/EN 62368-1, which will replace EN 60065 for A/V and EN 60950-1 for IT and communication technology equipment, and which must be applied to new and existing products in Europe after June 2019.

- **Energy Efficiency**

It is estimated that over 80% of all product-related environmental impacts are determined during the design phase of a product. Join us to learn about the updates in energy efficiency regulations for electronic products for US, Canada and EU and ensure your product's compliance.

TÜV SÜD Academy public training courses are enhanced by the real life experiences of our auditing and testing teams, offering years of experience in the worldwide international standards arena. This relationship allows us to provide clients with seasoned auditors and engineers as trainers and subject matter experts, transferring their knowledge and expertise directly to you. Visit their website for details, [www.tuv-sud-america.com/us-en/resource-center/training](http://www.tuv-sud-america.com/us-en/resource-center/training).

**UL Knowledge Services (ULKS)** is UL's training and advisory services business unit, providing safety and compliance-related knowledge solutions that facilitate product development and create safer working environments

for people. ULKS's comprehensive service offerings are designed to help customers access first-hand, real-time, industry-critical information. In addition to comprehensive coverage of UL standards, ULKS addresses specific topics intended to help customers and constituents design and/or install safer products, increase efficiency and realize improved speed to market. For a full listing of 2015 dates and locations please visit <http://lms.ulknownledgeservices.com/home.aspx?LSMID=465473>.

Washington Laboratories Academy offers Product Safety Seminars throughout the year. Visit them online at [www.wll.com/academy.html](http://www.wll.com/academy.html) for locations and dates.

## ELECTROSTATIC DISCHARGE (ESD)

The ESD Association holds educational opportunities throughout the year both online and at events. For full details, visit the ESD Association's website at [www.esda.org](http://www.esda.org).

- ***Fundamental Handling Practices, Basic ESD Control Program, and Simplified Measurements***

This 2-day tutorial set is specifically focused on providing practical ESD information to small to midsize electronic and related companies who do not have in-house ESD experts but want to ensure themselves that they have good ESD practices and processes in place to protect their products. This series is designed primarily for personnel working in a contract manufacturer, parts distributor, electronic repair facility, and electronic field service organizations.

## PRIVATE/CUSTOM SEMINARS

Many experts offer private seminars designed to train select personnel at

your location. These seminars offer companies an opportunity to train multiple compliance personnel with a customized approach designed for their needs. Following is a list of experts who offer private seminars.

- **Best ESD Technical Services**

([www.bestesd.com](http://www.bestesd.com))

Classes and seminars can be arranged on different topics – from basic introduction to highly-specialized classes on a particular subject of ESD or EMC/EMI relevant to your applications.

- **Cherry Clough Consultants**

([www.cherryclough.com](http://www.cherryclough.com))

Seminars allow for a customized approach to training in basic and advanced EMC design, the EMC Directive and EMC engineering practices for EMC testing techniques and EMC functional safety.

- **DLS Electronics Systems**

(<http://dlsemc.com/emc-class/emc-seminar.htm>)

DLS experts offer practice oriented seminars and workshops on EMC design and regulatory compliance issues.

- **Kimmel Gerke Associates, Ltd.**

([www.emiguru.com](http://www.emiguru.com))

Kimmel Gerke offers seminars on EMC design fundamentals and techniques for ensuring EMC Compliance.

- **Montrose Compliance Services**

([www.montrosecompliance.com](http://www.montrosecompliance.com))

Montrose Compliance Services offers worldwide customized training programs on achieving EMC compliance, EMC design fundamentals and techniques.

- **Henry Ott Consultants**

([www.hottconsultants.com](http://www.hottconsultants.com))

Henry Ott Consultants offers one to three day EMC seminars (in plant and public) on over 25 different

topics, including "Partitioning and Layout of Mixed-Signal PCBs" and EMC Considerations in Switching Power Supply Designs."

- **Wyatt Technical Services, LLC**

([www.emc-seminars.com](http://www.emc-seminars.com))

An independent consulting firm that specializes in EMC design, troubleshooting and training services to commercial and industrial manufacturers with global distribution in the consumer, computer, network & telecommunications, industrial and scientific industries.

## ON-LINE TRAINING

If webinars are your preferred style of learning, many companies sponsor on-demand style webinars for viewing at your convenience. Please visit the following sites for specific topics:

- **Associated Research**

([www.asresearch.com/events-training/webinars.aspx](http://www.asresearch.com/events-training/webinars.aspx))

Associate Research's webinars provide detailed information on many aspects of electrical safety testing.

- **CST of America**

([www.cst.com/events/webinars](http://www.cst.com/events/webinars))

CST of America offers webinar programs throughout the year that focus on design challenges across the field of electrical engineering, in microwaves and RF, EMC, EDA and charged particle dynamics.

- **Intertek Academy**

([www.intertek.com/training](http://www.intertek.com/training))

Intertek offers educational opportunities in quality, safety and energy efficiency. Intertek's 2015 line-up of technical seminars, webinars, workshops, training events, conferences and white papers provide in-depth guidance for understanding new standards and specs, innovative techniques and compliance.





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- **MET Laboratories**  
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MET Laboratories offers webinars throughout the year and also offers on-demand viewing of past webinars.
- **SIEMIC 2015 Regulatory Compliance Webinars**  
([www.siemc.com/us/company/webinars\\_2015.php](http://www.siemc.com/us/company/webinars_2015.php))  
Presented in a series of monthly one-hour presentations, these webinars will present the latest regulation changes, importation requirements, and hot compliance issues for the most important and dynamic market countries.
- **TÜV SÜD America**  
([www.tuv-sud-america.com/us-en/resource-center/training/webinars](http://www.tuv-sud-america.com/us-en/resource-center/training/webinars))  
TÜV SÜD America offers webinars and online seminars in the areas of Safety, EMC, management systems and competency assessments. Webinars are also available for on-demand viewing.

## INDUSTRY SYMPOSIA AND TABLE-TOP PROGRAMS

These annual symposia are an excellent resource for extensive technical training, and exchange of new ideas and technical concepts. The benefit of attending these events is that attendees can sample a vast array of workshops quickly and efficiently while networking with colleagues and professionals with the same interests.

- **2015 IEEE Symposium on Electromagnetic Compatibility & Signal Integrity (EMCSI)**  
March 15-21, 2015 – Santa Clara, CA  
[www.emc2015usa.emcss.org/](http://www.emc2015usa.emcss.org/)

**31st International Review of Progress in Applied Computational Electromagnetics (ACES 2015)**  
March 22-26, 2015 – Williamsburg, VA

[www.aces-society.org/conference/2015](http://www.aces-society.org/conference/2015)

- **EMV 2015**  
March 24-26, 2015 – Stuttgart, Germany  
[www.mesago.de/en/EMV/home.htm](http://www.mesago.de/en/EMV/home.htm)
- **Microwaves & RF 2015**  
April 1-2, 2015 – Paris, France  
[www.microwave-rf.com](http://www.microwave-rf.com)
- **Electrostatics 2015**  
April 12-16, 2015 – Southampton, UK  
<http://elec2015.iopconfs.org/home>
- **EuCAP 2015 – The 9th European Conference on Antennas and Propagation**  
April 12-17, 2015 – Lisbon, Portugal  
[www.eucap2019.org](http://www.eucap2019.org)
- **2015 China International Exhibition on EMC, Microwave, RF and Safety Tests & Certification (China EMC 2015/China MW 2015)**  
April 21-23, 2015 – Beijing, China  
[www.emcchinaexpo.com](http://www.emcchinaexpo.com)
- **9th Annual International Electrostatic Discharge Workshop (IEW)**  
May 4-6, 2015 – Lake Tahoe, CA  
[www.esda.org/IEW.htm](http://www.esda.org/IEW.htm)
- **2015 IEEE International Instrumentation and Measurement Technology Conference (I2MTC)**  
May 11-14, 2015 – Pisa, Italy  
<http://imtc.ieee-ims.org/>
- **IMS2015 – 2015 International Microwave Symposium**  
May 17-22, 2015 – Phoenix, AZ  
[www.ims2015.org](http://www.ims2015.org)

- **IEEE Symposium on Product Compliance Engineering**  
May 18-20, 2015 – Chicago, IL  
[www.psessymposium.org](http://www.psessymposium.org)
- **Joint IEEE International Symposium on Electromagnetic Compatibility and EMC Europe 2015**  
August 16-22, 2015 – Dresden, Germany  
[www.emc2015.org](http://www.emc2015.org)
- **European Microwave Week 2015**  
September 6-11, 2015 – Paris, France  
[www.eumweek.com](http://www.eumweek.com)
- **37th Annual Electrical Overstress/ Electrostatic Discharge Symposium**  
September 27 – October 2, 2015 – Reno, NV  
[www.esda.org/symposiaEOS-ESD.html](http://www.esda.org/symposiaEOS-ESD.html)
- **37th Annual Symposium of the Antenna Measurement Techniques Association (AMTA)**  
October 11-16, 2015 – Long Beach, CA  
[www.amta2015.org](http://www.amta2015.org)
- **IEEE EMC Society 2015 Regional Events**  
Dearborn, MI: May 7, 2015  
[www.emcfest.org](http://www.emcfest.org)  
Contact: Scott Lytle, Yazaki North America, [scott@emcsociety.org](mailto:scott@emcsociety.org)  
  
Bloomington, MN: September 15, 2015  
[www.mnmcevent.com](http://www.mnmcevent.com)  
Contact: Dan Hoolihan, (651) 213-0966, [danhoolihanemc@aol.com](mailto:danhoolihanemc@aol.com)







# Creating Your Own Compliance Network

Advice and Guidance on Building Your Connections and Your Career

BY MARK MAYNARD

*“The delicate balance of mentoring someone is not creating them in your own image, but giving them the opportunity to create themselves.” – Steven Spielberg*

In the 1960s and 1970s, large technology companies like IBM assigned senior engineers on their technical staff to serve as mentors to new engineers entering the workforce. The arrangements were expected to be long-term, along with the expectation that the engineers would have a long-term career at the company, to help them “learn the ropes” with someone outside of their management chain with whom they could speak freely in seeking technical advice and career guidance, and who could make introductions for them to their contacts within the compliance community both inside and outside of the company. These arrangements helped to ensure that hard-learned experience could be passed on, and that new engineers would benefit from the years of wisdom and knowledge possessed by more experienced engineers.

Beginning in the 1980s, however, the expectations of long-term careers at tech companies started going away, and opportunities for formalized mentoring programs became less available. With short stays at multiple companies becoming the norm for a career path, mentoring programs became less common, as the number of long-term employees with years

of experience at one firm declined. This has resulted in much inefficiency and waste in the modern work environment, since the absence of experienced engineers has forced new engineers to continually “reinvent the wheel.”

## DO IT YOURSELF

In today’s fast-paced work environment, regulatory compliance professionals are expected to make knowledgeable decisions and assessments on their projects, to avoid costly

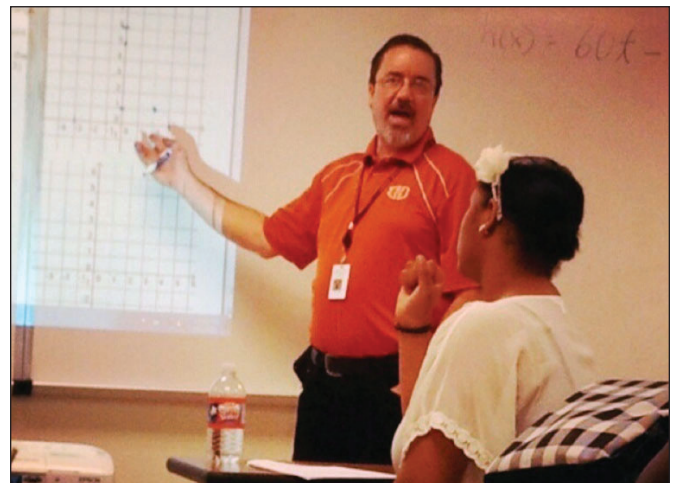

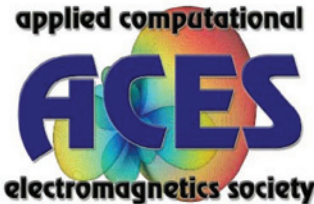


Figure 1: Traditional mentoring relationships

mistakes that could result in even shorter-term employment. Without the availability of in-house experts from whom to seek advice and guidance and who can help make external connections, it is incumbent on each compliance professional to develop their own network of knowledge resources, from their own activities within their company, and from groups and individuals outside of their company.

Especially in the regulatory compliance field, with the constantly changing standards and technology requirements, it is vital to have available a multitude of knowledge resources that can quickly provide information, or point to other sources that could be useful. In this article, I am going to present and discuss different resources, groups, and methods for creating your own unique and personal knowledge network that will help you to grow and develop, and that you can pass on as you mentor others later in your career. Within this knowledge network, you'll also be able to identify a few key individuals who could become mentors, and I'll discuss some ideas on how best to establish these types of special relationships.



**The 31<sup>st</sup> International Review of Progress in Applied Computational Electromagnetics (ACES 2015)**

March 22-26, 2015 Williamsburg, Virginia

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The international ACES symposium serves as a forum for developers, analysts, and users of computational techniques applied to electromagnetic field problems at all frequency ranges. Various tutorials will be offered which are open to all attendees.

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**Plenary Speakers:**  
Dr. Mahbub Hoque, CERDEC, The US Army  
Prof. Manos M. Tentzeris, Georgia Tech  
Prof. Dejan S. Filipovic, University of Colorado  
Prof. Randy Haupt, Colorado School of Mines

**General Chairs:**  
C. J. Reddy, Altair / Applied EM, Inc.  
Khaled ElMahgoub, Trimble/MIT

**Technical Program Chairs:**  
Kubilay Sertel, The Ohio State University  
Veyssel Demir, Northern Illinois University

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## IN-HOUSE TALENT

Start your search for expertise at your current company. Even though there may not be a large number of long-term employees at your place of business, there will be experienced team members who have worked at a variety of different companies, and will have knowledge from which you can benefit.

Find opportunities in your daily work to seek out the more experienced staff members, and talk with them about their work background and experience. Most of your fellow workers will be glad to share their knowledge, but always be conscious that they have their own job responsibilities, so respect their time. For longer discussions, you might want to take them to lunch, where you will have the opportunity for more in-depth discussions, without the pressure of the workplace getting in the way. Just be sure to let them know beforehand what you would like to talk about, so they are prepared for the discussion.

To make the best use of the discussions, always take notes, so in the future you can know their particular areas of expertise, and will be able to quickly identify the contacts who would most likely have the knowledge you are looking for. Personally, I keep a spreadsheet with names, contact information, and categories for items such as "EMC Testing," "Product Safety," and "International Certifications."

Also, be aware that, for these relationships to last, they need to be mutually beneficial. They can't be one-sided affairs in which you are constantly asking for information but giving nothing in return. Whether it is letting them know about a new standard that you think might be of interest or offering some additional help on a project they are working on, keep the Golden Rule in mind in all of your interactions.

## PROFESSIONAL ORGANIZATIONS AND AFFINITY GROUPS

One of the best sources I have found for knowledge experts is professional organizations and affinity groups. These private non-governmental organizations (NGOs) are made up of individuals with all levels of experience, with many different backgrounds and life experiences, and can be instrumental in building your knowledge base and your career. One good way to find out which groups are best for your industry is by asking the senior staff members at your current company.

The organizations that will best meet your needs depends on your particular industry and job functions. But, in my career in regulatory compliance engineering, there are a few that I have found to be the most beneficial. They include the Institute of Electrical and Electronics Engineers (IEEE), the Telecommunications Certification Body Council (TCBC),

and the Project Management Institute (PMI). Although each of these organizations charge a nominal annual membership fee, if you'll do some investigation and reviews, I think you'll agree that the benefits far outweigh the costs. Also, some employers will pay or reimburse you for these annual fees, since they recognize the value of that these organizations provide in training and educating their employees.

Founded in 1963, the IEEE ([www.ieee.org](http://www.ieee.org)) is by far the largest engineering organization in the world, with more than 430,000 members, located in over 160 countries, with more than half of the members residing outside of the US. There are 38 Technical Societies within the IEEE, and many are directly related to the regulatory compliance engineering community, including:

- IEEE Aerospace and Electronic Systems Society
- IEEE Antennas and Propagation Society
- IEEE Consumer Electronics Society
- IEEE Electromagnetic Compatibility Society
- IEEE Engineering in Medicine and Biology Society
- IEEE Microwave Theory and Techniques Society
- IEEE Power & Energy Society
- IEEE Product Safety Engineering Society
- IEEE Vehicular Technology Society

Each of these Societies has local chapters in most major metropolitan areas, where you can meet and network with technology experts in your area. In addition, joining an IEEE Society gives you access and discounts for their peer-reviewed publications and conferences, as well as access to the worldwide professional network of technology experts within the Society membership. The full listing of all 38 IEEE Societies, along with full descriptions of each, can be found online at [www.ieee.org/membership\\_services/membership/societies](http://www.ieee.org/membership_services/membership/societies).

Also within the IEEE are special interest groups, which are similar in purpose to the IEEE Societies, but usually

smaller in number of members. Some focus on new areas of technology development such as the IEEE Internet of Things Community, IEEE Electric Vehicles Community, and the IEEE Smart Grid Community. Others are focused on specific demographics, which can provide support for certain communities, such as the IEEE Women in Engineering Technical Council, and the IEEE Young Professionals Technical Council (formerly IEEE Graduates of the Last Decade).

To find out more about all of the benefits provided by the IEEE, and information on how to join, go to their website at [www.ieee.org/membership\\_services](http://www.ieee.org/membership_services). You don't have to be an engineer to join, there is no minimum number of years of experience required, and only you can decide if joining is the right decision for you.

Next, I'd like to introduce you to the TCBC ([www.tcbccouncil.org](http://www.tcbccouncil.org)), which is a NGO that provides resources for those telecommunication certifications bodies (TCBs) that have been authorized by the U.S. Federal Communications Commission (FCC) to test and issue certifications for wireless and telecom equipment. TCBC members include TCBs, the FCC and other government agencies such as Industry Canada, laboratory accreditation bodies like the American Association for Laboratory Accreditation ([www.A2LA.org](http://www.A2LA.org)), test laboratories, equipment manufacturers, product developers, consultants, and other interested stakeholders. The purpose of the TCB Council, as stated on their website, is to "provide a forum for periodic dialogue between the FCC and the TCB's and to facilitate on-going activities geared toward the improvement of TCB technical and administrative performance."

The TCBC's website contains general information on the organization and member benefits. The members of this organization have a wealth of experience in all aspects of the TCB program, including training materials from previous workshops and presentations. Two great opportunities for network-building are provided by the monthly conference calls with FCC staff members, and the semi-annual

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- Attend some of the many **industry and professional meetings** to take your participation to the next level.
- Visit the **Exhibit Hall** with hundreds of booths filled with the latest products, equipment and services.
- Meet and greet old friends, experts, and colleagues at numerous formal and informal **networking functions**.
- **Interns and newly graduated EE/EMC engineers** will have the chance to learn from experienced professionals and connect with peers during the Young Professionals activities.

From novice to expert, across all industries and academia, the symposium is the must attend engineering event.



**Graduate and Undergraduate Engineering Students** are encouraged to participate in the **2015 Student EMC Hardware Design Competition**. The competitors are required to design a differential-pair circuit producing an optimal signal with minimal distortion. Finished designs due by 1/19/2015. Learn more at: [www.emc2015usa.emcss.org/students](http://www.emc2015usa.emcss.org/students)

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training workshops on the latest compliance requirements, featuring presenters from the FCC, Industry Canada, the European Union, and other international government regulators, in addition to the TCBs and international regulatory compliance consultants.

Anyone can become a member of the TCB Council. Membership is extended to a company, which pays an annual membership fee based on their specific membership category, and any employees of the member company can receive TCBC membership benefits without any additional cost. Any FCC designated TCB can join as a full TCB council member, and all other companies can join as associate members.

The final organization I'd like to recommend is the Project Management Institute (PMI, at [www.pmi.org](http://www.pmi.org)). In today's workplace, it is common for regulatory compliance professionals to manage their own compliance projects, but many have not received any formal training or have access to those with project management experience within their own company.

PMI is the world's leading not-for-profit professional membership association for project and program management professionals, and was founded in 1969. With more than 2.9 million professional members working in almost every country in the world, this organization helps to educate, advance careers, improves organizational success, and further advance the profession of project management through its global standards, certifications, resources, tools, academic research, publications, professional development courses, and networking opportunities. With local chapters in most major metropolitan areas around the world, PMI can provide local learning and mentoring opportunities as well.



**Figure 2: Professional organizations and affinity groups**

Membership is open to all that have an interest in the field, with various levels dependent on years of experience and certifications. PMI members get access to PMI publications, including global standards, and online communities can provide resources for remote members who may not be near a local city chapter. To learn more about PMI membership, and to investigate whether membership might be beneficial for your career, go to their website at [www.pmi.org/membership.aspx](http://www.pmi.org/membership.aspx).

## CONFERENCES & SYMPOSIUMS

Conferences and symposiums are great places to jump-start your compliance network efforts. These are held by the same professional organizations and affinity groups we have just discussed, but are also held by other industry organizations, private companies, and government organizations. Once again, a good way to find out which conferences or symposiums would be of greatest benefit is by asking the senior staff members at your current workplace. However, I don't recommend attending any conference or symposium "sight unseen," that is, without obtaining references or feedback from others that have attended. That's because the level of technical content and applicability can vary widely, especially for those events put on by "for-profit" organizations. In many cases, employers will cover the cost for attending such events within the scope of their training

budgets, because of the value of the technical content of the presentation, and the networking benefits provided for those that attend.

For example, I regularly attend the IEEE Electromagnetic Compatibility (EMC) Symposium and the IEEE Symposium on Product Compliance Engineering (ISPCE). While these Symposia

differ regarding their focus, the length of the Symposium and the number of attendees, they both provide similar benefits in helping to build your professional compliance network.

The IEEE EMC Symposium is sponsored and managed by the IEEE EMC Society, and typically has close to 2000 EMC professionals from industry, education, and government organizations. With multiple simultaneous tracks of presentations held over a five day period, you can select the specific presentations that cover your areas of interest, and target the presenters that would make good professional contacts for your network. There are ample opportunities for informal networking at scheduled break times between presentations and at social events held during the evenings. In addition, a large trade show with exhibits from test equipment manufacturers, test labs, industry publications, and other affiliated groups presents another opportunity to develop new professional contacts. You can learn more about this event and the benefits of attending at [www.emc2015usa.emcss.org](http://www.emc2015usa.emcss.org).

Similar to the EMC Symposium but on a smaller scale, the IEEE Symposium on Product Compliance Engineering is sponsored and managed by the IEEE Product Safety Engineering Society. Attendance is around 200 regulatory compliance professionals, with multiple tracks of presentations held over a three day period. This Symposium has a broad scope, covering many different





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- Network with you colleagues during our Social Events hosted in some of Dresden's most charming locations.
- Experience the beautiful baroque city of Dresden located in the heart of Europe.



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aspects of compliance, including product safety, energy management and conservations, EMC, telecom/wireless, and environmental aspects of electronic products. It also has a trade show that presents more opportunities for networking and developing new contacts. To find out more about this event, go to <http://psessymposium.org>.

## GOVERNMENT REGULATORY AGENCIES

Government regulatory compliance agencies can be another valuable source of information, and are valuable contacts to have in your personal network. It is not always possible to meet agency staff members at their offices, but it is possible to make personal contact with staff at government-held training events and other venues.

For example, the FCC Office of Engineering and Technology (OET) has a wealth of informational resources available on their website (<http://transition.fcc.gov/oet/>). The OET doesn't typically conduct on-site training events, but OET representatives do attend the TCBC workshops held in Baltimore, Maryland in April and October every year, providing opportunities for face-to-face presentations and direct contact.

One US government agency that does hold training events applicable to the regulatory compliance industry is the National Institute of Standards and Technology (NIST), which is under the authority of the US Department of Commerce. The Standards & Trade department of NIST has periodic workshops and training sessions on topics related to global trade, and more information can be found on the NIST Standards & Trade webpage at <http://gsi.nist.gov/global/index.cfm/L1-4>.

## SOCIAL MEDIA RESOURCES


Social media sites have become important venues for information sharing, and this is true for the regulatory compliance industry as well. In my opinion LinkedIn ([www.linkedin.com](http://www.linkedin.com)) is the most business-useful social media site, with dozens of special interest groups focused on the regulatory compliance industry sharing information and contacts, making it easier to expand your professional network with virtual contacts.

Once you set up an account on LinkedIn, you can join up to 50 special interest groups. Just as suggestions, here are some of my favorite regulatory compliance groups on the site, which you can find by searching on the group names listed:

- Electromagnetic Compatibility Forum
- EMC Goggles
- IEC The Electrotechnical Standards Group
- IEEE Consumer Electronics Society
- IEEE Product Safety Engineering Society (PSES)
- InCompliance Magazine
- International Approvals/Certifications
- RF and Microwave Community
- SAR Compliance Testing
- Wireless Certification Professionals

## FINDING A MENTOR

Finally, after starting your efforts at building our own personal compliance network, it's time to select a mentor that can best help you at the current stage of your career. Go back over the contacts you have made so far, and pick out two or three who you think best represent the direction or specific field in which you would like to develop more expertise. Then, arrange to meet them so that you can discuss your plan to identify a mentor to help you develop and grow your career, and to determine their possible interest. Make sure to discuss your expectations, and also find out what expectations the potential mentor might have.

After you have "interviewed" your candidates, make your selection, and then work out a schedule with your mentor. Determine how often you should meet, what will be discussed, and any "homework" that might be assigned. A good resource on the mentor-mentee relationship is the IEEE Mentor Centre webpage, which includes downloadable PDF publications that can be accessed at [www.ieee.org/membership\\_services/membership/mentoring/index.html](http://www.ieee.org/membership_services/membership/mentoring/index.html). 

(the author)

### MARK MAYNARD

is a Director at SIEMIC, a global compliance testing and certification services firm with strategic locations in the US and Asia. He is the new President-Elect for the IEEE Product Safety Engineering Society, and also serves on the Telecommunication Certification Body Council. Mark holds two Texas State University degrees, a BS in Mathematics and a BAAS in Marketing and Business, and has over 20 years of experience in international regulatory compliance engineering and product certifications. He can be reached at [mark.maynard@siemic.com](mailto:mark.maynard@siemic.com).





# CPSC Mandates Safety Programs for Manufacturers and Retailers

The History Behind the CPSC's Action

BY KENNETH ROSS

Since its inception, the U.S. Consumer Product Safety Commission (CPSC) has encouraged companies to implement active product safety management programs. Since 2010, however, the CPSC has made this a bit more official. Requirements for the establishment of safety compliance programs have appeared in a final rule of factors to be considered for civil penalties, in a number of consent decrees and settlement agreements for civil penalties, in letters from the CPSC where they decided not to seek civil penalties, and finally in a proposed interpretive rule.

This article will examine the CPSC's previous guidance on safety programs, describe the new requirements and proposed rules and discuss what they might mean for product manufacturers.

## PRIOR GUIDANCE ON SAFETY PROGRAMS

The CPSC first published the *Handbook for Manufacturing Safer Consumer*

*Products* in the 1970s, shortly after the agency was created. The last edition of this handbook came out in 2006 and discusses product safety policies, organization, and training as well as all aspects of design, manufacturing, quality, corrective actions, etc. In other words, it discusses safety procedures that it believes are appropriate for any company making consumer products in all aspects of design, production, sales, and post-sale.

At the beginning of the handbook, it says:

*"Manufacturers must assure the safety of consumer products. This is achieved through the design, production and distribution of the products they manufacture. It is best accomplished by a comprehensive systems approach to product safety, which includes every step from the creation of a product design to the ultimate use of the product by the consumer. The basic concepts for a comprehensive systems approach for the design, production and distribution of consumer products are discussed in this Handbook."*

In addition, the CPSC's Recall Handbook, in existence for many years but updated in March 2012, has had sections on the appointment of a Recall Coordinator, development of a company recall policy and plan, and extensive suggestions for the creation and retention of records to support a recall.

The safety processes advocated in these handbooks are just suggestions and not legal requirements. In addition, they are similar to those procedures employed by companies who have a well-functioning safety effort. So, there is nothing particularly onerous here that a company shouldn't already be doing.

## NEW REQUIREMENTS FOR SAFETY COMPLIANCE PROGRAMS

Recently, however, new requirements for safety compliance programs have been inserted by the CPSC into various documents.





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## Factors to Consider for Civil Penalties

First, on March 31, 2010, the CPSC published in the *Federal Register* a final rule of factors that its staff is expected to consider when deciding whether to seek civil penalties. The rule (16 CFR §1119.4(b)(1)) clearly states that product safety programs are one of the factors to be considered by the staff in assessing civil penalties:

*“The Commission may consider, when a safety/compliance program and/or system as established is relevant to a violation, whether a person had at the time of the violation a reasonable and effective program or system for collecting and analyzing information related to safety issues. Examples of such information would include incident reports, lawsuits, warranty claims, and safety-related issues related to repairs or returns. The Commission may also consider whether a person conducted adequate and relevant premarket and production testing of the product at issue; had a program in place for continued compliance with all relevant mandatory and voluntary safety standards; and other factors as the Commission deems appropriate. The burden to present clear, reliable, relevant, and sufficient evidence of such program, system, or testing rests on the person seeking consideration of this factor.”*

In addition, the Commissioners released a statement dated March 10, 2010 concerning these new factors that said in part:

*“The safety/compliance program factor takes into account the extent to which a person (including an importer of goods) has sound, effective programs/systems in place to ensure that the products he makes, sells or distributes are safe. Having effective safety programs dramatically lessens the likelihood that a person will*

*have to worry about the application of this civil penalty rule. Any good program will make sure that there is continuing compliance with all relevant mandatory and voluntary safety standards. This is not the same as saying if one’s product meets all mandatory and voluntary standards that the Commission will not seek a civil penalty in appropriate cases. The Commission expects companies to follow all mandatory and voluntary safety standards as a matter of course.”*

## Daiso Consent Decree

At the same time that the new civil penalty factors were being finalized, the establishment of a product safety management program was included for the first time in a consent decree for civil penalties. In a March 4, 2010 agreement, Daiso Holding, a U.S. subsidiary of a Japanese company, agreed to pay a little more than \$2 million in fines for violating various laws and regulations concerning the sale of toys and children’s products.

The consent decree required Daiso to hire a product safety coordinator approved by the CPSC to do, in part, the following:

- Create a comprehensive product safety program
- Conduct a product audit to determine which of Defendants’ merchandise requires testing and certification of compliance with the FHSA, the CPSA, and any other Act enforced by the CPSC
- Establish and implement an effective and reasonable product safety testing program in compliance with the FHSA, the CPSA, and any other Act enforced by the CPSC
- Create guidance manuals for managers and employees on how to comply with product safety requirements
- Establish procedures to conduct product recalls

- Establish systems to investigate all reports of consumer incidents, property damage, injuries, warranty claims, insurance claims and court complaints regarding products under the jurisdiction of the CPSC that Defendants imported into the United States

The consent decree contains many more specific requirements, and also includes the following monitoring requirements:

*“At the end of the first year of the monitoring period and at the end of any 180-day extension of the monitoring period under this paragraph, the Coordinator shall provide a written report to the Office of Compliance. If the Coordinator certifies Defendants are in compliance as described in this paragraph, the monitoring period will end. If the Coordinator cannot certify that Defendants meet each of the compliance requirements listed below, the monitoring period shall continue for an additional 180 days, at the end of which the Coordinator shall provide an updated written report to the Office of Compliance.”*

Daiso retained an independent consultant to certify compliance, and the CPSC sent its staff to Daiso facilities to audit compliance. Daiso passed and the monitoring was ultimately discontinued.

## Safety Requirements in Civil Penalty Settlement Agreements

The CPSC did nothing further to impose safety requirements until they were inserted into civil penalty settlement agreements starting in February 2013. In the first such agreement, Kolcraft agreed to pay a \$400,000 civil penalty. In addition, they agreed to the following language:

*“Kolcraft shall maintain and enforce a system of internal controls and*



procedures designed to ensure that: (i) information required to be disclosed by Kolcraft to the Commission is recorded, processed and reported in accordance with applicable law; (ii) all reporting made to the Commission is timely, truthful, complete and accurate; and (iii) prompt disclosure is made to Kolcraft's management of any significant deficiencies or material weaknesses in the design or operation of such internal controls that are reasonably likely to adversely affect in any material respect Kolcraft's ability to record, process and report to the Commission in accordance with applicable law.

"Upon request of Staff, Kolcraft shall provide written documentation of such improvements, processes, and controls, including, but not limited to, the effective dates of such improvements, processes, and controls. Kolcraft shall cooperate fully and truthfully with Staff and shall make available all information, materials, and personnel deemed necessary by Staff to evaluate Kolcraft's compliance with the terms of the Agreement.

"Kolcraft shall implement and maintain a compliance program designed to ensure compliance with the safety statutes and regulations enforced by the CPSC that, at a minimum, contains the following elements (i) written standards and policies; (ii) a mechanism for confidential employee reporting of compliance-related questions or concerns to either a compliance officer or to another senior manager with authority to act as necessary; (iii) effective communication of company compliance-related policies and procedures to all employees through training programs or otherwise; (iv) senior manager responsibility for compliance; (v) board oversight of compliance (if applicable); and (vi) retention of all compliance-related

records for at least five (5) years and availability of such records to CPSC upon request."

Then, Chairman Tenenbaum and Commissioner Adler issued a joint statement in connection with this agreement, stating their concern that Kolcraft had had a dozen recalls since 1989 and that some further action was required. They said:

"The failure of a company to have an effective means of detecting and addressing serious or continuous safety issues with its products is contrary to the expectations of consumers and is unacceptable to this Commission. While we certainly understand that even the most responsible companies can make mistakes, the failure of a company to have in place an effective compliance program and internal controls is irresponsible. Thus, going forward, we expect those 2 companies that lack an effective compliance program and internal controls to voluntarily adopt them. If not, we will insist that they do so."

The Commissioners also made it clear in their statement that having an adequate safety program does not let a company off the hook for failing to report a safety problem in a timely manner.

Then, in May 2013, Williams-Sonoma agreed to pay \$987,500 in civil penalties for failing to report a safety problem to the CPSC in a timely manner. The three paragraphs from the Kolcraft opinion quoted above were also inserted in the Williams-Sonoma agreement. In addition, Commissioner Nord submitted a statement on the Williams-Sonoma agreement that questioned the piecemeal creation of a mandate for such programs through enforcement. Commissioner Adler responded to Commissioner Nord's concern and signaled his views on the

future use of such safety requirements. He said, in part:

"Far from viewing this settlement as punishment, I view it as the Commission and the company mutually agreeing to a set of reasonable measures designed to lead to safer products and fewer recalls in the future. Indeed, I suspect that the reason that companies agree to such language is their sense that any conscientious, responsible firm should follow such procedures in their approach to compliance. And to the extent that their past practices might have fallen short of these goals, they are eager to demonstrate that their future approach will be one of strict adherence to such provisions..."

"...The fact that the Commission has sought similar language in the two settlements says little at this point about whether there has been a shift in agency policy in the future. Even if it did, there is nothing improper about implementing the policy in individual case settlements. That said, I do not rule out asking for such clauses in future non-civil penalty settlement agreements nor do I rule out future expansions of the Commission's voluntary recall policies."

Since May 2013, every settlement agreement for civil penalties has had some compliance requirements. Based on this history, it is virtually certain that future settlement agreements will also contain some type of requirement for the establishment of more robust safety compliance programs. However, it is still an open question as to how compliance will be audited and monitored, and when the CPSC will require that additional processes and procedures be established. In addition, it is unknown what the CPSC would do if a firm failed to fully comply with these requirements.



Or, let's say the firm complies and then is charged again with late reporting. Will their new safety programs reduce the likelihood of penalties or reduce the amount of penalties? This is a concept that has already been adopted by the Department of Justice in connection with the Federal Sentencing Guidelines for Organizations. The establishment of a compliance program is taken into account when deciding whether to defer prosecution or the amount of penalties to seek.

## SAFETY REQUIREMENTS IN OTHER AGREEMENTS

As signaled by then Commissioner Adler in his statement above, even if the CPSC decides not to seek civil penalties, it might ask companies to set up more robust programs. In September 2013, I received a letter from the CPSC saying that a decision not to proceed with a civil penalty would be conditional upon the firm agreeing to take a variety of corrective measures similar to those in the above settlement agreements.

I have heard from other lawyers that they have also seen such requests in letters of this type. However, one recent letter used the word "encourage" rather than "required" concerning such programs. And some of these letters make it clear that the manufacturer still has a duty to report new information, and that they can again be subject to civil penalties for late reporting or for failing to report.

## SAFETY REQUIREMENTS IN CORRECTIVE ACTION PLANS

The last CPSC action concerning compliance programs is contained in a Notice of Proposed Rulemaking published in the November 21, 2013 *Federal Register*. This rule deals with voluntary recall notices, but also allows

the CPSC to mandate compliance programs as part of corrective action plans (CAPs). The requirements for safety programs are the same as those in the civil penalty settlement agreements described above.

This proposed interpretative rule also provides that the corrective action, including an agreement to establish a safety program, is legally binding. Therefore, if this rule is approved, the CPSC would be able to legally enforce the compliance program if a company fails to comply.

It is unclear how the CPSC will be able to evaluate the procedures and controls of the manufacturer or product seller and determine whether they are insufficient or ineffectual. Who will do it? When will they have time to do it? What is the basis of their determination? Will the recall be postponed until this analysis is done?

The comment period for this Notice of Proposed Rulemaking ended in February 2014. As of this writing, we are waiting to see what the CPSC Commissioners and staff decide to do.


## CONCLUSION

It is certainly possible for a company that has a robust safety program to fail to notify the CPSC of certain potentially reportable information because it does not believe that there is a product defect or substantial product hazard. Indeed, reasonable minds may differ in such matters. However, the open question is whether the CPSC is justified in imposing new procedures

on a manufacturer that may already have sufficient safety programs in place. It will be interesting to see whether, going forward, companies that have good safety programs are able to keep these provisions out of future agreements, and whether such programs will enable them to escape all civil penalties or negotiate lower civil penalties.

In the meantime, product manufacturers should consider all of these requirements and evaluate their own programs. They should also consider the new ISO standard (ISO 10377) that sets forth some "best practices" in safety management, as well as other studies and reports on what is an effective product safety management program. (See articles in [www.productliabilityprevention.com](http://www.productliabilityprevention.com) discussing the new ISO standard and other product safety management best practices.)

Most companies don't do a good enough job in monitoring product safety issues and incidents, especially when they are selling their products globally. Therefore, it would be prudent for every company to pull their safety program out of the file cabinet and review it with a fresh eye.

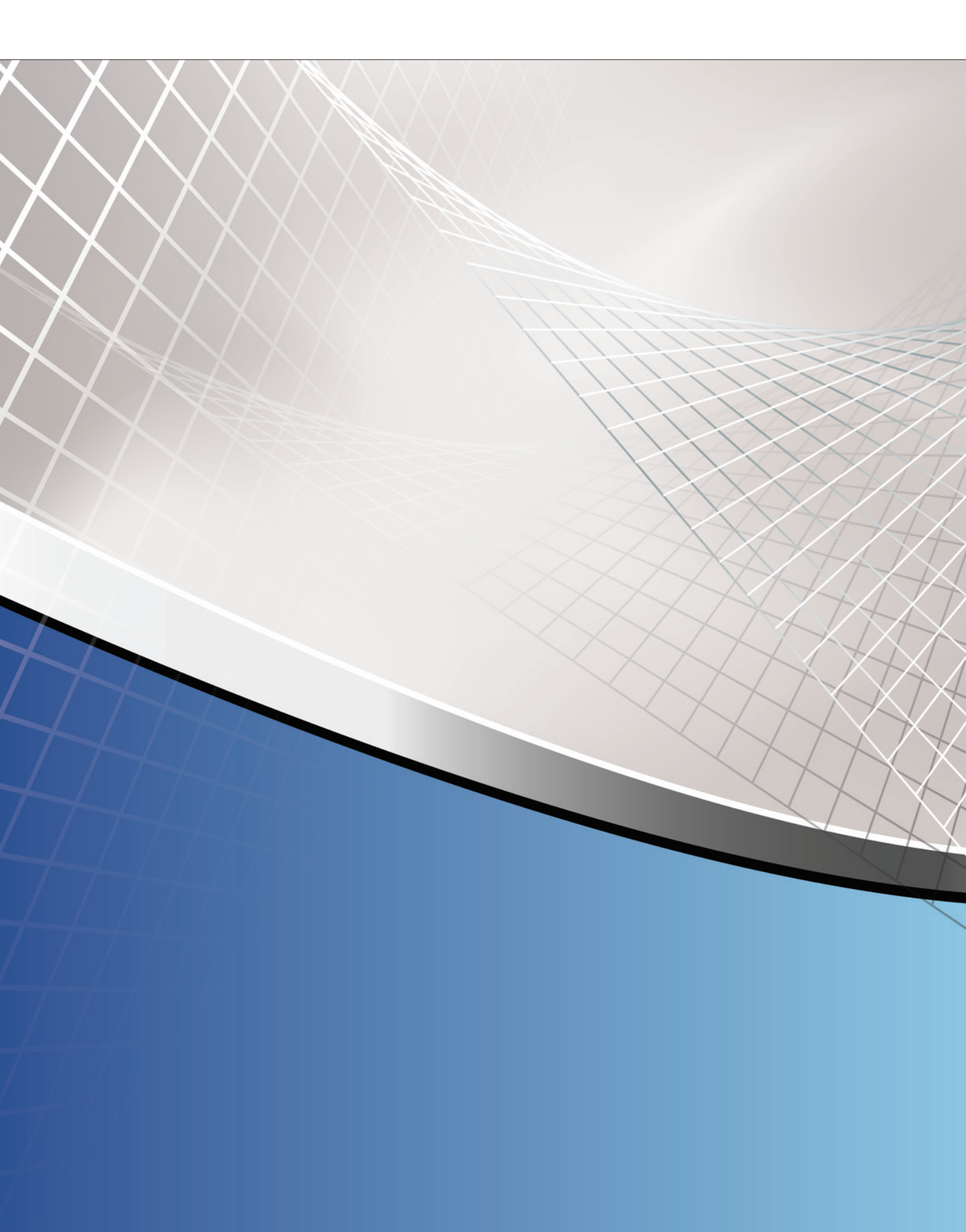
The responsible course of action is to be proactive about complying with these requirements before a safety problem arises. Dealing with such issues after the fact only increases the risk of their becoming a much bigger problem, both for your products and for your company. 

(the author)

### KENNETH ROSS

is a former partner and now Of Counsel in the Minneapolis, Minnesota office of Bowman and Brooke LLP, where he provides legal advice to manufacturers and other product sellers in all areas of product safety, regulatory compliance and product liability prevention, including safety management, recalls and dealing with the CPSC. He can be reached at 952-933-1195 or [kenrossesq@comcast.net](mailto:kenrossesq@comcast.net). Other articles by Mr. Ross can be accessed at [www.productliabilityprevention.com](http://www.productliabilityprevention.com).





# A Theory of Shielding Electromagnetic Waves

## Revisiting Shielding Effectiveness Equations

BY GEORGE M. KUNKEL

In this article, we analyze the shielding effectiveness equations ( $SE = R + A + B$ ) as defined by Ott, Schnellkunoff, White, and Frederick. The analysis consists of deriving the values of R and A, and evaluating and comparing the values of R, A and B with test results obtained by Al Broaddus and George Kunkel in their paper entitled “Shielding Effectiveness Tests of Aluminizing Mylar.”<sup>1</sup> The analysis and test data presented clearly demonstrate that the equations have been misinterpreted by Schelkunoff and others, and that there is no reflected loss inside a shielding barrier. The contribution to shielding theory by Schelkunoff is also evaluated. An analysis of circuit theory versus wave theory is performed, and the results conclude that wave theory does not represent the actual phenomena associated with a conducted wave on a transmission line, and that wave theory is only a theory.

### SHIELDING EFFECTIVENESS EQUATIONS

Most of the literature dealing with the shielding theory of electromagnetic (EM) waves defines the level of attenuation of the wave through a barrier by the use of shielding effectiveness equations. These equations are:

$$SE \text{ (shielding effectiveness)} = R + A + B$$

Where:

$$R \text{ (reflection loss)} = 20 \log \frac{(k + 1)^2}{4k} \text{ (dB)}$$

<sup>1</sup> Broaddus & Kunkel, paper entitled “Shielding Effectiveness of Aluminized Mylar.”

$$A \text{ (absorption loss)} = 20 \log e^{-t/\delta} = 8.686 t/\delta$$

$$B \text{ (re-reflection coefficient)} = 20 \log \left[ 1 - \left( \frac{k - 1}{k + 1} \right)^2 e^{-2t/\delta} \right]$$

$$\& k = Z_{\text{wave}}/Z_{\text{barrier}}$$

Table 1 illustrates the analysis results using the shielding effectiveness equations (as given in the Sidebar “Shielding Effectiveness Equations”) on the test conditions used by Broaddus and Kunkel. The test results obtained by Broaddus and Kunkel (and shielding effectiveness analysis) are based on the following test conditions: 1) the test barrier has a resistance of 1.4 ohms (impedance of 2.0 ohms); 2) the EM wave sources are a high impedance (electric dipole) antenna and a low impedance (magnetic dipole) antenna 20 centimeters from the barrier; and 3) the frequency range is between 100 kHz and 10 MHz.

Comparing the results of the analysis with the test results (as illustrated in Figures 1 and 2 and Table 1) yields significant insight into the meaning and value of the equations.

The reflective loss “R” is derived from transmission lines as obtained using the equations associated with “wave theory.” It is assumed that the reflection coefficient (R) using the wave theory equation on a transmission line is identical to that of when a radiated wave is reflected from a shielded barrier, where the loss is equally the same for the E and H fields. Figures 1 and 2 compare the results obtained using the “SE” equations with the E field attenuation obtained by Broaddus and Kunkel. No loss in the H field was detected during the test.



The term “absorption loss” implies a power loss (or an  $I^2 R$  loss as defined in our high school physics classes). It is actually an attenuation factor. When an EM wave is impinged on a shielding barrier, current (surface current density  $-J_s$ ) is coupled to the barrier. This current generates an H field at right angles to the direction of the current. The H field in turn creates a back EMF (voltage) which forces the current flowing in the barrier to flow close to the incident surface of the barrier. This phenomenon is classified as “skin effect” where the average depth of the current flowing on the surface of an infinitely thick (greater than an extinction depth or  $2\Pi\delta$  meters) is one skin depth where  $\delta$  is one skin depth.

The “re-reflective coefficient” is applicable when the thickness of the barrier is “thin” (less than  $2\Pi\delta$ ). In the literature on shielding, this function is to be applied due to the wave bouncing back and forth inside the barrier. The equation is actually a correction factor for assumptions made in applying the reflection loss equation. These assumptions are:

1. The wave impedance  $Z_w$  is greater than the barrier impedance  $Z_b$ . The equation for “R” yields a reflective loss when  $Z_w < Z_b$ . As illustrated in Figure 1 and Table 1, there is not a loss of shielding under these conditions. The equation for “B” is a correction factor when  $Z_w$  is less than the  $Z_b$  (as is the case at 100kHz using the low impedance source).
2. The thickness of the barrier is greater than  $2\Pi\delta$  meters. The equation for the impedance of the barrier (consistent with shielding effectiveness theory) is:

$$Z_b = \frac{(1 + j)}{\sigma\delta}.$$

When this equation is applied to the test conditions used by Broadbudd and Kunkel, the impedance of the 2.0 ohm barrier results in impedance of .0001, .0005 and .0015 ohms for 100 kHz, 1MHz and 10 MHz respectively. The actual impedance for a barrier of any thickness is:

$$Z_b = \left[ \frac{(1 + j)}{\sigma\delta(1 - e^{-t/\delta})} \right]$$

Using this equation, the impedance is 2.0 ohms for all three frequencies. The “B” equation containing  $(1 - e^{-2t/\delta})$  is used as a correction factor when the thickness “t” is less than  $2\Pi\delta$  (see Table 1).

Most of the literature on the shielding of EM waves states that the attenuation of the E and H fields through a barrier is equal. This is justified because the reflection loss “R” equation provides for a loss when  $Z_w < Z_b$ . The impedance inside a barrier is less than the 377 ohm impedance of free space. However, we know from Table 1 that the shielding equations predict zero shielding under these conditions. As a result there is no reflected loss inside the barrier. Any H field attenuation is the result of skin effect or the absorption “A” equation.

## SCHELKUNOFF’S CONTRIBUTION TO SHIELDING THEORY

Sergei Alexander (S.A.) Schelkunoff is credited with providing the electrical engineering community with the theory of shielding electromagnetic waves. In his book *Electromagnetic Waves* published in 1943, he provided the

Antenna Source	$Z_w$	$Z_b$	K	$\delta$	$e^{-2t/\delta}$	$\frac{k-1}{k+1}^2$	R dB	B dB	A dB	SE dB
@ 100 kHz										
High Z	$9 \times 10^5$	.0001	$6 \times 10^9$	.0003	.9998	1.0000	183.6	-76.4	0.0	107
Low Z	.158	.0001	1058	.0003	.9998	.9962	48.4	-48.1	0.0	0
@ 1 MHz										
High Z	90,000	.0005	$190 \times 10^6$	.0001	.9995	1.0000	153.6	-66.4	0.0	87
Low Z	1.0000	.0005	2120	.0001	.9995	.9981	54.5	-52.5	0.0	2
@ 10 MHz										
High Z	9000	.0015	$6.03 \times 10^6$	$2.67 \times 10^5$	.9905	1.0000	123.6	-56.4	0.0	67
Low Z	15.79	.0015	$16 \times 10^3$	$2.67 \times 10^5$	.9905	.9996	68.5	-54.5	0.0	14

**Table 1: Shielding Effectiveness Analysis of Test Conditions used by Broadbudd and Kunkel in their Presentation at the 1992 EMC Symposium.**

engineering community with the presently accepted shielding effectiveness equations, i.e.:

$$S = R + A + 20 \log \left[ 1 - \left( \frac{k-1}{k+1} \right)^2 e^{-2t/\delta} \right]$$

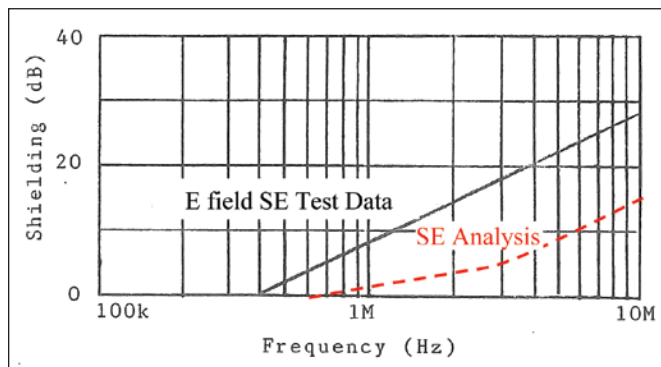
Where:

$$R = 20 \log \frac{(k+1)^2}{4k} \text{ (dB)}$$

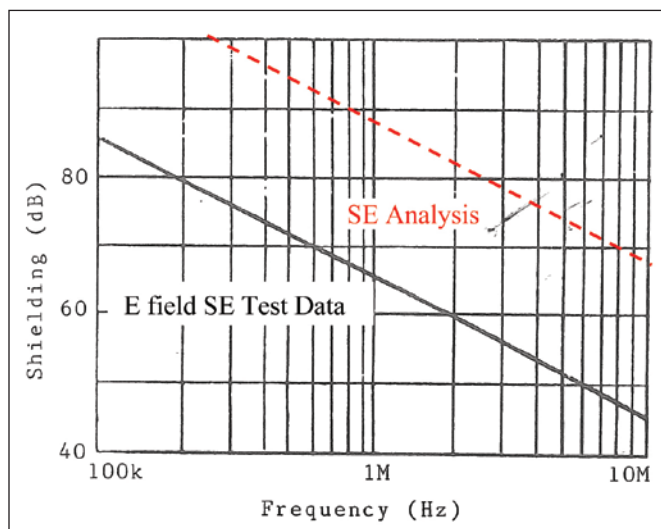
$$A = 8.686 t/\delta$$

$$k = Z_{\text{wave}} / Z_{\text{barrier}}$$

Along with the equations, he also provided us with an example for which he developed the values of R and A. He also provided the following interpretation of the reflection loss equation "R:" "The wave is partially reflected at the outer surface of the shield and then partially re-reflected at the inner surface."



**Figure 1: E Field Shielding Effectiveness Test Data versus SE Analysis of 2.0 ohm Barrier Using a Low Impedance Source 0.20 Meters from the Barrier.**



**Figure 2: E Field Shielding Effectiveness Test Data versus SE analysis of 2.0 ohm Barrier Using a High Impedance Source 0.20 Meters from the Barrier.**

## Shielding Effectiveness Equations

$$SE = R + A + B \text{ (dB)}$$

Where:

$$R = 20 \log \frac{(K+1)^2}{4|K|} \text{ Reflection Loss (dB)}$$

$$A = 8.686 \alpha d \text{ Absorption Loss (dB)}$$

$$B = 20 \log \left| 1 - \left[ \frac{K-1}{K+1} \right]^2 e^{-2\alpha d} \right| \text{ Re-reflection Coefficient (dB)}$$

$$K = \frac{Z_{\text{wave}}}{Z_{\text{barrier}}} = \left[ \frac{j\omega\mu}{\sigma} \right]^{1/2} = \frac{1+j}{\sigma\delta}$$

$$Z_{\text{wave}} \approx -j 377 \lambda / 2 \pi r, (r < \lambda / 2 \pi) \text{ High Impedance Source}$$

$$\approx j 377 (2 \pi r / \lambda), (r < \lambda / 2 \pi) \text{ Low Impedance Source}$$

$$\approx 377, (r \geq \lambda / 2 \pi) \text{ All Sources}$$

$$\alpha = \left[ \frac{\mu\sigma\omega}{2} \right]^{1/2} = 1/\delta$$

d = Thickness of Barrier (meters)

r = Distance from Source to Barrier (meters)

$$\omega = 2\pi f$$

$\mu$  = Absolute Permeability of Barrier (H/m)

$$\mu = 4 \pi \times 10^{-7}$$

$\sigma$  = Absolute Conductivity of Barrier (mhos/m)

$$\sigma_{\text{copper}} = 5.82 \times 10^7$$

$$\sigma_{\text{aluminum}} = 3.55 \times 10^7$$

$$\lambda = c/f = 3 \times 10^8 / f \text{ (meters)}$$

Extracted from "Handbook of RFI, Volume 3",  
Frederick Research Corp., Weaton, Maryland, 1962

The reflection loss “R” is derived using “wave theory” as applied to conducted transmission lines. Schelkunoff believed that wave theory represented a physical representation of a wave on a transmission line. He also believed in a direct relationship to the reflective loss in a transmission line as predicted by wave theory and the reflective loss associated with a radiated wave striking a shielding barrier. The analogous relationships between the reflective waves are as follows:

1. The Impedance (E/H) of a radiated wave striking a barrier is analogous to the characteristic impedance ( $Z_o$ ) of a transmission line.
2. The reflected E field of a radiated wave (when  $Z_w > Z_b$ ) striking a shielding barrier is analogous to the reflected voltage of a transmission line when  $Z_o > Z_L$ .
3. The re-reflected wave at the inner surface of a shielding barrier is an H field and is analogous to

the reflected current loss of a transmission line when  $Z_o < Z_L$ .

The third analogy of the H field being analogous to the reflected current is the justification for the wave being “partially re-reflected at the inner surface.” As is illustrated in Figure 1 and Table 1, there is no predicted or measured shielding effectiveness (using the SE equations) when  $Z_w < Z_b$ . Therefore, the argument for a reflected

## Circuit Theory vs. Wave Theory

In the mid-1800s two principal methods of solving electrical circuit problems were proposed. They were wave theory and circuit theory as formulated by Gustav R. Kirchoff. Kirchoff’s laws and subsequent equations proved to be easier to understand and use, and considerably more applicable. Wave theory was discarded but not forgotten. A cursory look at wave theory is taught in nearly all graduate-level courses on electromagnetic theory. This consists of informing the student that, when the load impedance of a transmission line varies from that of the characteristic impedance of the transmission line, the conducted wave is reflected. The basic laws and equations governing the reflection are provided. Detailed analysis as contained below is not performed. As a result most electrical engineers refer to the reflection of conducted waves.

We prefer to use the logic and equations described by Walter C. Johnson in his book *Transmission Lines and Networks*. Using Johnson’s laws and equations, the load impedance (as viewed from the source) varies as a function of the length of the line versus the wave length of the frequency of concern (as illustrated in a Smith Chart). A good example of using Johnson’s laws and equations over that of wave

theory is the radiation pattern of a mono pole antenna when the frequency approaches a quarter ( $1/4$ ) wave length (see Figure A1).

As can be seen from Figure A1, the radiated intensity spikes when the length of the antenna is at  $1/4$  wave length. This is due to the fact that the open circuit of the antenna appears as a short at the antenna input. Using wave theory, you obtain the same reflection regardless of the length where the predicted radiation is directly proportional to the length of the antenna and has nothing to do with wave length.

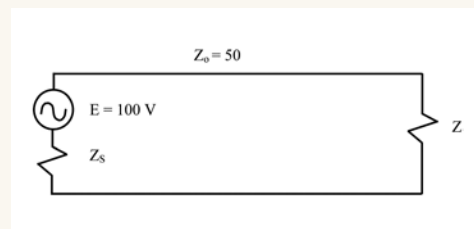
As can be seen by the analysis below, not only are the wave theory equations more difficult to use than those formulated by Kirchoff, but they also have strict boundary conditions. These are:

1. The circuit must be a simple circuit consisting of a voltage source with a source and load impedance.
2. The source and load impedances are resistive.

Wave theory will provide accurate results to a circuit problem, but only when the above constraints are met.

Consider the following illustration:

Given Circuit:



Let  $Z_L$  and  $Z_s$  equal the following:

- a)  $Z_s = 50 \Omega$ ,  $Z_L = 50 \Omega$
- b)  $Z_s = 50 \Omega$ ,  $Z_L = 1 \Omega$

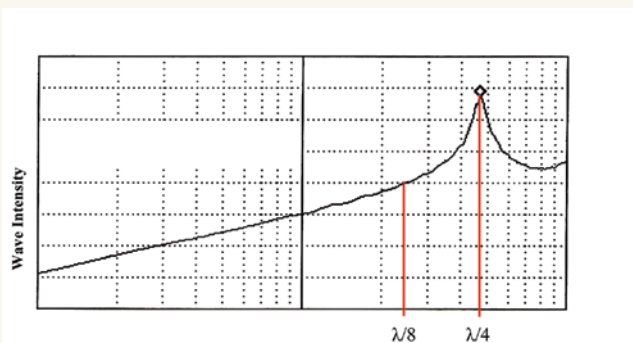



Figure A1: Radiated Field Strength from a Monopole Antenna as a Function of its Wave Length



wave inside the barrier is not valid, and does not exist.

## SUMMARY

The hypothesis upon which the shielding effectiveness, and accepted shielding theory, are based is: 1) that wave theory represents the actual physical phenomena associated with a transmission line; and 2) the reflective coefficients as predicted using wave theory on a transmission

line are identical to that of a radiated wave striking a shielding barrier. This hypothesis is incorrect. As illustrated in the Sidebar to this article, "Circuit Theory vs. Wave Theory," wave theory does not produce accurate circuit results when the load and source impedance are not resistive. The reflected E and H field form a radiated wave striking a barrier cannot be predicted using wave theory, as there is no H reflected wave when the wave impedance is less than the barrier impedance ( $Z_w < Z_b$ ). 

(the author)

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is the founder and chief engineer of Spira Manufacturing Corporation. He holds both B.S. & M.S. degrees in Engineering from UCLA, and has been active with the IEEE EMC Society for 50 years, serving as a chairman of multiple technical committees and working groups. Kunkel has authored over 100 EMC technical papers and revised several SAE-ARP test standards. He can be reached at [George@spira-emi.com](mailto:George@spira-emi.com).



- c)  $Z_s = 50 \Omega$ ,  $Z_L = 2500 \Omega$
- d)  $Z_s = 50 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$
- e)  $Z_s = 1 - j49.99 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$

Using circuit theory:

- a)  $Z_s$  &  $Z_L = 50 \Omega$ ,  $I = 1.0$  Amps
- b)  $Z_s = 50 \Omega$ ,  $Z_L = 1 \Omega$ ,  $I = 1.9608$  Amps
- c)  $Z_s = 50 \Omega$ ,  $Z_L = 2500 \Omega$ ,  $I = 0.0392$  Amps
- d)  $Z_s = 50 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$ ,  $I = 1.4105$  Amps
- e)  $Z_s = 1 - j49.99 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$ ,  $I = 50.0$  Amps

Using wave theory:

Reflected Loss (RL) =  $(K+1)^2 / 4(K)$

where  $K = Z_o / Z_{Load}$

- a)  $Z_s$  &  $Z_L = 50 \Omega$ ,  $RL = (1+1)^2 / 4(1) = 1.0$
- b)  $Z_s = 50 \Omega$ ,  $Z_L = 1 \Omega$ ,  $RL = (50+1)^2 / 4(50) = 13.005$
- c)  $Z_s = 50 \Omega$ ,  $Z_L = 2500 \Omega$ ,  $RL = (.02+1)^2 / 4(.02) = 13.005$
- d)  $Z_s = 50 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$ ,  $RL = (1+1)^2 / 4(1) = 1.0$
- e)  $Z_s = 1 - j49.99 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$ ,  $RL = (1+1)^2 / 4(1) = 1.0$

The reflective coefficient (RC) is as follows:

- a)  $Z_s$  &  $Z_L = 50 \Omega$ ,  $RC = 0$  or 0% Reflected
- b)  $Z_s = 50 \Omega$ ,  $Z_L = 1 \Omega$ ,  $RC = .923106$  or 92.3106% Reflected
- c)  $Z_s = 50 \Omega$ ,  $Z_L = 2500 \Omega$ ,  $RC = .923106$  or 92.3106% Reflected
- d)  $Z_s = 50 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$ ,  $RC = 0$  or 0% Reflected
- e)  $Z_s = 1 - j49.99 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$ ,  $RC = 0$  or 0% Reflected

When:

- a)  $Z_s$  &  $Z_L = 50 \Omega$
- d)  $Z_s = 50 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$
- e)  $Z_s = 1 - j49.99 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$

The reflected power is zero (0)

- b)  $Z_s = 50 \Omega$ ,  $Z_L = 1 \Omega$
- c)  $Z_s = 50 \Omega$ ,  $Z_L = 2500 \Omega$

The reflected power is:

$$(.923106) (50) = 46.1553 \text{ watts}$$

Therefore the power absorbed by the load impedances when

$Z_s = 50 \Omega$  and

$Z_L = 1.0$  or  $Z_L = 2500 \Omega$  is:

$$50 - 46.1553 = 3.8447 \text{ watts}$$

The current through the load impedance using wave theory is:

- a)  $Z_s$  &  $Z_L = 50 \Omega$ ,  $I = 1.0$  Amps
- d)  $Z_s = 50 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$ ,  $I = 1.0$  Amps
- e)  $Z_s = 1 - j49.99 \Omega$ ,  $Z_L = 1 + j49.99 \Omega$ ,  $I = 1.0$  Amps
- b)  $Z_s = 50 \Omega$ ,  $Z_L = 1 \Omega$ ,  $I^2(1.0) = 3.8447$   
 $I = 1.9608$  Amps
- c)  $Z_s = 50 \Omega$ ,  $Z_L = 2500 \Omega$   
 $I^2 = 3.8447/2500$   
 $I = 0.0392$  Amps

Therefore:

1. Wave theory provides accurate circuit results only when the source and load impedances are resistance.
2. Wave theory does not represent a physical representation of an EM wave in a transmission line (i.e., there is not a reflection of the wave due to a mismatch between the characteristic impedance of a transmission line and the load impedance).

Based on the above arguments, Figure A1, and the results of the above illustration, it can be concluded that "wave theory" is only a theory.

## Newest Solid State Pulse Amplifier Available For Rent

Advanced Test Equipment Rentals (ATEC), supplier of complete testing solutions for electromagnetic compatibility (EMC), now offers, for rent, the recently released Instruments For Industries (IFI) S31-500-900P solid state pulsed amplifier. The S31-500-900P has a 500W continuous rating and the ability to deliver more than 900W in the pulsed peak mode.

"ATEC is pleased to be offering the IFI S31-500-900P to our customers,"

said George Bollendorf, ATEC marketing manager. "We are continually looking to provide the latest and most relevant equipment to the industries we support, and the S31-500-900P will certainly be a hit with automotive testing.



[www.atecorp.com](http://www.atecorp.com)

## Programmable Tester Rocks at Jukebox Manufacturer

Clare's multi-function HAL 101 programmable tester is rocking to a different beat after being specified for hipot testing at the UK's only classic jukebox manufacturer. Sound Leisure, one of only two companies in the world producing classic 1940s and 1950s style jukeboxes, is using the HAL 101 to test the transformers used in the products its supplies to customers and distributors throughout North America. At its Leeds factory, dozens of new retro-styled jukeboxes are hand-made for American and



[www.seaward.co.uk](http://www.seaward.co.uk)

Canadian customers each year before being tested to ensure they operate safely and perform as required.

The HAL 101 is a programmable hipot tester with a user interface that enables manual use within a product compliance environment. It can be used with a barcode scanner to automate the production flow and enable the tester to be linked directly with most ISO quality systems.

## Electronic Kits Mall Launched

Jameco Electronics now has the largest selection of electronic kits and they are all easily accessible via an online shopping mall exclusively dedicated to electronics. The Electronic Kits Mall is easy to navigate and showcases Jameco's extensive collection of electronics projects, which are educational and fun for all ages and skill levels. These kits are created by popular manufacturers such as Adafruit, OWI-Robot, Parallax and Velleman, as well as exclusive kits created for Jameco by independent designers from around the world. Visit [www.jameco.com](http://www.jameco.com) for more information.

## New Intelligent Dual Mode Bluetooth Modules

Laird announced the release of the new BT900 Series, intelligent dual-mode modules for classic Bluetooth and Bluetooth Low Energy (BLE). The fully approved, programmable module features Laird's innovative, event-driven smartBASIC programming language, which significantly reduces OEM development risk and speeds time to market. The BT900 series allows anyone to easily and quickly add wireless capabilities to their embedded device such as a barcode scanner, portable medical device, and more. Visit [www.lairdtech.com](http://www.lairdtech.com) for more information.

## Remote Analyzer with Receiver Characteristics

Narda Safety Test Solutions has announced a new generation of RF analyzers: NRA RX. These 19" rack mount devices analyze RF signals up to 6 GHz in the frequency and time domains, and exhibit receiver characteristics at the same time, thanks to a new high frequency receiver section. They are therefore ideal for radio monitoring applications.

The devices are primarily designed for use in automated and remote controlled measuring systems. A 10 MHz reference input is provided for synchronization to the system frequency. Stand-alone operation with a PC is also possible. There are two models available.



[www.narda-sts.com](http://www.narda-sts.com)

## New Lines of Digitally Programmable Attenuators


Pasternack Enterprises, Inc. announced the release of their new 5 Bit, 8 Bit and 10 Bit broadband PIN diode digital step attenuators with performance up to 40 GHz depending on the configuration. These programmable, variable step attenuators are commonly used in electronic warfare, military and space communication systems, radar and test and measurement applications. Pasternack's new digital step attenuators come in 30 dB and 60 dB values and have attenuation step resolution of 0.25 dB to 1 dB depending on the model.



[www.pasternack.com](http://www.pasternack.com)

# PRODUCT Showcase

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## Business News

### Compact, High-current Chokes for 48-V Automotive Power Systems

TDK Corporation presents the new BCEM series of EPCOS high-current chokes designed specifically for buck-boost converters in 48-V automotive power systems.

These innovative SMD inductors have very compact

dimensions of only 27.5 mm x 29.5 mm x 14.5 mm thanks to their ERU27 ferrite cores with flat windings. The



[www.epcos.com](http://www.epcos.com)

new chokes feature inductance values of 3  $\mu$ H to 11  $\mu$ H and are designed for saturation currents of up to 50 A and operating temperatures of between -40 °C and +150 °C. The components are suited for switching frequencies from 100 kHz to 200 kHz, and are RoHS-compatible and qualified to AEC-Q200.

### TÜV SÜD America Authorized to Audit Within the MDSAP Pilot Program

TÜV SÜD America is one of the first auditing organizations to become authorized by the International Medical

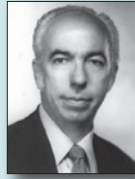
Device Regulators Forum (IMDRF) to carry out audits within the MDSAP pilot project. The Medical Device Single Audit Program (MDSAP) is designed to develop a standard for quality management audits at the manufacturers of medical devices that is mutually recognized by several countries. TÜV SÜD started to carry out audits under the MDSAP program in October 2014. Visit [www.tuev-sued.de](http://www.tuev-sued.de) for more information.

**Submit your press releases to [press@incompliancemag.com](mailto:press@incompliancemag.com)**



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We wish to thank our community of knowledgeable authors, indeed, experts in their field - who come together to bring you each issue of *In Compliance*. Their contributions of informative articles continue to move technology forward.

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## NSG 437 & NSG 438 ESD SIMULATORS – BEST-IN-CLASS FEATURES FOR 30 kV ESD TESTING

The NSG 437 and NSG 438 are the most user friendly ESD simulators, offering a unique touch screen and activity log. Even with its bright new color display, the NSG 438 features the longest battery life of any ESD simulator on the market, with over 30,000 discharges at 30 kV on a single battery charge. The simulators also feature a unique activity log, allowing the user to easily scroll through the touch screen to check what has been tested and in what timeframe.

As these simulators are fully compliant to the IEC, ANSI, SAE and ISO standards, they are ideal for use in ESD testing of automobiles and their subassemblies as well as ESD testing of all consumer electronics and white goods, information technology, medical and industrial equipment.

### Key Features

- Discharge voltage from 200 V to 30 kV in 100 V steps
- Up to 30 s hold time
- Battery life over 30,000 discharges at 30 kV (NSG 438)
- Over 60 quickly interchangeable discharge networks available (150 pF/330  $\Omega$  standard)
- Custom discharge networks from 0  $\Omega$  and up to 2 nF
- Built-in ISO self-calibration