APRIL 2013

IN COMPLIANCE™

THE COMPLIANCE INFORMATION RESOURCE FOR ELECTRICAL ENGINEERS

The Role of NEBS Requirements

in the Telecom Marketplace

PLUS

What Do You Mean, Environmental Test... and "Don't Stack Your Resonances"?

Things You May Not Have Heard About Lightning and Grounds

Engineering Our Future: A View of Changes Facing Engineers - Part 2

GOT GAIN?

improve your overall system sensitivity

Preamplifiers
20 MHz - 40 GHz
8 Models

Low-Loss Cables
DC - 40 GHz
4 Models

Like milk and cookies, preamplifiers go together with high-frequency low-loss cables. As frequency requirements increase, so do the losses encountered in antennas, cables and test instrumentation. Our preamplifiers provide the necessary gain to overcome these losses. The signal level at the receiver must be high enough to produce useful data. A.H. Systems has both preamplifiers and low-loss cables to match all antennas to 2, 4, 7, 18, 26.5 and 40 GHz. Our custom length low-loss cables match these frequencies and can be assembled and delivered in 2 days. Why wait when you can have it all now.

Preamplifiers... And Cables too.

Innovation Quality Performance

Phone: (818)998-0223 ♦ Fax (818)998-6892
http://www.AHSystems.com
A.H. Systems

We've topped the best.

The new R&S®BBA150 broadband amplifier.

Our broadband amplifiers now also cover the microwave range. Optimized for high frequencies, the R&S®BBA150 features an initial instantaneous frequency band of 0.8 GHz to 3.0 GHz. In combination with the R&S®BBA100 family, it is possible to set up amplifier systems from 9 kHz to 3.0 GHz – with switching options when desired.

Want to find out more?
Visit www.rohde-schwarz.com/ad/bba

R&S® BBA150

R&S® BBA100

ROHDE&SCHWARZ

COMMITMENT. COMMUNITY. COMPLIANCE.

OUT and ABOUT in the COMMUNITY

In Compliance is **COMMITTED** *to the* **COMMUNITY** *of* **COMPLIANCE** *engineering professionals who make up our readership. We actively participate in community events throughout the year.*

As a leader in the compliance community, we turn to you to tell us what you need. These events give us a chance to talk to you face-to-face. We encourage you to stop by and tell us your ideas, feedback and suggestions.

You can turn to us as your #1 source for all your compliance news - in our magazine, at events and online.

IN COMPLIANCE

IN COMPLIANCE

In Compliance Magazine
ISSN 1948-8254 (print)
ISSN 1948-8262 (online)
is published by

Same Page Publishing Inc.
531 King Street, Suite 5
Littleton, MA 01460-1279
tel: (978) 486-4684
fax: (978) 486-4691

editorial staff

editor/publisher Lorie Nichols
lorie.nichols@incompliancemag.com
(978) 873-7777

production director Erin Feeney
erin.feeney@incompliancemag.com
(978) 873-7756

contributing editor Mary Ann Kahl
maryann.kahl@incompliancemag.com

publishing staff

director of sales Sharon Smith
sharon.smith@incompliancemag.com
(978) 873-7722

national sales manager Shellie Johnson
shellie.johnson@incompliancemag.com
(404) 991-8695

marketing communications specialist Heather Stehman
heather.stehman@incompliancemag.com
(978) 873-7710

circulation manager Alexis Harrington
alexis.harrington@incompliancemag.com
(978) 873-7745

subscriptions

In Compliance Magazine subscriptions are free to qualified subscribers in North America.

Subscriptions outside North America are $129 for 12 issues.
The digital edition is free.

Please contact our circulation department at circulation@incompliancemag.com

advertising

For information about advertising contact:
Sharon Smith at 978-873-7722
sharon.smith@incompliancemag.com

CONTENTS

April 2013
Volume 4 ● Number 4

24 The Role of NEBS Requirements in the Telecom Marketplace

While product safety and reliability are core principles of virtually every manufacturer designing equipment for the telecom industry, the Telcordia Generic Requirements (GRs) that ensure the integrity of such devices and systems are not commonly understood by manufacturers around the globe.

Matt Marotto and Randy Ivans

DEPARTMENTS

FEATURES

News in Compliance

FCC News

FCC Proposes Changes to Equipment Approval Process

The Federal Communications Commission (FCC) has proposed important changes to its equipment testing and authorization program under Part 15 and Part 68 of its rules that it says will streamline the approval process and expedite the introduction of new devices to the market.

In a Notice of Proposed Rulemaking issued in February 2013, the Commission proposed a number of changes to its existing equipment authorization program. The key changes include:

- ***TCB Authority***—The FCC will no longer directly issue any grants of equipment authorization. Instead, telecommunications certification bodies (TCBs) will authorize all products subject to certification. TCBs will also be granted the authority to dismiss equipment authorization applications not in accordance with the Commission's requirements. The Commission will also establish a "pre-approval guidance" procedure for TCBs to follow when evaluating types of equipment for which rules, requirements and/or measurement procedures are unclear.
- ***Post-Market Surveillance***—The Commission will delineate post-market surveillance requirements of TCBs on the number and types of samples that a TCB must test. TCBs will also be authorized to request samples of equipment that they have previously certified directly from the certificate grantee.
- ***Assessing TCB Performance***—The Commission proposes to appoint NIST (formerly the National Institute of Standards and Technology) as the designating authority for TCBs in the U.S. The Commission has also outlined a process to address TCB non-performance issues, short of the complete withdrawal of TCB designation.
- ***TCB Accreditation Standards***—Under the proposed rule changes, TCBs would be accredited in accordance with the requirements of ISO/IEC 17011 and ISO/IEC 17065. These standards replace ISO/IEC Guides 58, 61 and 65.
- ***Testing Laboratories Accreditation***—The FCC has proposed that all laboratories that test equipment subject to certification or approval under any of its rules be accredited to ISO/IEC 17025.
- ***Measurement Procedures***—The Commission proposes to incorporate the requirements of ANSI C63.10-2009 into its rules as the procedure used to determine the compliance of intentional radiators, and ANSI C63.4-2009 as the procedure for assessing unintentional radiators.

The Commission hinted at the scope of changes in mid-2012, when it lifted restrictions limiting equipment identification codes to not more than three characters. In that Order, the Commission noted that it was exploring additional ways to improve the equipment authorization program, "including clarifying or modifying the administrative requirements and responsibilities of the Telecommunications Certification Bodies that perform equipment certification."

Comments on the Commission's proposed rule changes are due by late March.

The complete text of the Commission's Notice of Proposed Rulemaking is available at incompliancemag.com/news/1304_01.

The FCC has proposed important changes to its equipment testing and authorization program under Part 15 and Part 68 of its rules that it says will streamline the approval process and expedite the introduction of new devices to the market.

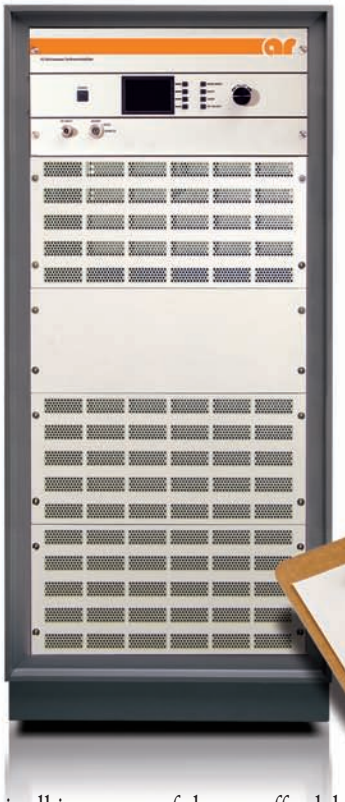
FCC Proposes Changes Affecting U-NII Devices in 5 GHz Band

The Federal Communications Commission (FCC) has proposed making additional unlicensed spectrum available in the 5 GHz band to facilitate public access to higher speed broadband connections.

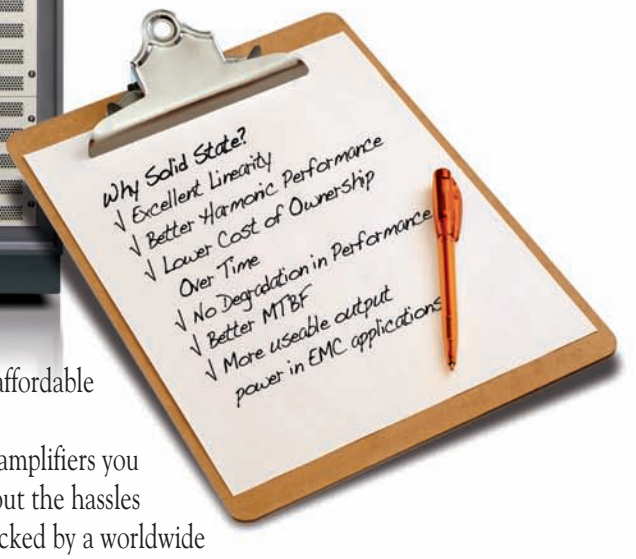
In a Notice of Proposed Rulemaking issued in February 2013, the Commission proposed to make available up to an additional 195 megahertz of spectrum in the 5 GHz band for so-called Unlicensed National Information Infrastructure (U-NII) devices. These devices are used for short range, high speed wireless connections, such as Wi-Fi enabled local area networks used in public places to connect smart phones,

Solid State Alternatives To TWT Amplifiers

Now 1000 Watts Of Power



1000S1G2z5
1000 Watts
1.0-2.5 GHz



The New 1 – 2.5 GHz "S" Series Solid State Power Amplifiers

There are several important things to consider when choosing a test amplifier. Things like harmonics, linearity, durability, power, reliability, and of course life cycle cost. Too often, you have to settle for an old TWTA design approach to achieve this power in such a small footprint, but now you can have it all in a state-of the-art affordable instrument to meet your demanding requirements.

With AR's new 100, 250, 500 and 1000-Watt 1-2.5 GHz "S" Series amplifiers you can have the reliability and performance advantages of solid state without the hassles that the old TWTA designs have. And because it's made by AR, it's backed by a worldwide service and support network that's second to none. So why settle for just any amplifier when you can get one with all the features you've been wishing for?

To learn more, visit us at www.arworld.us or for technical support call 800-933-8181.

***www.arworld.us*/1-2.5GHz**

ISO 9001:2008 Certified

rf/microwave instrumentation

Other ar divisions: modular rf • receiver systems • ar europe

USA 215-723-8181. For an applications engineer, call 800-933-8181.
In Europe, call ar United Kingdom 441-908-282766 • ar France 33-1-47-91-75-30 • ar Benelux 31-172-423-000

www.arworld.us

News in Compliance

FCC News

tablets and laptop computers to the broadband network.

In the same Notice, the Commission has also proposed a more streamlined equipment authorization procedure for N-III devices operating in the 5 GHz band.

The complete text of the Commission's Notice of Proposed Rulemaking is available at incompliancemag.com/news/1304_02.

Signal boosters are designed to improve wireless coverage in areas where signal strength is weak, and can also be used to extend wireless coverage to hard-to-serve areas, such as tunnels, subways and garages. These increased capabilities benefit consumers, but also support vital emergency services communications systems.

In its Report and Order issued in February 2013, the Commission has created distinct regulatory requirements for signal boosters used in both consumer and industrial applications. Of particular note are new requirements applicable to signal boosters intended for consumer use. Such devices will be expected to meet stringent technical specifications designed to protect the network. Further, consumers will be required to register any signal booster with their wireless service provider prior to its use. Finally, any booster that causes interference with wireless networks cannot be placed into operation, even if the device meets the FCC's technical specifications.

The Commission says that all four nationwide wireless carriers as well as many regional and rural carriers have consented to the use of signal boosters on their networks, as long as the devices meet the new technical specifications.

The complete text of the Commission's Report and Order regarding signal boosters is available at incompliancemag.com/news/1304_03.

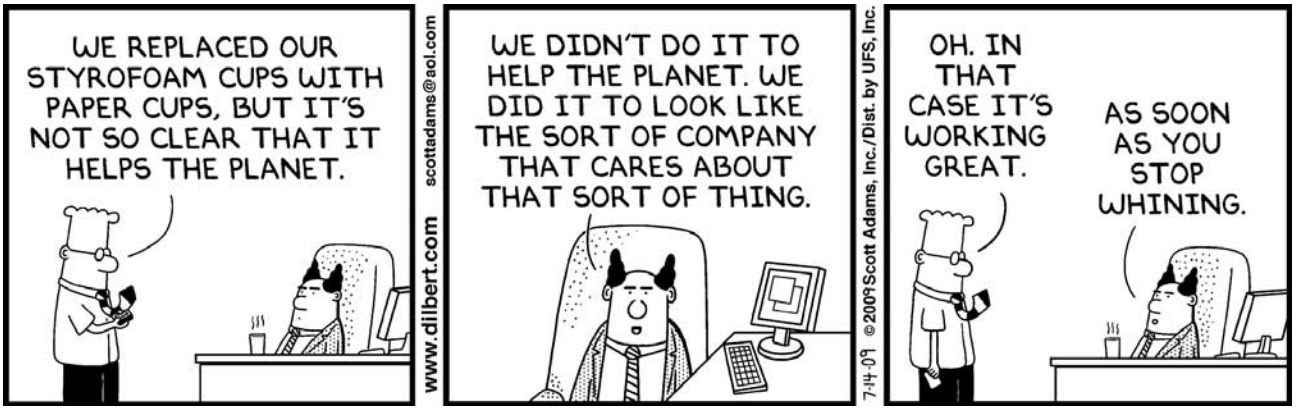
The Federal Communications Commission has released a white paper that provides national comparisons of both licensed and unlicensed spectrum available for mobile broadband services.

Rule Changes to Improve Wireless Coverage with Signal Boosters

The Federal Communications Commission (FCC) has issued new technical specifications for signal boosters in an effort to improve wireless coverage while protecting wireless networks.

FCC Issues White Paper on International Spectrum for Mobile Broadband Services

The Federal Communications Commission (FCC) has released a white paper that provides national comparisons of both licensed and unlicensed spectrum available for mobile broadband services.



FCC News

The Commission's white paper, "The Mobile Broadband Spectrum Challenge: International Comparisons," provides comparative data from the U.S. and nine other industrialized countries on the amount of licensed spectrum available for mobile broadband services. The paper also summarizes the availability of unlicensed spectrum for mobile broadband in both the U.S. and the European Union.

Of the countries surveyed, Australia ranks #1 in the amount of licensed spectrum now or soon to be available for mobile broadband services, with over 700 megahertz. The U.S. is second, with approximately 663 megahertz, closely followed by the U.K. (617 megahertz), Germany (615 megahertz), France (605 megahertz) and Spain (600 megahertz).

The white paper notes that the U.S. licensed spectrum figure does not include spectrum for mobile broadband applications that will be made available through incentive auctions and federal spectrum repurposing efforts.

The complete text of the FCC White Paper is available at incompliancemag.com/news/1304_04.

FCC to Open Public Testing of Google's TV Band Database

To facilitate the interference-free operation of unlicensed wireless devices operating in TV spectrum bands, the Office of Engineering and Technology of the Federal Communications Commission (FCC) has launched a public trial of Google's TV band database system.

Under the Commission's Part 15 rules, wireless devices that operate on unlicensed TV bands are required to reference an authorized database system to identify those channels that are available for interference-free operation. An authorized database accepts input from a device regarding its specific location, and then returns a list of channels available at that location for operation. In this way, the database protects authorized service transmitters from interference while facilitating the operation of unlicensed devices.

Scheduled to run until mid-April 2013, the public trial of Google's TV band database provides an opportunity for the Commission and the public to assess the accuracy of the results being provided by the database prior to authorizing the database for regular public use.

Google says that its TV band database system will contribute to efforts to free up spectrum for dynamic sharing, and improve device connectivity globally.

The complete text of the Commission's Notice regarding the public testing period for Google's TV band database is available at incompliancemag.com/news/1304_05. Google's TV band efqwFSgrwrwatabase test facility is available at incompliancemag.com/news/1304_06. Google has also posted additional information about its spectrum database project at incompliancemag.com/news/1304_07.

News in Compliance

CPSC News

Owner of Peanut Butter Manufacturer Indicted for Salmonella Cover-Up

The former owner of a Georgia peanut processing company has been indicted by the U.S. Department of Justice for knowingly selling peanut products contaminated with salmonella.

According to a recent report in the *Wall Street Journal*, Stewart Parnell, the owner of Peanut Corporation of America, allegedly engaged with other company employees in a multi-year conspiracy to hide the contamination problem from its producer customers. Tainted peanut butter and peanut paste from Peanut Corporation facilities was eventually used as an ingredient in thousands of products, ranging from cookies and crackers to pet food.

Prosecutors in the case allege that Peanut Corporation failed to notify its customers of the problem, even after independent laboratory tests confirmed the presence of salmonella. Company officials also allegedly fabricated test results, or claimed that their products were salmonella-free despite testing results to the contrary.
a
The Centers for Disease Control and Prevention estimates that nine people died and hundreds more became sick in 2009 after eating products containing peanut butter and other peanut ingredients that originated from Peanut Corporation facilities. The outbreak also led to the recall of more than 2000 food products, and spurred action by the Congress to strengthen the enforcement authority of the U.S. Food and Drug Administration (FDA).

Parnell was indicted on 76 separate counts, including conspiracy, wire fraud, obstruction of justice and introducing adulterated food into the market.

The complete text of the *Wall Street Journal* article is available at incompliancemag.com/news/1304_08.

The former owner of a Georgia peanut processing company has been indicted by the U.S. Department of Justice for knowingly selling peanut products contaminated with salmonella.

Ryobi Battery Pack Recalled

Importer One World Technologies, Inc. of Anderson, SC has recalled about 54,200 Ryobi-brand lithium battery packs manufactured by Techtronic Industries Co. Ltd. of China.

One World says that the battery packs can overheat and burst while on a charger, posing fire and burn hazards to consumers. The company has received four separate reports of battery packs overheating, resulting in minor property damage. However, there have been no reports of injuries associated with the recalled battery packs.

The battery packs were sold at Home Depot stores nationwide, online at Homedepot.com, and at other retailers from September 2012 through December 2012 for about $99. An additional 2200 battery packs were sold at Home Depot stores in Canada, and are subject to a separate product recall by Health Canada.

More information about this recall is available at incompliancemag.com/news/1304_09.

Company Recalls Single Cup Coffee Makers

Importer Jerdon Style, LLC of Richardson, TX is recalling about 6000 of its one-cup coffee makers manufactured in China.

Jerdon Style says that the recalled coffeemaker model can overheat, posing a fire and burn hazard to consumers. In a notice filed with the U.S. Consumer Product Safety Commission (CPSC), the company reports that it has received four reports of coffeemakers overheating, but no reports of injuries.

The recalled coffeemakers were sold through hotel and motel product suppliers and through major online retailers from July 2012 through January 2013 for between $15 and $26.

Further details about this recall can be found at incompliancemag.com/news/1304_10.

CPSC News

Pre-lit Christmas Trees Recalled

Balsam Hill LLC of Redwood City, CA has announced the recall of approximately 700 pre-lit Christmas trees manufactured in China and Taiwan.

According to the company, the remote control receiver box attached to the Christmas tree can overheat and melt, posing burn and shock hazards to consumers. Balsam Hill says that it has received 10 reports of the remote control receiver box overheating and melting. However, there have been no reports of injuries to consumers.

The recalled pre-lit Christmas trees were sold online at the Balsam Hill website from July 2012 through December 2012 for between $1250 and $3550.

Additional information about this recall is available at incompliancemag.com/news/1304_11.

Fireplace TV Captivates Norway Audience

(From our "You Can't Make This Stuff Up" file)

For those who think that modern cable television doesn't offer viewers enough options, there may be an answer in a recent television broadcast in Norway.

The Reuters News Service reports that Norwegian public broadcasting network NRK ran a 12 hour long broadcast in February showing only a burning fireplace. The broadcast was reportedly accompanied by "color commentary" by "firewood specialists," along with tutorials on fire-making and cultural segments.

The idea for the marathon log burning television show apparently came from a best-selling book by Lars Mytting, reputedly Norway's biggest firewood celebrity. His firewood book, "Hel Ved," has sold approximately 130,000 copies in the past year, more than any other title in Norway except *Fifty Shades of Grey*.

iNARTE Informer

The Transfer Continues

BY BRIAN LAWRENCE

In the near future all iNARTE certificate holders, FCC license applicants and certification applicants will be transferred from the iNARTE database to the RABQSA International IT system.

Following this transfer, everyone in the system will have the ability to log in via a secure web portal, access their personal files and perform the following actions:

- Update contact details;
- View the program(s) in which they are currently certified
- View the upcoming requirements for maintaining certification (program dependent);
- Upload additional information to support ongoing certification applications or currency, (program dependent);
- Review all previously submitted documents;
- Make your Resume/CV viewable by the public – only on your approval (great for people who like to promote their experience to the marketplace)
- Download a PDF of your current Certificate(s) of Competency;
- Download a copy of a receipt of payment;
- See the current status of their application (if applicable).

We will be making an announcement in this article and on our web site when this data migration has been completed.

PRODUCT SAFETY CERTIFICATION

Last month we reported the preliminary findings resulting from our Product Safety Job Analysis. Our thanks go to those of you who took time to complete this survey. As you can imagine there are many statistics that can be studied, given the number of different questions asked in different sections of the survey, and here are a few of the more interesting:

- Almost 90% of the respondents were Engineers with a Bachelor degree or higher
- 80% of respondents had duties other than those involving Product Safety
- 70% of respondents' other duties involved different aspects of Product Compliance
- Only 60% of respondents spend more than half their time on Product Safety issues
- 80% of respondents worked in larger organizations with more than 100 employees
- 80% of respondents had more than 10 years of experience working in Product Safety

We also asked about the relative importance and frequency of use of the different Product Safety related disciplines currently featured in our certification examinations. A further study of these responses will suggest several changes to examination structure in the future in order to bring greater relevance and value to this credential.

A NEW EMC STEERING COMMITTEE

The demographics of the global EMC communities have been, and are still changing. There are many regions where the discipline is mature, stable, and in some cases declining, due to migration of manufacturing industries. Conversely new requirements for competent EMC practitioners are emerging elsewhere, often at a pace too rapid to be adequately satisfied by the new graduating classes. It is important that iNARTE certifications form a valuable part of these changes. It is no longer sufficient for our EMC certification to merely identify the top 20% to 25% of practitioners with many years of experience, such a credential has little immediate value in emerging communities. What is needed there is to identify a skill set for the entry level EMC Engineer and Technician so that employers can have some assurance of hiring real contributors and not

Join us for this 3-Day Intensive Course

presented by renowned EMC expert Henry Ott

Electromagnetic Compatibility Engineering

a course in noise and interference control in electronic systems

April 9 - 11, 2013 **Westford, MA**

TOPICS INCLUDE:

- Cabling
- Grounding Principles
- Digital Layout & Grounding
- High Speed Digital Decoupling
- D-M Emission Modeling
- Common-Mode Filtering
- Transmission Lines
- Mixed Signal PCBs
- RF & Transient Immunity
- Conducted Emission
- Shielding

In this three-day intensive course

we cover practical aspects of noise and interference control in electronic systems and we provide a working knowledge of EMC principles.

Ideas are illustrated with examples of actual case histories and mathematic complexity is kept to a minimum.

Participants will gain knowledge needed to design electronic equipment that is compatible with the electromagnetic environment and in compliance with national and international EMC regulations.

Who Should Attend

This course is directed toward electrical engineers. However, mechanical engineers, reliability and standards engineers, technical managers, systems engineers, regulatory compliance engineers, technicians and others who need a working knowledge of electromagnetic compatibility engineering principles will also benefit from the course.

Get more information and register for this course at www.hottconsultants.com

EMC Exhibits and reception - Wednesday, April 10, 2013

Exhibitors: for information contact Sharon Smith at sharon.smith@incompliancemag.com or (978) 873-7722

Presented by Henry Ott Consultants in partnership with IN COMPLIANCE Magazine

www.incompliancemag.com

HENRY OTT

Henry W. Ott is President and Principal Consultant of Henry Ott Consultants (www.hottconsultants.com), an EMC training and consulting organization. He has literally "written the book" on the subject of EMC and is considered by many to be the nation's leading EMC educator. He is the author of the popular EMC book Noise Reduction Techniques in Electronic Systems (1976, 1988). The book has sold over 65,000 copies and has been translated into six other languages. In addition to knowing his subject, Mr. Ott has the rare ability to communicate that knowledge to others.

Mr. Ott's newly published (Aug. 2009) 872-page book, Electromagnetic Compatibility Engineering, is the most comprehensive book available on EMC. While still retaining the core information that made Noise Reduction Techniques an international success, this new book contains over 600 pages of new and revised material.

Mr. Ott is a Life Fellow of the IEEE and has served the EMC Society in various capacities including: membership on the Board of Directors, Education Committee Chairman, Symposium Committee Chairman and Vice President of Conferences. He is also a member of the ESD Association and an iNARTE certified ESD engineer. He is a past Distinguished Lecturer of the EMC Society, and lectures extensively on the subject of EMC.

iNARTE Informer

merely students. The traditional iNARTE program will still remain and can then be used to identify the more experienced Engineers and Technicians as they gain more experience and a higher level of knowledge.

To assist us in developing and revising our EMC certification program accordingly, we have been fortunate enough to have formed a new EMC Steering Committee of volunteers, each with an extensive background in the discipline and each with a wealth of experience in different sectors of industry and the global economies.

At the same time we will be circulating an EMC Job Analysis Survey, both in the USA and in other countries, the results of which will help guide the focus of our Steering Committee. If you are among those that receive an invitation to respond to this survey, please do so. Your answers will help shape the EMC credentials of the future and maintain the currency and value of the iNARTE brand.

THE NEW QUESTION REQUIREMENT

All certification applicants should use the current downloadable pdf application forms from the iNARTE website. Within the last month all application forms have been updated to stipulate the new question requirements.

All new certification applicants, all iNARTE support committee members, certification review committees, and anyone interested in the science of good question writing must watch the two part presentations that RABQSA has now uploaded to YouTube.

Part 1 (required for all question writers):
https://asq.webex.com/asq/k2/e.php?AT=RINF&recordingID=6221112

Part 2 (optional but helpful for question writers):
https://asq.webex.com/asq/k2/e.php?AT=RINF&recordingID=6221212

Although the number of questions required have been significantly reduced, we will be much more critical of question quality. Remember that your certification is a valuable credential only as long as the level of knowledge and experience required to achieve it is maintained. The questions you send us are intended to be included in our question pools and will likely appear in a future examination, so make sure that they are adequately challenging. IN

QUESTION OF THE MONTH

Last time's question came from the ESD pool:

The magnitude of a charge during triboelectric charging is dependent on the size, shape, composition and electrical properties of the two materials generating the charge, and which other of the following:

A) the weight of the two substances

B) any source of ultra violet rays in the vicinity.

C) the relative humidity

D) whether or not the person handling the materials has a good ESD ground or not.

The correct answer was C) the relative humidity.

This month's question from the EMC Design Engineer pool is:

When designing high-speed Printed Wiring Boards, should power and return planes be on adjacent layers, and for what reason?

A) Yes, to reduce noise on the power plane at high frequencies.

B) No, because the material that separates the power and return planes will often fail and short the power plane.

C) Yes, it is industry standard to design the connectors so that they are forced to feed the power and grounds on adjacent layers.

D) Yes, If the planes are not routed next to each other, the boards may warp during fabrication.

(the author)

BRIAN LAWRENCE began his career in electromagnetics at Plessey Research Labs, designing "Stealth" materials for the British armed services. In 1973 he moved to the USA and established a new manufacturing plant for Plessey to provide these materials to the US Navy. In 1980 he joined the "Rayproof" organization to develop an RF Anechoic Test Chamber product line. As a result of acquisitions, Rayproof merged into Lindgren RF Enclosures, and later into ETS-Lindgren. Following a career spanning more than 40 years in the electromagnetic compatibility field, Brian retired as Managing Director of ETS-Lindgren UK in 2006. Later that year he assumed the position of Executive Director for the National Association of Radio and Telecommunications Engineers, NARTE. Now renamed iNARTE, the Association has expanded its operations and is today an affiliate of RABQSA under the overall banner of the American Society for Quality, ASQ.

ACADEMY

Current Courses from the Washington Laboratories Academy

Introduction to

CISPR 32

Got Multimedia? Get CISPR 32! Learn All About it!

Electromagnetic Compatibility of Multimedia Equipment: Emission Requirements

June 12-13, Boston

This workshop is designed to increase your understanding and application of the new CISPR 32 standard. CISPR 32 was designed to replace CISPR 13 and 22 which are used internationally for showing compliance to emission regulations for receivers and information technology equipment. The approach used in CISPR 32 is to identify tests which are applied to ports of the multimedia equipment. There will be a discussion on what options that the manufacturer can select such as the video display. Measurement uncertainty is also considered in the standard and has to be indicated in the test report. There will be actual demonstrations of the measurement technique, as well as product arrangement and configuration at a laboratory test facility. Attendees will get a chance to participate in the testing as well as solving problems on the use of the standard.

Workshops feature industry leaders and members of the CISPR working group that produced the standard. They include Don Heirman, Workshop Director, (Don HEIRMAN Consultants) and Dave Arnett (US technical expert for CISPR SC/I).

Who should attend?

- Product Managers and Developers
- EMC Engineers and test technicians
- Regulatory Compliance Managers
- Test Instrumentation Developers
- Calibration labs/technicians
- Accreditation bodies and lab quality assessors
- Test instrumentation and chamber manufacturers
- Data reduction analysts

Seminar Location:

Bureau Veritas
Consumer Products Services
Littleton Distribution Center
One Distribution Center Circle, Ste. #1
Littleton, MA 01460

What you'll learn:

- Emission measurement procedures
- Regulatory implications
- Test facility and instrumentation requirements
- Test arrangements and configurations

Partners:

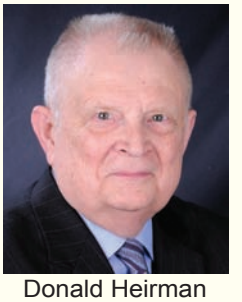
Don HEIRMAN Consultants

Bureau Veritas
Consumer Products Services

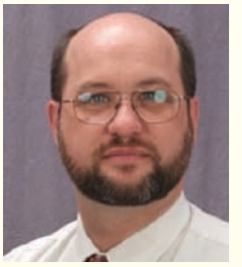
IN Compliance Magazine

Course Schedule:
June 12, 2013:
9:00 am - 5:00 pm
June 13, 2013:
9:00 am - 12:00 noon

Instruction by:



Donald Heirman



Dave Arnett

Registration:
$895 Includes 1-1/2 day seminar, lecture flash drive, continental breakfast, lunch, breaks, and completion certificate.

Register at wll.com/academy

Washington Laboratories, Ltd.
7560 Lindbergh Drive • Gaithersburg, Maryland 20879 • 301-216-1500 • academy@wll.com • wll.com/academy

Neutralization of Static Charges by Air Ions

Part I: Theory

BY NIELS JONASSEN, sponsored by the ESD Association

When the conductivity of the material cannot be made acceptable, air ions can be used to neutralize static charges.

INTRODUCTION

Associate Professor Neils Jonassen authored a bi-monthly static column that appeared in *Compliance Engineering Magazine*. The series explored charging, ionization, explosions, and other ESD related topics. The ESD Association, working with *In Compliance Magazine* is re-publishing this series as the articles offer timeless insight into the field of electrostatics.

Professor Jonassen was a member of the ESD Association from 1983-2006. He received the ESD Association *Outstanding Contribution Award* in 1989 and authored technical papers, books and technical reports. He is remembered for his contributions to the understanding of Electrostatic control, and in his memory we reprise "Mr. Static".

~ The ESD Association

In "How Fast Does a Charge Decay?" the neutralization of charges by conduction through the bulk or along the surface of a material was discussed.[1] Although bulk and surface conduction are important processes in static neutralization, in many situations, the materials involved cannot be made sufficiently conductive in an acceptable way. In these cases, the only solution is neutralization by air ions. The physical properties of air ions were discussed in "Ions."[2] However, their use in charge neutralization was touched on only briefly.

AIR IONS

Air ions or atmospheric ions differ from electrolytic ions in several ways. Air ions are small molecular clusters consisting mostly of water molecules grouped around a nitrogen or oxygen molecule that has lost or gained an electron. In the case of positive ions, the number of water molecules may range from 10 to 15, and in the case of negative ions, from 8 to 12 (see Figure 1). In the latter case, the (negatively) charged molecule is always oxygen.

Air ions have only a limited lifetime. In undisturbed air, that lifetime is in the order of minutes. They disappear in a number of ways. Positive and negative ions can recombine, air ions can combine with airborne particles, and air ions can plate out on surfaces, either by diffusion or with the aid of an electric field. It is the latter process that is utilized in charge neutralization.

Ions will move in an electric field with a velocity v proportional to the field strength E given by the equation

$$v = k \cdot E \,. \qquad (1)$$

The factor k is the mobility of the ion, and the unit of measurement is $m^2V^{-1}s^{-1}$. For positive ions, $k^+ \approx 1.3–1.4 \cdot 10^{-4}\ m^2V^{-1}s^{-1}$, and for negative ions, $k^- \approx 1.8 \cdot 10^{-4}\ m^2V^{-1}s^{-1}$.

An atmosphere with concentrations n^+ and n^- of positive and negative ions, respectively, may be characterized by polar conductivities λ^+ and λ^-, which are given by

$$\lambda^+ = n^+k^-e \qquad (2)$$

and

$$\lambda^- = n^-k^-e \qquad (3)$$

where e is the (numerically) common charge of the ions.

Often, it is more convenient to use the corresponding polar resistivities

$$\rho^+ = \frac{1}{\lambda^+} = \frac{1}{n^+k^+e} \qquad (4)$$

and

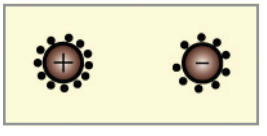


Figure 1: Positive and negative air ion

$$\rho^- = \frac{1}{\lambda^-} = \frac{1}{n^- k^- e} \cdot \quad (5)$$

CHARGE NEUTRALIZATION

Figure 2 shows a positively charged conductor A surrounded by an atmosphere containing positive and negative ions. The field created by A moves the surrounding ions. Positive ions are repelled from the body and move away. Negative ions are attracted, and eventually, they plate out on the charged body. The field from the plated-out ions is superimposed on the original field from the positive charge, thus making it appear as if the charge on A has been reduced.

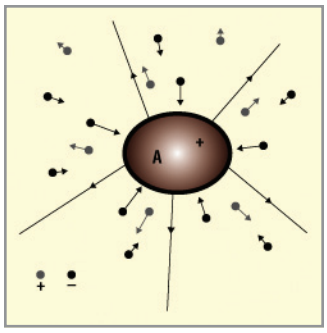


Figure 2: Charge neutralization

Let us consider a section of the surface of A, where the charge density is $\sigma^+(C \cdot m^{-2})$. The charge will create a field perpendicular to the surface with the strength

$$E = \frac{\sigma^+}{\varepsilon_o} \quad (6)$$

where ε_o is the permittivity of air and of vacuum $(8.85 \cdot 10^{-12}\ F \cdot m^{-1})$.

According to Ohm's law, this field causes a current directed toward A, with the current density $j^-(A \cdot m^{-2})$ given by

$$j^- = \frac{E}{\rho^-} = \frac{\sigma^+}{\varepsilon_o \rho^-} \cdot \quad (7)$$

The current density is the rate at which the charge density is being neutralized (the rate at which it decays), that is,

$$j^- = -\frac{d\sigma^+}{dt} = \frac{\sigma^+}{\varepsilon_o \rho^-}, \quad (8)$$

MR. Static

However, in many (probably most) practical cases, the electric flux from the charge is spread over several regions of different permittivities and resistivities.

with the solution

$$\sigma^{+} = \sigma_{o}^{+} \cdot e^{-\frac{t}{\tau_{o}^{+}}}, \quad (9)$$

where is the initial charge density and

$$\tau_{o}^{+} = \varepsilon_{o}\rho^{-} \quad (10)$$

is the time constant for positive charges.

If the charge density is integrated over the whole surface of A, the total charge would be

$$q^{+} = q_{o}^{+} \cdot e^{-\frac{t}{\tau_{o}^{+}}}, \quad (11)$$

where is the initial total positive charge. Similarly, for a negative charge, we get

$$q^{-} = q_{o}^{-} \cdot e^{-\frac{t}{\tau_{o}^{-}}}, \quad (12)$$

where

$$\tau_{o}^{-} = \varepsilon_{o}\rho^{+}. \quad (13)$$

Equations 11 and 12 state that a charge on a conductor decreases exponentially according to the time constant $\varepsilon_{o}\rho$, where ρ is the relevant (opposite) resistivity of the air.

FLUX DISTRIBUTION

Equations 11 and 12 are valid only if the field from the charge extends exclusively through air with a given resistivity. However, in many (probably most) practical cases, the electric flux from the charge is spread over several regions of different permittivities and resistivities.

Figure 3 shows a relatively simple example of this situation. A metal disk with an area *A* is placed on a slab of insulative material (a dielectric) with a thickness *d* and permittivity ε, and resting on a grounded plane. The disk has a positive charge *q*, which creates a field E_d in the dielectric and a field E_a in the ambient air. If we assume the dielectric to be perfectly insulative, only the field E_a will contribute to the neutralization of *q*. The relationship between E_d, E_a, and *q* can be estimated by considering the capacitance of the disk with respect to ground, C_d, and with respect to the surrounding air, C_a.

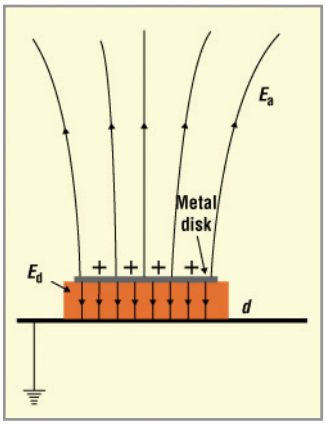


Figure 3: Flux distribution from a charged disk

Capacitance C_a depends on the shape of the disk and the distance (above the disk) to grounded surroundings.

If we assume that the thickness d of the dielectric is much smaller than the linear dimensions of the metal disk, the capacitance C_d can be written as

$$C_d = \varepsilon \frac{A}{d} \,. \tag{14}$$

Capacitance C_a depends on the shape of the disk and the distance (above the disk) to grounded surroundings. An appropriate approximation of C_a seems to be that of a semispherical capacitor (see Figure 4) with a capacitance

$$C_a = 2\pi\varepsilon_o \frac{R \cdot r}{R - r}, \tag{15}$$

where r is the equivalent radius of the disk,

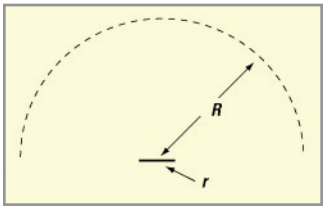


Figure 4: Semispherical capacitor

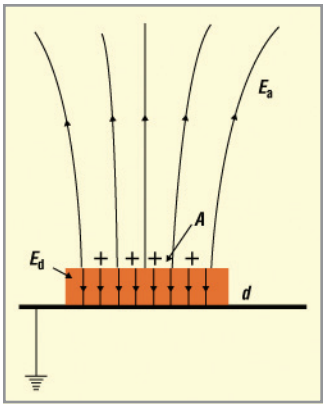


Figure 5: Flux distribution from a charged insulator

$$r = \sqrt{\frac{A}{\pi}} \,,$$

and R is the average distance to grounded surroundings.

As we can usually assume that $r << R$, Equation 15 can be written as

$$C_a \approx 2\pi\varepsilon_o r \,. \tag{16}$$

The total capacitance of the disk is

$$C = C_a + C_d \,. \tag{17}$$

The charge q will be distributed on the disk, with

$$q_a = \frac{C_a}{C_a + C_d} \cdot q \tag{18}$$

on the topside, and

$$q_d = \frac{C_d}{C_a + C_d} \cdot q \tag{19}$$

on the underside.

The field in the surrounding air from the charge q_a causes the neutralizing

current I^- to flow to the disk. Using Equations 6, 7, and 8, we find

$$I^- = A \cdot j^- = \frac{A \cdot \sigma^+}{\varepsilon_o \rho^-} = \frac{q_a}{\varepsilon_o \rho^-} . \quad (20)$$

However, I^- is also the total charge's decay (or neutralization) rate, that is,

$$I^- = \frac{q_a}{\varepsilon_o \rho^-} = \frac{\frac{C_a}{C_a + C_d} \cdot q}{\varepsilon_o \rho^-} = -\frac{dq}{dt} . \quad (21)$$

Equation 21 has the solution

$$q = q_o \cdot e^{-\frac{t}{\tau^+}}, \quad (22)$$

where the time constant τ^+ is given by

$$\tau^+ = \frac{C_a + C_d}{C_a} \cdot \varepsilon_o \rho^- \quad (23)$$

or, using Equations 14 and 16,

$$\tau^+ = \frac{2\pi\varepsilon_o r + \frac{\varepsilon A}{d}}{2\pi\varepsilon_o r} \cdot \varepsilon_o \rho^- . \quad (24)$$

Using $A = \pi r^2$ and $\varepsilon = \varepsilon_r \varepsilon_o$, where ε_r is the relative permittivity of the insulative slab, Equation 24 can be written as

$$\tau^+ = \left(1 + \frac{\varepsilon_r r}{2d}\right) \varepsilon_o \rho^- . \quad (25)$$

Using Equations 5 and 10, Equation 25 may also be written as

$$\tau^+ = \left(1 + \frac{\varepsilon_r r}{2d}\right) \frac{\varepsilon_o}{n \cdot k \cdot e} \quad (26)$$

and

$$\tau^+ = \left(1 + \frac{\varepsilon_r r}{2d}\right) \tau_o^+ . \quad (27)$$

For a given ion environment, Equations 25, 26, and 27 give the rate of neutralization by air ions of a positive charge as a function of the geometrical and dielectric location of the charge. Similar symmetric equations hold true for the neutralization of negative charges.

Equations 25, 26, and 27 were developed for a charge located on a conductor, that is, in a situation in which the concept of capacitance can be applied. However, with some approximations, the same formulas are also valid in the case of charged insulators.

Figure 5 shows the distribution of the electric flux from a charged insulator disk. It is the same situation as the one shown in Figure 3, except that in Figure 5, the metal disk has been removed and the charge is uniformly distributed on an area A of the insulator surface.

The fields E_a and E_d are therefore the same in the two situations; consequently, the neutralization processes are identical. Therefore, Equations 25, 26, and 27 still express the rate of charge neutralization.

Here, some readers may ask, "When everything seems to be the same for the conductor and the insulator, why not use the same concepts, especially the concept of capacitance, in the two cases?" The short version of the answer is the following. If a conductor with a capacitance C and a charge q is grounded, an energy

$$W_C = \frac{q^2}{2C}$$

would be released in a discharge (most likely a spark). In the situation of Figure 3, the energy W_C would amount to

$$W_C = \frac{q^2}{4\pi\varepsilon_o r + \frac{2\varepsilon A}{d}}$$

and this energy can be released by approaching the surface of the metal disk with a grounded wire. In the situation of Figure 5, exactly the same energy is stored in the field, as the flux distribution is the same in the two cases. However, touching the surface of the charged insulator with a grounded wire may provoke a brush discharge, releasing a fraction of the total energy stored in the field. As capacitance is intimately related not only to the energy stored in the field but also to the energy that may be dissipated in a discharge from the charged item, capacitance has no place in the description of charged insulators.

CONCLUSION

It has been shown that it is possible theoretically to relate the neutralization rate of a charged item with given dimensions and dielectric properties to quantities that are, at least in principle, measurable. In Part II of this article, the theory will be applied in practice.

REFERENCES

1. Niels Jonassen, "How Fast Does a Charge Decay?" in Mr. Static, *Compliance Engineering* 17, no. 2 (2000): 26–33.
2. Niels Jonassen, "Ions" in Mr. Static, *Compliance Engineering* 16, no. 3 (1999): 24–28.

(the author)

NIELS JONASSEN, MSC, DSC, worked for 40 years at the Technical University of Denmark, where he conducted classes in electromagnetism, static and atmospheric electricity, airborne radioactivity, and indoor climate. After retiring, he divided his time among the laboratory, his home, and Thailand, writing on static electricity topics and pursuing cooking classes. Mr. Jonassen passed away in 2006.

2013 IEEE International Symposium on Electromagnetic Compatibility

WINDS OF CHANGE

August 5 - 9, 2013 • Denver, Colorado

Technology is advancing at a MILE HIGH pace and EMC testing is necessary to the success of this progress. No longer are the boundaries of EMC testing relegated to open area test sites, laboratories and text books; they are becoming part of our daily lives. The electric and hybrid vehicles and the Smart Grid, are two big arenas where EMC plays a major role.

The EMC 2013 Symposium will include many topics to enhance your understanding of EMC, sharpen your design skills, and perfect your skills in dealing with EM phenomena. Join us in the Mile High City for a week of learning, collaboration and connecting with industry peers and start your path into the world of EMC green.

Learn the Leading Edge Info on:

- EM Interference and Environments
- Shielding, Grounding, Bonding
- EMP, Lightning, ESD
- Transient Suppression
- EMC Measurement
- Signal Integrity
- EMC Management
- Nanotechnology
- Spectrum Management
- EM Product Safety

For Event Details Visit: **www.emc2013.org**

IEEE EMC SOCIETY®

ON Your Mark

Kitting

Implementing a Systems Approach to Safety Label Inventory

BY GEOFFREY PECKHAM

In this column, we'll discuss one way to carry out a systems approach to safety: label 'kits'.

You may recall that, in one of my prior articles in the *On Your Mark* series ("It's Not a Bunch of Labels – It's a System", December 2012), we explored how it can be beneficial not to look at product safety labeling singularly, but as part of a larger picture of safety. We introduced the concept of safety labels functioning as a system – a safety communication system – in order to most effectively improve safety and reduce liability. It's one thing to learn about and understand this systems approach to labeling and quite another to implement it. This is where the concept of kitting comes into play.

Those who work in the field of product safety engineering should be aware that more and more companies are turning to kitting as a solution to some significant liability and safety issues related to the installation of product safety labels.

What is kitting? Kits are a means to bring together all of the safety labels needed for a specific product or piece of equipment, place them in one package, and give the package a single part number. The actual kitting of the labels takes place at your label printer's facility so your labels arrive to your company as complete packages to be installed, one per product. By ordering your labels delivered in this way, your kits support your systems approach to labeling. Since multiple safety labels are often placed on products, kitting allows the group of labels you select for your product to be easily understood as a system.

What are the benefits of this approach? First, kits allow the ordering and inventorying of your safety labels to be dramatically simplified. When you implement a kitting approach to specifying your safety labels, you order and inventory a single kit part number rather than a wide number of individual label part numbers. This, in turn, provides cost savings in inventory management by reducing the items that need to be managed; it significantly decreases the time it takes to inventory labels into your parts department and the time it takes to retrieve labels when called for by manufacturing.

These are all valid advantages from your purchasing agent's perspective. But there is a second reason for kitting that goes over and above inventory cost reduction. As a product safety engineering professional, kits improve safety by ensuring that each of the essential safety labels you specify on your engineering drawings are actually picked from inventory and installed. Creating a kit of the labels needed for each product or project is a way to ensure that your exact specifications for on-product safety messages are

At left, multiple on-product safety labels reinforce each other, working as a "system" to convey essential safety messages. At right, a typical kit of safety labels. (Label designs ©Clarion Safety Systems.)

carried out. From a product liability perspective, you are better able to point to the additional control measure kitting gives you for assuring that your engineering drawing specifications for labels are carried out. On a side note, even with kitting, I highly recommend that you take photographs of your products before they leave the door as evidence that all guards and safety labels were installed. Of course this suggested step may be impractical if you produce a large number of products. But if you are able to do this, the photographs will serve as important documentation if an accident occurs, proving that all safety measures were properly installed before your product left your control.

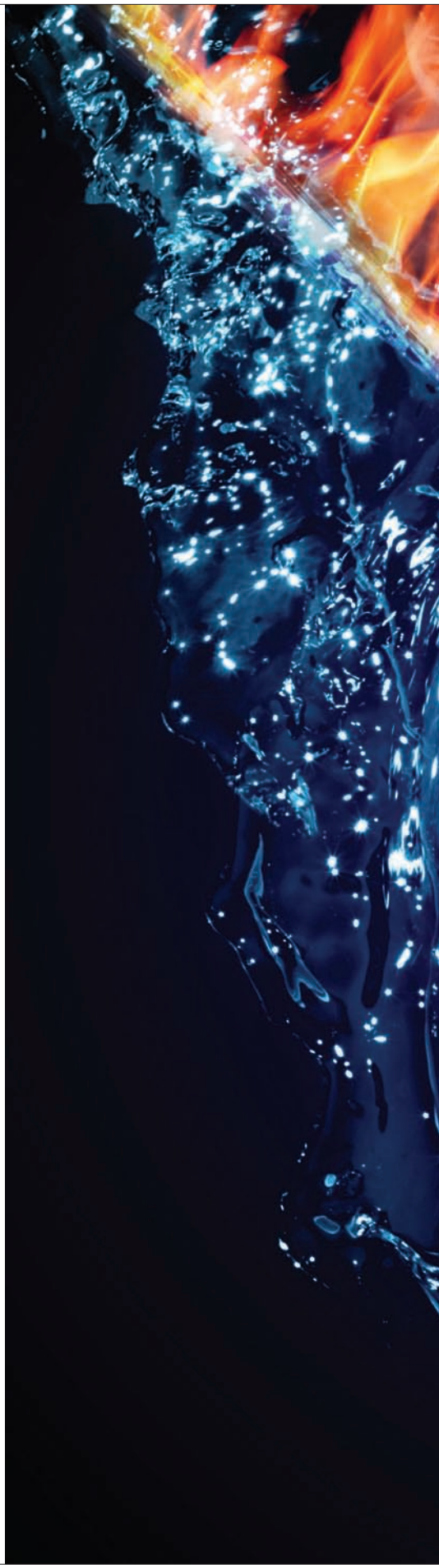
Implementing a systems approach to safety labeling is a multifaceted task which can help to improve safety and reduce liability. Consider thinking outside the box – or in the case of kitting, inside the bag – to make improved safety measures easier to implement across your product lines and across your organization. Be sure to pass the concept of kitting along to your purchasing department as it could significantly help them with the chore of correctly ordering these critical component parts. It is highly likely that kitting will save your organization money. But, more importantly, it can help you to protect people from harm and potentially save lives.

For more information on kitting, visit www.clarionsafety.com.

(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.

The Role of NEBS Requirements in the Telecom Marketplace



While product safety and reliability are core principles of virtually every manufacturer designing equipment for the telecom industry, the Telcordia Generic Requirements (GRs) that ensure the integrity of such devices and systems are not commonly understood by manufacturers around the globe.

BY MATT MAROTTO AND RANDY IVANS

As an increasing amount of equipment used in telecommunications networks is being produced in different parts of the world, recognizing and adhering to these standards and requirements is essential to competing in this ever-expanding market.

Among these requirements is the NEBS family of requirements, which stands for Network Equipment Building System. Unlike more traditional product safety standards, compliance to the NEBS family of standards ensures the personal safety of equipment operators and service technicians and the protection of facilities housing equipment, all while ensuring the integrity of an overall telecommunications network. This family of requirements is what members of the Telecommunication Carrier Group (TCG), such as Verizon and AT&T, and smaller local service providers use to evaluate telecommunications equipment to ensure network integrity and protect against hazards associated with the location of equipment.

It is this all-encompassing focus on safety, reliability and performance of network equipment and its impact on

NEBS requirements are designed to:

- ✓ Protect personnel
- ✓ Streamline equipment design and installation
- ✓ Prevent service outages and interference in a network caused by incompatible equipment
- ✓ Reduce the risks of fire in network facilities
- ✓ Guard against the potential negative impacts on equipment from extreme temperatures, vibration and airborne contamination
- ✓ Support equipment compatibility with the network's electrical environment.

the environment of telecom facilities that distinguishes NEBS requirements from other telecommunications standards. NEBS requirements are designed to:

- Protect personnel
- Streamline equipment design and installation
- Prevent service outages and interference in a network caused by incompatible equipment
- Reduce the risks of fire in network facilities
- Guard against the potential negative impacts on equipment from extreme temperatures, vibration and airborne contamination
- Support equipment compatibility with the network's electrical environment.

Like other industry requirements, meeting NEBS requirements can positively impact a manufacturer's bottom line. NEBS requirements consist of three levels of compliance, each ensuring a different stage of network protection. Understanding in advance the required level of compliance for a particular product can help a manufacturer minimize product development, installation and maintenance costs. Increasingly, telecommunications equipment manufacturers around the world are requiring their component suppliers to demonstrate compliance with NEBS and including this stipulation in requests for proposal (RFPs) and supplier contracts. In fact, requirements are beginning to apply to both wire line installations as well as wireless applications.

UNDERSTANDING LEVELS OF COMPLIANCE

As most TCG members require demonstration of NEBS compliance prior to the purchase and/or deployment on their telecommunication network infrastructure, equipment manufacturers document compliance to NEBS requirements by having testing performed by an ISO 17025 accredited third-party test laboratory. In certain circumstances, NEBS-related testing can be performed in-house, assuming an internal laboratory is properly accredited to ISO 17025. However, some TCG members require all testing to be performed or witnessed by an accredited independent test laboratory (ITL).

NEBS requirements apply to telecommunications equipment installed in a Central Office (CO) environment, certain Outside Plant applications (OSP), and Customer Premises Equipment (CPE). There are generally two primary GRs that apply to most equipment designated for use in a CO: GR-1089-CORE (Issue 6), which covers electromagnetic compatibility, electrical transients and electrical safety; and GR-63-CORE (Issue 4), which covers physical requirements. GR-1089-CORE and GR-63-CORE together are commonly referred to as the "NEBS Criteria."

It's important to understand that individual TCGs may have additional requirements beyond those found in GR-1089-CORE and GR-63-CORE.

Helping to speed and simplify the compliance process without jeopardizing network reliability in the deployment of new equipment, the Telcordia special report SR-3580, NEBS Criteria Levels, divides NEBS requirements into three levels of compliance.

- Level 1 is the minimum acceptable level of NEBS environmental compatibility needed to preclude hazards and degradation of a network facility and hazards to personnel. Level 1 comprises only safety and risk criteria. Conformance to Level 1 does not assure equipment operability or service continuity. Level 1 is typically used by service providers for early deployment into their COs and/or interoperability laboratories, and to allow collocaters to install equipment in a central office. A collocater is a company that rents space in a central office and provides some type of communications service (such as Internet access or long distance).
- Level 2 is the minimum level of NEBS environmental compatibility needed to provide some limited assurance of equipment operability within the network facility environment. This assurance of operability is limited to the controlled or normal environments as defined by the criteria. Rarely a focus of customers, Level 2 includes all requirements of Level 1 with some added level of operability reliability.
- Level 3 is the minimum level of NEBS environmental compatibility needed to provide maximum assurance of equipment operability within the network facility environment. The Level 3 criteria provide the highest assurance of product operability. Level 3 criteria are suited for equipment applications that demand minimal service interruptions over the equipment's life. Most TCGs require NEBS Level 3 prior to acceptance/installation on the network as they require this level of compliance for equipment operation in the central office, but not collocated equipment.

While SR-3580 identifies the tests required by the three levels, most equipment manufacturers submit their equipment to be evaluated to NEBS Level 3. Even in pursuing the highest assurance of product operability that Level 3 provides, manufacturers should know where their product is going to be deployed on a network: in a CO operated by telecom carriers, outside plant environment or customer premises. The setting of product deployment determines the tests that need to be performed to meet NEBS requirements. For example, specific environmental testing, in accordance with GR-63-CORE, simulates exposure to extreme environments that include high/low temperatures, high humidity, shock and exposure, fire ignition and flame spread, seismic conditions and airborne contaminates. By understanding the testing process, and the additional tests that may be required by specific carriers, manufacturers are better able to work most effectively and efficiently with third-party testing laboratories.

EXPLORING QUALIFIED NEBS TESTING LABORATORIES

Choosing the right NEBS testing laboratory to work with involves considering a host of issues, from laboratory capabilities and accreditations to staff expertise.

It's important to note that a comprehensive, full service laboratory will support NEBS testing with the following:

- ✓ Full EMC test facility capable of conducting both immunity and emissions testing
- ✓ Environmental chambers to conduct temperature and altitude testing
- ✓ Vibration and seismic test facilities
- ✓ Full-scale fire facility
- ✓ Facilities to support acoustic power measurements
- ✓ Various test facilities to support lightning surge and power fault simulations, DC power measurements
- ✓ Conditioning chambers to support mixed flowing gas testing and test apparatus to support hygroscopic dust exposure

Equipment manufacturers might also examine whether a provider is able to outline start dates and availability for project planning well before testing actually begins.

In assessing provider capabilities, manufacturers should:

- be aware that product size and weight limitations might preclude some laboratories from completing certain test profiles.
- make sure the NEBS test facility is ISO 17025 accredited and qualified under any carrier specific laboratory accreditation programs, such as the Verizon ITL program.
- inquire about the training and expertise of testing staff and ensure engineers are actively engaged in industry technical committees, regularly attend industry symposia and are current with any applicable professional certifications.

It's important to note that a comprehensive, full service laboratory will support NEBS testing with the following:

- Full EMC test facility capable of conducting both immunity and emissions testing
- Environmental chambers to conduct temperature and altitude testing
- Vibration and seismic test facilities
- Full-scale fire facility
- Facilities to support acoustic power measurements
- Various test facilities to support lightning surge and power fault simulations, DC power measurements
- Conditioning chambers to support mixed flowing gas testing and test apparatus to support hygroscopic dust exposure

These laboratories should document and deliver a test report that outlines an overall test strategy and contains individual test methods and results.

The test laboratory should also include separate videos of the large-scale fire tests and seismic tests.

In addition to the Telcordia Generic Requirements, a testing laboratory should be familiar with the related American National Standards developed by the Alliance for Telecommunications Industry Solutions (ATIS). These standards, such as ATIS-0600319, Equipment Assemblies – Fire Propagation Risk Assessment, or the ATIS-0600015 series of energy efficiency testing standards are often referenced in the Telcordia GRs or, in some cases, are specifically required by the service provider community.

A full service laboratory should also be able to support testing to international standards for manufacturers that seek compliance for the global marketplace. Examples of these standards include the ETSI 300 019 and 300 386 series of standards dealing with the physical and EMC environments, respectively. No matter the current or future setting of laboratory testing, telecom equipment manufacturers should ensure that their equipment undergoes proper NEBS and customer specific required testing. Viewing this commitment as an important part of product investment, manufacturers should seek out an ITL with the technological tools and expertise to carry out the testing process, including test methods that address any modifications to requirements.

In understanding and achieving NEBS compliance, a manufacturer gains standing as a company whose equipment enhances rather than jeopardizes network integrity and protects the safety of the personnel who operate it. The return on this product investment not only includes reduced design and related costs over the long term, but the advantage of being positioned to make great strides in an evolving worldwide marketplace that presents exciting, new opportunities every day.

UL is a premier global safety science company with more than 100 years of proven history. A pioneer in NEBS testing since 1992, UL operates three full service EMC facilities located throughout North America. Each has a variety of NEBS capabilities and is staffed with highly trained, experienced, and NARTE certified engineers.

(the author)

MATT MAROTTO
is currently the North American Wireless & EMC Quality Manager for UL. In 2008, Marotto served as Global NEBS Program Development Manager and was responsible for developing and implementing UL's NEBS Fastrack Program, which enables international Telecom manufacturers to perform NEBS and telecom related testing in their own laboratories under the witness of UL staff. Prior to that, Marotto was Operations Manager for UL's EMC and NEBS testing laboratories in Research Triangle Park, N.C. Matt received his bachelor's degree in electrical engineering from the University of Alabama and is an iNARTE certified product safety engineer.

RANDY IVANS
is UL's Principal Engineer in the high tech and telecommunications area. He is responsible for the development, implementation and maintenance of various UL Standards and certification programs including UL's NEBS Mark program. Randy is a member of the National Electrical Code, NFPA 70, Code Making Panel No. 16 that is responsible for Chapter 8 covering communications systems. He is chairman of the TIA TR41.7 Committee on Environmental and Safety Issues and is a member of the ATIS Sustainability in Telecom: Energy and Protection Committee (STEP) in which he chairs the NPP subcommittee on physical protection. Randy received his bachelor of science degree in electrical engineering and his master of science in technology management from Polytechnic University and is an iNARTE certified product safety engineer.


FREIGHT TRANSPORTATION
CARGO
CONTAINER
EXPRESS
CARGO
EXPRESS
CARGO
CARGO
TARE
MAX.GW
160 km/h

What Do You Mean, Environmental Test…

and "Don't Stack Your Resonances"?

BY WAYNE TUSTIN

Mention the word "environment" to most people and they think of air pollution, soot, contaminated beaches, etc. Those certainly are problems we must all consider, but I'm using the word "environment" differently here.

CLIMATIC ENVIRONMENTAL TESTING

On one hand, let's consider *climatic* environmental testing. Our electronic and other hardware gets placed in a chamber that is programmed to reach appropriate temperatures, altitudes, high and low extremes of humidity, etc. Appropriate here means that laboratory chamber temperature, for example, will get a bit hotter and later a bit colder than the temperature extremes at the storage/transport/service location(s) that must be survived by our hardware. A typical chamber is shown in Figure 1.

Figure 1: Combined environment testing chamber shaker table (courtesy MB Dynamics)

DYNAMIC ENVIRONMENTAL TESTING

On the other hand, let's consider *dynamic* environmental testing. Our electronic and other hardware gets placed on a shaker or shock test machine or in a reverberation chamber. These tools are programmed to comply with appropriate vibration, shock, and intense noise test standards. Appropriate vibration means that the laboratory shaker table, with our hardware under test properly attached, will be vibrated at the frequencies and intensities under which our hardware will be stored or transported or used in real situations. An electrodynamic shaker is also visible in Figure 1.

COMBINED ENVIRONMENTAL TESTING

Climatic environment extremes and significant levels of vibration often occur in the real world simultaneously. Thus many environmental tests labs combine at least one of their climatic test chambers with at least one of their shakers, as in Figure 1.

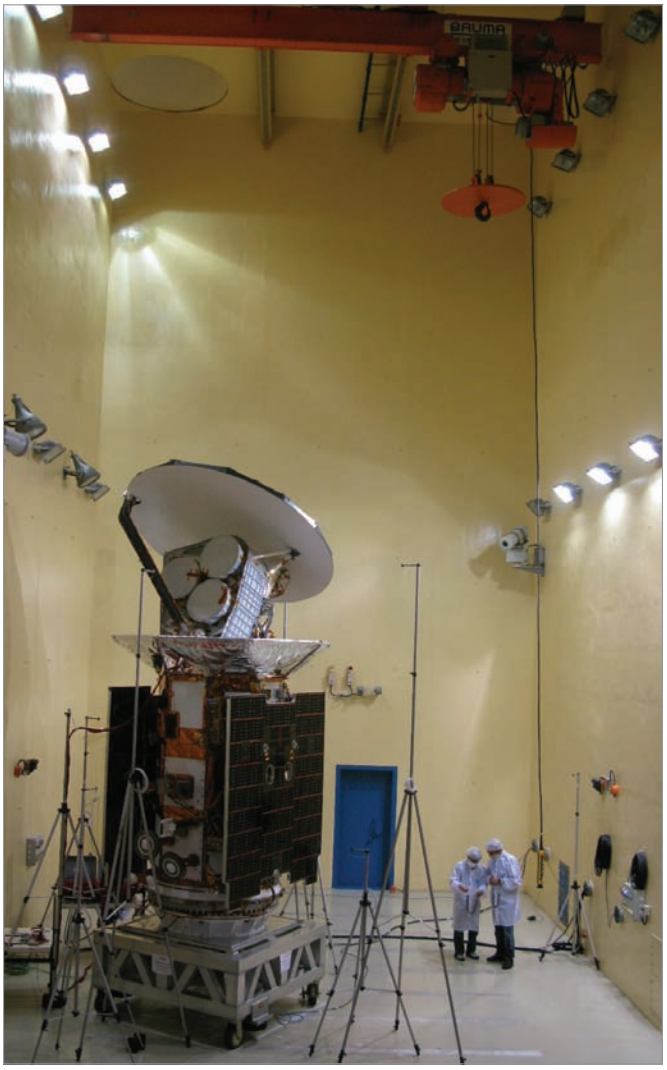


Figure 2: An RAF

Appropriate shock testing places similar requirements on shock test machines. Appropriate intense noise standards place similar requirements on a reverberant acoustic chamber (RAF), as shown in Figure 2, or on a progressive wave chamber.

WHY FOCUS ON DYNAMIC ENVIRONMENTAL TESTING?

The reason to focus on dynamic environmental testing is because it is less understood than climatic environmental testing. This is the message continually repeated by my students from industry and from the military services. These students include not only those who *conduct* tests, but also the designers of products that will be stored, transported and/or used on land vehicles (automobiles, trucks, armored vehicles, trains), marine vehicles (unmanned Navy high performance boats in particular), manned and unmanned aircraft, rockets, missiles, etc.

Yet very few universities touch this field. Oh, their mechanical engineering undergrads may get a course labeled "Vibration". But many BSMEs tell me such courses are mostly math, without practical application.

GREAT CURRENT NEED

Yet in testing laboratories there is a great current need for dynamic environmental test training, perhaps the greatest need I've seen. Why? Most executives, while skilled in financial management, have little understanding of the importance and complexity of environmental testing. Unfortunately, they have also lost many if their most experienced test experts. Meanwhile, my friends who repair shakers tell me that business has never been so good.

Among designers of products for military and other severe applications, there is need for somewhat similar dynamics training, mainly including an awareness of mechanical resonances that may give in-storage, during-transportation, or in-service usage problems. It would be better for these problems to appear during dynamic environmental testing than in service.

VIBRATION INPUTS

The vibrations that products will receive during *transport* will be concentrated in certain frequency ranges, depending upon the carrier's particular truck, rail car or aircraft used. The vibrations that products will receive during *usage* will be concentrated in certain forcing frequency (f_f) ranges, depending upon the vehicle aboard which the products are

Figure 3: Platform simulates rail or other transport (courtesy MTS)

Figure 4: 12-shaker multiaxis electrodynamic (courtesy Team Corp)

mounted. For military applications, please refer to *Military Standard 810*, since the 2008 "G" revision.

PRODUCT RESONANCES

Products will inevitably resonate at certain natural frequencies ($f_{n)}$ that depend upon configurations, dimensions, materials chosen, etc. By resonate, I mean that certain elements will respond with greater displacement, with greater velocity and with greater acceleration than is experienced in the test lab, transport, or service. Continued for too many seconds, the responding elements will be damaged. The product will fail.

DON'T STACK RESONANCES

The greatest danger arises from f_f matching f_n. So the designer should ask about the location on the vehicle aboard which products will be mounted. "What are the forcing frequencies f_f?" he should ask. "I need to know so that I can design a product for which the natural frequencies f_n are placed elsewhere." "I don't want to stack my resonances," he should explain.

VIBRATION AXES

How shall we identify a vehicle's three major axes? How about:

X, or fore-and-aft,

Y, or lateral and

Z, or vertical?

It is common to require three single-axis vibration tests, perhaps identified as X, then Y, then Z. This means there should be three tests, requiring at least two and perhaps three fixtures for attaching the test article to the shaker or shock test machine.

IS "REAL WORLD" VIBRATION SINGLE AXIS?

No, the real world experience of a product is rarely so simple. Motion measurements with three-axis "triaxial" accelerometers show that the three motions occur simultaneously, and that these three vibrational orientations differ markedly. Product natural frequencies also differ markedly between X, Y and Z. Thus last-century, single-axis testing misses some of a product's weaknesses. It's time to embrace multiaxis servohydraulic shaker testing, as in the automotive test lab shown in Figure 3.

It's also time to embrace multiaxis electrodynamic (ED) shaker testing, as in Figure 4. Whereas most multiaxis ED systems employ three ED shakers, this system involves twelve. Yes, twelve shakers providing not only north-south, east-west and vertical shaking but also roll, pitch and yaw motions. This illustration shows the larger of two such systems being installed at Sandia Albuquerque and at the Naval Air Warfare Center, China Lake.

The more we develop and refine our product technologies, the more we must also develop and refine our systems for testing these product in the design stages … not only to save money and time, but also to conserve energy and resources. Creating better equipment for testing products in their intended environments is a good investment. But creating greater appreciation among designers and managers for the importance of sound environmental testing is even more important. Ultimately, it's good business to design produces that will stand up to their environments. And it's not so bad for the environment, either.

(the author)

WAYNE TUSTIN
founded the Equipment Reliability Institute, Santa Barbara, California, in 1996. This specialized engineering school offers 3-day introductory courses about random vibration and shock testing. Concurrently, he is developing an iBook tablet version of his 2005 text ISBN 0-9741466-0-9. This July, Wayne will be teaching multiaxis vibration testing in Burlington, Washington.

Things You May Not Have Heard About Lightning and Grounds

BY AL MARTIN

The obvious solution to a problem isn't always the best.

For example, will making a grounding rod longer or a grounding system bigger always reduce the risk of lightning damage? Reality may be different from expectations. One way to set expectations is to study the effect of a ground rod on the waveshape of a surge, which can tell us a lot about how the ground rod is behaving. Standards have advice on this. For example based on a reading of the IEC 61312-1 [1] standard, we might assume that the waveshapes of the current flowing in the grounding system and that flowing in the electrical circuit are the same – implying that the grounding system is simply a resistance. But is that really the case?

LIGHTNING MEASUREMENTS AT STRUCTURES

For another view, consider the work of Rakov, Uman and their associates at the Camp Blanding triggered lightning facility in Florida. They have a facility with a launch tower [for rocket-induced lightning] and an instrumented building. They have shown [2] that the waveshapes of the currents in the grounding system and those entering the building electrical circuits are considerably different [in their case for a subsequent surge]; and they attribute the difference to the performance of the ground rods in the two cases.

The obvious solution to a problem isn't always the best.

That observation suggests that we need to look more closely at the effects of ground rods on an incident lightning waveform. Maybe ground rods can act differently than the IEC expects. From the recorded the waveforms of the currents at the launch tower and at the ground rods, Rakov *et al* found that the surge *currents* in the ground rods have a much faster rise time and a much shorter duration than those of the incident surge[1].

1 As explained in the January 2005 IEEE Transactions on Power Delivery [3], this lightning is mostly subsequent strokes.

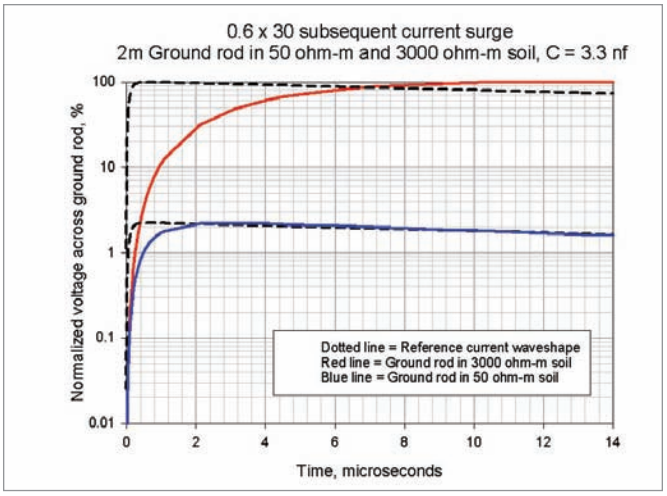


Figure 1: The voltage developed across a short (2 m) ground rod for a typical subsequent surge current

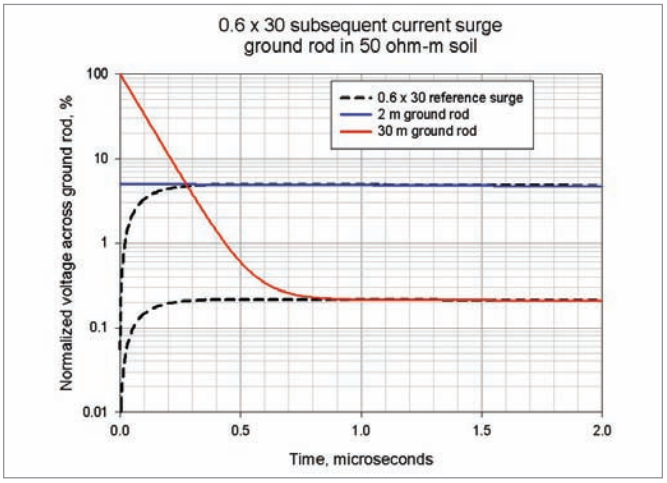


Figure 2: The voltage developed across various ground rods by a subsequent surge in low-resistivity soil

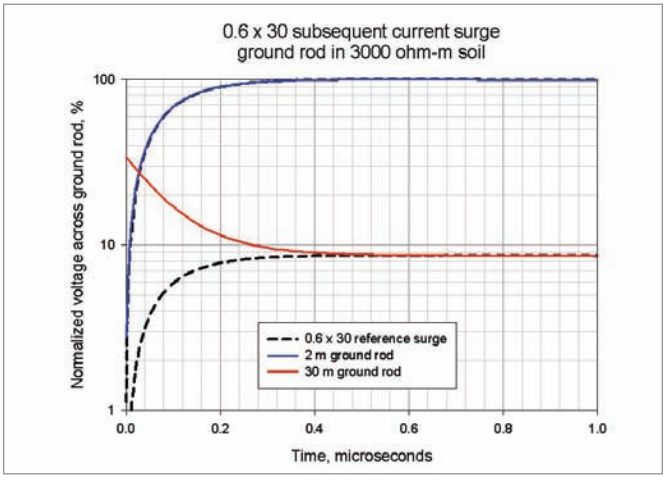


Figure 3: The voltage developed across various ground rods by a subsequent surge in high-resistivity soil

So what's going on? The short explanation is that the ground rods used in the study by Rakov et al [2] are acting like lossy capacitors – probably not what most of us would expect. This observation also suggests that ground rods may have other behavior that we don't expect, so let's look at what is known about them.

GROUND RODS (OR HORIZONTAL GROUND WIRES)

The analysis of the behavior of ground rods also applies to horizontal ground wires, so in this article, the term "ground rods" will include horizontal ground wires. Generally, ground rods have been assumed to behave like resistors. The unexpected behavior occurs because ground rods also have reactive elements. The effect of these reactive elements on the wave shape of a surge will be greatest on high frequency components of the surge. The high frequency components of the surge primarily affect the surge rise-time, so the reactive elements of a ground rod may change the rise-time of the surge. The fall-time is generally less affected, depending on the type of surge and the resistance of the ground rod.

To assess their impact on lightening, quite a bit of work has been done recently on the high-frequency behavior of ground rods [4]. The results can be divided into two categories: short ground rods which look capacitive, and long ground rods which look inductive [5].

SHORT GROUND RODS

Short ground rods are most likely to be found at residences. A number of groups ([6][7][8]) have estimated the capacitance of short ground rods, with estimates running around 3.3 nF for a 2 m long ground rod.

The ground rod capacity is in parallel with the resistance of the ground, so the effect of the capacity depends in the resistivity of the soil. As review, the resistance of a ground rod as a function of soil resistivity and length can be calculated from Dwight's 1936 calculation [9]:

$$R = \frac{\rho}{2\pi \cdot l}\left[\ln\left(\frac{4l}{a}\right) - 1\right] \text{ ohms/m, for } l >> a \qquad (1)$$

where ρ is the resistivity of the ground, l is the length of the ground rod, and a is its diameter. The values of l/a typically run from about 280 for 2 m ground rods to 2520 for 32 m ground rods.

Using a linear approximation for l/a, (1) can be written:

$$R = \frac{\rho}{2\pi \cdot l}\left[\ln(513 + 300 \cdot l) - 1\right] \text{ ohms/m} \qquad (2)$$

Now consider a subsequent surge, since that has the fastest rise and fall times, and is most affected by the reactance of the ground rod. A typical short ground rod is 2 m long. This ground rod in low resistivity (50 ohm-m) and high resistivity (3000 ohm-m) soil would have a resistance of about 25 ohms and 1400 ohms, respectively. Using these resistances and a capacitance of 3.3 nF, the response to a subsequent surge as characterized in [3] is shown in Figure 1. This figure shows that a ground rod in low resistivity soil is characterized by a modest slowing of the rise time of the surge. The curve for the 3000 ohm-m soil has a much greater slowing of the rise time and a higher amplitude than that of the 50 ohm-m soil because the resistance of the ground rod is higher, leading to a higher voltage for the same reference current.

LONG GROUND RODS

Long ground rods may be driven at commercial structures to lower the surge resistance to ground. Long horizontal ground wires and grounding grids also fall into this category. These have been characterized using transmission line analyses; e.g. Verma [10] for ground rods and wires, and Gupta[11] and Grecv [12] for grounding grids. As pointed out in Grecv, circuit-based models tend to overestimate voltages compared to transmission line models. But in that sense, circuit-based models are conservative.

Transmission line analysis is necessary for very long grounding systems (e.g. over 30 m) and any system in which reflections from discontinuities is important. For ground rods that are not too long (e.g. less than 30 m), it is simpler to calculate the inductance of the ground rod and then calculate the response of a series R-L circuit. The inductance of the ground rod is given in Verma as:

$$L = 0.2 \cdot \ln\left(\frac{2l}{a}\right) \ \mu\text{H/m} \qquad (3)$$

where l and a are as given in (1). Using the same approximation as was used to obtain (2), (3) can be written as:

$$L = 0.2 \cdot \ln(256 + 150 \cdot l) \ \mu\text{H/m} \qquad (4)$$

From (4), a 10 m ground rod has an inductance of 15 µH, and a 30 m ground rod has an inductance of 51 µH.

Considering inductive effects alone, Figure 2 shows that in low resistivity soil, a short ground rod has a relatively small inductive effect on a fast-rising subsequent surge. (The initial shape of the curve in this case may be an artifact of the calculation.) A longer ground rod (30 m) has a large inductive effect on a subsequent surge. The 30 m rod has about 15x less resistance than the 2 m rod, hence a lower ultimate voltage drop.

Figure 3 shows that, in high resistivity soil, a short (2 m) ground rod has basically no inductive effect on a subsequent surge because its resistance dominates its inductance. A Longer (30 m) ground rod has a significant effect, but much less than it has in low resistivity soil.

The results illustrated above are dependent on the assumptions made in the calculations. Nevertheless some general conclusions can be drawn. Short ground rods are most simply modeled by a parallel RC circuit, where the resistance is determined by the resistivity of the soil and the capacitance can be estimated at about 3 nF. Long ground rods are most simply modeled by a series RL circuit, where again the resistance is determined by the resistivity of the soil. Table 1 summarizes general conclusions about the dominant effects of ground rod length and soil resistivity.

THE PRACTICAL EFFECT OF GROUND RODS

We have seen how, from a surge standpoint, ground rods can be either capacitive or inductive in nature, depending on their length and the resistivity of the soil. The practical effect of a ground rod depends on the frequency content of the incident surge. A double exponential of the form $\exp(-at) - \exp(-bt)$ can be represented in the frequency domain as

$$\frac{b-a}{(s-a)(s-b)} \qquad (5)$$

where $s = j\omega$

Rod type and soil resistivity	Reactive effect	Relative resistance	Effect on rise time	Leading edge spike	Voltage beyond the spike
Short, low ρ	Capacitive	Low	Least	None	Low
Short, high ρ	Capacitive	High	Most	None	High
Long, low ρ	Inductive	Low	Most	Highest	Low
Long, low ρ	Inductive	High	Least	Moderate	High

Table 1

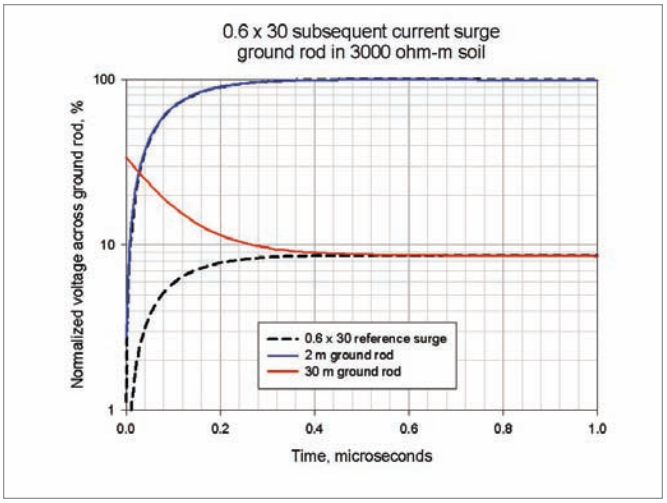


Figure 4: Normalized spectrum of a 4.5x77 and a 0.6x30 surge

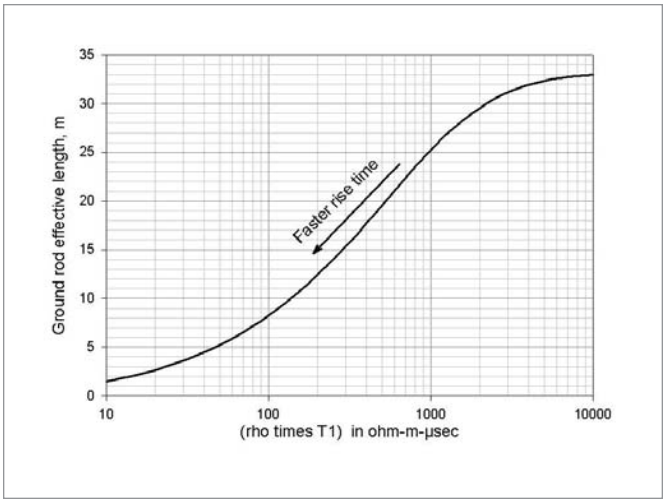


Figure 5: Variation in the effective length of a ground rod with soil resistivity and the zero-to-peak time of the surge

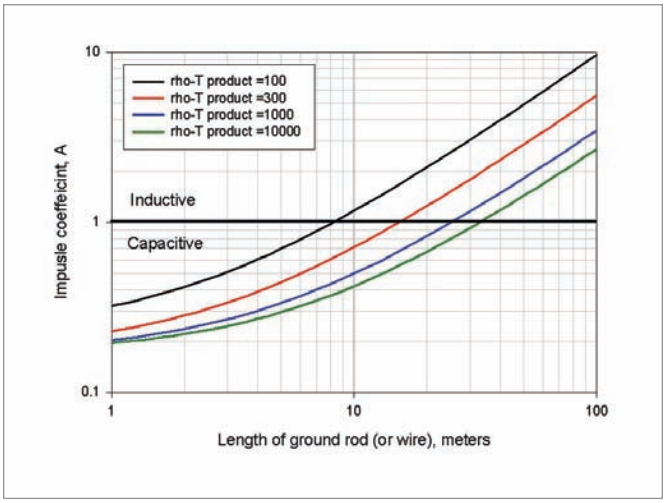


Figure 6: Impulse coefficient versus length of ground rod (or wire)

For a typical first surge, a = 2.52x10^3 and b = 1.26x10^6; and for the subsequent surge, a = 2.38x10^4 and b = 1.11x10^7 (*cf.* [3] [13]) So from (5) the normalized frequency spectrums of these surges look like Figure 4.

What is clear from Figure 4 is that the high amplitude part of both the 4.5x77 and the 0.6x30 surges is concentrated at low frequencies. At low frequencies, a ground rod is essentially resistive. Since resistance decreases as the length of a ground rod increases, a long ground rod helps to reduce the specific energy (Amp^{2}sec) of the surge by diverting the relatively high-amplitude, low-frequency components to ground. But a long ground rod looks inductive at higher frequencies, and this effect can lead to potentially damaging voltage spikes. So at what length does the inductive effect become important?

THE CONCEPT OF IMPULSE COEFFICIENT AND EFFECTIVE LENGTH

Grecv [4] has defined the effective length of a ground rod as

$$l_{eff} = \frac{1-\beta}{\alpha} \tag{6}$$

where

$$\alpha = 0.025 + \exp\left[-0.82(\rho \cdot T_1)^{0.257}\right] \tag{7}$$

$$\beta = 0.17 + \exp\left[-0.22(\rho \cdot T_1)^{0.555}\right] \tag{8}$$

ρ = soil resistivity in ohm-m and T_1 is the zero-to-peak rise time of the lightning current pulse. We can use (7) and (8) to make a plot of l_{eff} vs. ρT_1, as shown in Figure 5.

If the length l of the ground rod is less than l_{eff}, the ground rod is primarily resistive, with a possible capacitive effect. If the length l of the ground rod is greater than l_{eff}, the ground rod will have inductive effects. As they are potentially damaging, how big are the reactive effects for a ground rod of a given length? Grecv [4] has proposed the relation

$$A = \alpha \cdot l + \beta \tag{9}$$

where A = Z/R is the impulse coefficient (defined as the ratio of peak voltage to the peak voltage across a purely resistive ground rod or wire) and R = ground rod resistance.

For A > 1, the ground rod has a series inductance in addition to its resistance. In this case the peak voltage will be A times bigger than it would have been if the ground rod were purely resistive.

For A < 1, the ground rod has a parallel capacitance in addition to its resistance. In this case the peak voltage will be A times lower than it would have been if the ground rod were purely resistive.

From (9) the effect of the ground rod reactance can be calculated. As an illustration, take the four cases of ρT_1, = 100, 300, 1000 and 10,000 and use (9) to plot A vs. length of rod. The result is shown in Figure 6.

CONCLUSION

Back in the beginning we said that the work of Rakov et al [2] was at odds with the IEC 61312-1 statement that the wave shapes of the current flowing in the grounding system and that flowing in the electrical circuit are the same. Now we can see that in order for the IEC 61312-1 statement about wave shapes to be valid, it must also be assumed that ground rods are purely resistive. Here we have shown that ground rods are resistive only under some conditions and that, in general, they also have a reactive component which can significantly affect the wave shape of the surge voltage, especially for subsequent surges.

The point is that when we think of grounding systems, we tend to think only of resistance and how resistance can be reduced. But the things we do to lower resistance may increase inductance, which could actually make matters worse, especially for fast-rising secondary surges. This is something to bear in mind when designing protection.

REFERENCES

1. IEC Standard 61312-1, *Protection Against Lightning Electromagnetic Impulse- Part 1: General Principles.*

2. V. A. Rakov et al, "Direct Lightning Strikes to the Lightning Protective System of a Residential Building: Triggered-lightning Experiments," *IEEE Transactions on Power Delivery* vol. 17, no. 2 (April 2002).

3. "Parameters of Lightning Strokes: A Review," *IEEE Transactions on Power Delivery* vol. 20, no. 1 (January 2005).

4. L. Grecv, "Impulse Efficiency of Ground Rods," *IEEE Transactions on Power Delivery* vol. 24, no. 1 (January 2009), 441-451.

5. A. Rousseau, "Lightning Earthing System: A Practical Guide," *Proceedings of the International Lightning Protection Association, 1st Symposium,* (Valencia, Spain, 2011).

6. B. H. Lee, J. H. Joe, and J. H. Choi, "Simulations of Frequency-dependent Impedance of Ground Rods Considering Multi-layered Soil Structures," *Journal of Electrical Engineering and Technology* vol. 4, no. 4 (2009), 531-7.

7. R. S. Alipio, M. A. O. Schroeder, M. M. Afonso, and T. A. S. Oliviera, "The Influence of Soil Parameters Dependence with Frequency on Impulse Grounding Behavior," *Proceedings of the Xth International Symposium on Lightning Protection* (Cruitiba, Brazil, 2009), 369-373.

8. A. Rousseau, M. Guthrie, and V. Rakov, "High Frequency Earthing Impedance Measurements at Camp Blanding, Florida," *39th International Conference on Lightning Protection – ICLP 2010* (Cagliari, Italy, 2010), 1303.1-1303.9.

9. H. B. Dwight, "Calculation of Resistances to Ground," *Transactions of the American Institute of Electrical Engineers* vol. 55 (1936), 1319-1328.

10. R. Verma and D. Mukhedkar, "Impulse Impedance of Buried Ground Wire," *IEEE Transactions of Power Apparatus and Systems* vol. PAS-99, no. 5 (1980), 2003-2007.

11. B.R. Gupta and B. Thapar, "Impulse Impedance of Grounding Grids," *IEEE Transactions on Power Apparatus and Systems* vol. PAS-99, no. 5 (1980), 2357-2362.

12. L. Grecv and V. Arnautovski-Toseva, "Grounding Systems Modeling for High Frequencies and Transients: Some Fundamental Considerations," *IEEE Bologna Power Technical Conference, June 23-26* (Bologna, Italy, 2003).

13. A. Martin, "Lightning-induced GPR: Why It's a Problem, Characteristics and Simulation," *In Compliance Magazine* (June 2012).

14. "Bibliography of Research on Parameters of Lightning Strokes," See www.ewh.ieee.org/soc/pes/lpdl/TF_minutes/parm_biblio.html.

(the author)

AL MARTIN

Al holds a BEE degree from Cornell University, and a PhD from UCLA. Al joined Raychem [now TE Connectivity] in 1975, where he was initially involved with shielding effectiveness and surface transfer impedance measurements. In 1989 he joined Raychem's Polyswitch Division, where he currently manages the compliance test program.

Al is a contributing member of TIA TR41, ATIS NIPP-NEP, and IEEE. He has been an editor for TIA TR41, ATIS NIPP-NEP, and IEEE standards, and is presently chairman of IEEE WG3.6.7, and vice-chairman of WG3.6.2. He is the author or co-author of over 20 papers on EMC and telecommunications. Al is a Life Senior member of the IEEE.

Engineering Our Future: A View of Changes Facing Engineers

BY GREGG KERVILL

Editor's Note: In Part 1 of this 3 part series (In Compliance January 2013), author Gregg Kervill explores trends and patterns throughout history that, in his opinion, have led us to the present day landscape of our economy, technology and the future of engineering. Here in Part 2, we look at the importance of rebalancing our economy to move toward innovation and advancement. We begin where we left off.

In comparison with countries like France, which has not balanced[1] a single budget since 1981 and whose public debt has risen to 22% of GDP, the US has not done so badly. But being contented by not being at the bottom of the class will not impress the electorate, in much the same way that a poor report card did not impress our parents. Being content and safe at the bottom of the class is not a strategy for improvement, nor does it present a pulpit from which we can lead the world.

GOING FORWARD AND THE NATIONAL DEBT

To resort to family economics again, what do we do when our outgoings exceed our income? We cut back – we look for a better paying job – we get a second job.

So, how does the US get a better paying job? Simply put, it can't – but it can switch from producing products with low ROI to high tech goods that usually have a higher price tag and much


RECOVERY
GROWTH
PTIMISM
CESSION

higher margins. This is the path that US companies must take. However before this can happen, the US technical workforce must either grow, or use its existing workforce more efficiently, or rely on overseas workers by increasing the number of Visas. Outsourcing product design is not an option as it would be counterproductive to advancing our own economy, education and expertise.

A very important question to consider here is - can the education sector respond fast enough to meet our needs? The answer is, most probably, no. It will most likely take between 5 and 20 years to retask our education system with new priorities. The good news is that some projects have already begun. One such program, Liberal Education and America's Promise (LEAP)[2] was launched in 2005 by The Association of American Colleges and Universities. LEAP was established to introduce science and engineering students to a more liberal education program, creating a forum for economic creativity.

Point of interest: earning a typical Honors Science Degree in Europe takes *only 3 years*, significantly less than the cost of a degree program in the U.S. education system.

We know that we have a problem. The last US balanced budget was in 1998[3], followed by surpluses in 1999, 2000 and in 2001. Since that time, several things have taken place leading us to our current financial situation.

- We have fought two unfunded wars, paying for them using our National "Credit Card".
- A lack of financial regulation allowed refinancing and borrowing against over-valued houses, paid out billions of dollars in commission to the finance industry and brought our economy to the brink of collapse.
- The use of this credit to fuel equally massive spending on foreign goods
- Massive outsourcing – A 2011 analysis by John Lounsbury, Correlating US Demographics Trade Deficits and Employment[4], reviews the downward spiral preceding the financial collapse..This analysis is essential to our understanding that it is we, the public, that are responsible for the massive offshoring of manufacturing jobs between about 1996 and 2006.
- The rate at which we spent our new found credit was so high that it exceeded our national capability to manufacture. It was our massive, uncontrolled spending that forced companies to offshore jobs because it was the only way they could keep pace with our demand.
- The collapse of the financial markets and subsequent bail-out with more borrowed money.

These are some of the major causes of our huge debt – so let's not do that again. We also know that that solution(s) is(are) outside of politics; because, if it took more than 12 years to get into this mess of debt and it is going to take much longer to get out of it. The solution is unlikely to come from our political leaders because it will take more than 25 years, or seven Presidential elections, during which there must be a consistent financial policy.

So we have discovered that many of the problems (including the financial collapse and offshoring) are the result of our actions. What can we do about it? Or better put, what **shall** we do about it?

Turn back to our history[5] from Part 1 of this article, "Some groups will survive better – the Resourced (those with money, wealth or power) the Resourceful, the Leaders, and the Lucky" It's best we not rely on the Resourced and the Lucky to control our future. The solution must come from Entrepreneurs and business owners –

Can the education sector respond fast enough to meet our needs? The good news is that some projects have already begun. One such program, Liberal Education and America's Promise (LEAP) was launched in 2005 by The Association of American Colleges and Universities. LEAP was established to introduce science and engineering students to a more liberal education program, creating a forum for economic creativity.

the Leaders; and Engineers – the Resourceful. We are the solution and we are the best placed to pull the country out of its present financial mess.

There is perhaps one alternative. But, it has been tried in many civilizations before ours – to take from the defenseless, the old, the poor and the crippled. We can cut the social safety nets and let the devil take the hindmost. Please don't think this is what I am advocating. It is a viable policy and we must consider all viable options. It has been tried and has worked - for a limited time, *but be careful to contrast this with the 4 year timespan needed for political expediency.* For what happens when we ourselves become old; lose our job; or become sick? To give Isaac Asimov the last word on this subject – "Any dogma, primarily based on faith and emotionalism, is a dangerous weapon to use on others, since it is almost impossible to guarantee that the weapon will never be turned on the user." So perhaps we truly must be our own salvation.

The Spread of New Inventions and Products

New products cannot be brought into existence without the appropriate knowledge: and because that knowledge can only be passed between people, the one factor that limits its speed is the rate at which we can communicate.

Up until a few hundred years ago geography and communications were great limiters to the transfer of ideas, and our social and economic development. For example:

- The first reference to gunpowder in China occurs in the mid-9th century, but the first time gunpowder was used in the west was 1262.
- Rice was found in China 3000 BC, it did not reach Africa until between 1500 and 800 BC, Europe in the 15th century and America in the 17th century.

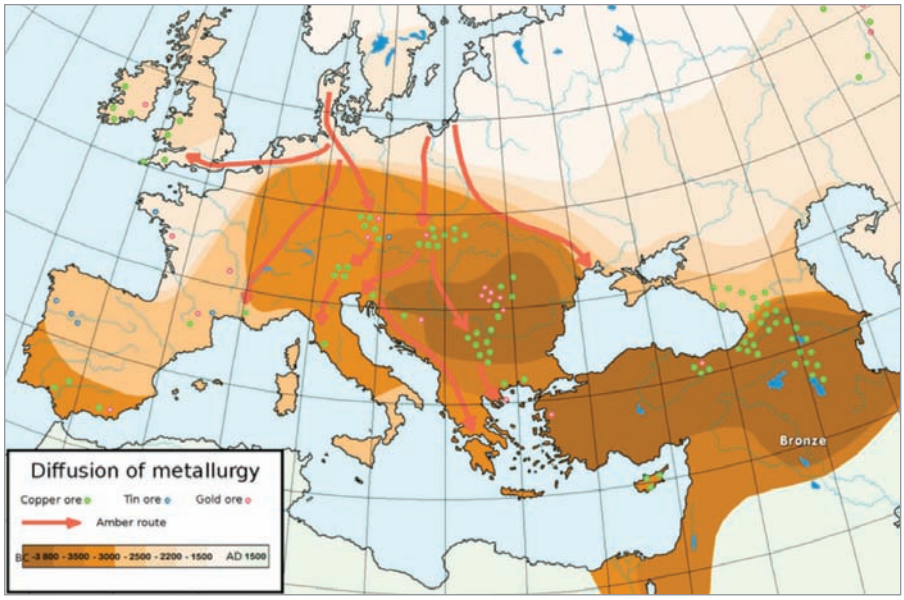


Figure 1: This illustration (Wikipedia) shows the gradual spread of technologies necessary to reduce ore and forge metals.

Explorers and traders journeyed into far distant lands; high speed travel had a pace of 50 miles a day – assuming you could keep your horse well fed and well shod. Progress was slow and everyone lived off the land. There was no technology; there were no factories; there were no public schools. Information traveled, not at the speed of light (as today), but at the speed of foot.

Gradually, farming communities formed and agriculture became more efficient. Some groups and tribes ceased a nomadic existence and gradually the first great thinkers like Thales, Plato, Panini, Pythagoras, Aristotle and Archimedes were freed from the daily drudge of physical labor and began to develop technology and scientific tools. The keystones of engineering were established and spread slowly to northern climes.

The point to note from this is that scientific thinkers were funded either by their local community or by a local benefactor – the parallel is Wikipedia, funded by individuals that value its worth. They were not paid when they had a new idea. They were, generally, insulated from the needs experienced by the common man – free to think without day-to-day clutter, or telephone calls.

Teaching was by internship and apprenticeship. There were no courses, no universities, no examinations and no need for teaching certificates as our forebears established the first education systems. It was not until the late 700s that the first European teacher, Saint Alcuin, formed what was to become a mode; of our schools and universities.

Today, communications are now so fast that ideas are limited only by our ability to output, uptake and process data. What does this mean? Distance is no longer something that shapes or influences new ideas, concepts and products.

A New Scope for Innovation?

Study, research and teaching were considered an 'overhead' and part of a society's fixed-cost. In much the way that a town considers a mayor a necessary post. Having a 'thinker' on a retainer or as a member of staff and taking legal ownership of her inventions is a relatively new concept. It also has modern parallels; many companies pay retainers to specialists

Perhaps there is scope for other ways of encouraging innovation and new ideas. From the perspective of this paper the ownership of an idea is immaterial – our criterion is to make maximum capital from each new idea so that the resultant wealth can be spread to the community.

and consultants so that they can obtain an 'instant' response without the delay of a purchase order.

Perhaps there is scope for other ways of encouraging innovation and new ideas. From the perspective of this paper the ownership of an idea is immaterial – our criterion is to make maximum capital from each new idea so that the resultant wealth can be spread to the community.

The Six 'X' Factors for New Ideas and Products

The evolution of a new idea or product relies on several 'X' factors: these include

- Resources
- Culture
- Geography
- Knowledge
- Environment
- Need

Take 'iron' for example: it cannot be smelted without resources (wood, clay and cheap labor), culture (coordinated team working) and is dependent on soil rich in iron ore (geography); and knowledge to make charcoal, reduce iron ore to iron, make a kiln. History does not tell us the pressing need that drove iron manufacture and trade – it would be nice to believe that it was to furnish a stronger plough and not stronger weapons.

Rice was essential to feed growing populations and required cheap labor; coordination and a stable government (it takes years to develop a rice paddy); the right terrain and soil; knowledge; and a warm wet climate,

REMEMBER THE PAST, DIRECT THE FUTURE – TAKING CONTROL

In the 80s I worked on a product that was exported to South Korea. At the start of the project we did not know that a special manufacturing plant had been built and staffed with graduate engineers. We did not know that every one of the assembly line and other workers had recently graduated and spoke good English – there had been a colossal investment in buildings, equipment (including the latest CNC machinery) people, and education.

Our contract included supply of finished parts and instruction to install, align and commission the equipment.

We delivered drawings and kits of parts for assembly in Korea. It was only during the contract that we realized we were training Korean design engineers to develop the next generation of products, to understand our quality systems, design concepts and drawing standards.

The equipment needed extremely high accuracy. We used the best gears we could afford, 'over-meshed' them and ground them into position with grinding paste. Our 'students' did not take long to see the reliability problem we had created. They also had the solution – the CNC Machines they had sitting in a room next door. Their strategy was to learn what we knew, then to improve our design and to compete with us.

In short, the product we delivered was immaterial, the purpose of the contract, we realized later, was to transfer technology and knowledge and to train a new generation of design engineers that was to become our competition.

History does not tell us the pressing need that drove iron manufacture and trade – it would be nice to believe that it was to furnish a stronger plough and not stronger weapons.

How many times did our parents tell us: "You can't be good at everything!" So does this also apply to countries? India carved out a niche in software design, African countries have carved out a niche in mobile phone applications, and the list goes on.

In the previously referenced 2011 analysis we see that South Korea is ranked in the top position by two methods of analysis and fourth in the third method. I believe their position is no accident – but is the result of a carefully planned, well financed and brilliantly executed policy with unswerving commitment.

Our UK Company formed a vital part in that strategy to create a center of excellence and we unwittingly, destroyed the future export market for ourselves, our European and US competitors. This was an example of a first-class top level strategy and commitment to creating a center of expertise. The more widely known example was the creation of IT professionals and investment in high technology pockets with good access to the Internet backbone. Within 10 years India had become a source of cheap software, call handling and out-sourcing.

Rewind – and Replay

During the 1850s UK Industrial Revolution companies began to export machines used in cotton processing to the US, because it was cheaper to refine the cotton before it was shipped. Soon after, hundreds of workers lost their jobs in the UK and European Cotton trade. Next, weaving machines were exported; using 'cheap' US labor, this led to the loss of more European manufacturing jobs. Finally UK companies exported the machine tools used to make spinning, weaving and other machines for the cotton industry. For every lathe sold orders for dozens of machines were lost. There is no record of the number of engineering jobs lost. Lack of a clear technical strategy, export policy and short-termism had destroyed a major European industry and hundreds of workers were unemployed.

Short-Termism - The lesson we may never learn?

During the last 20 years the universities of industrialized countries have educated foreign students, grateful for the additional revenue. Is it any surprise that we have competition from the countries whose students we have educated? This is not to suggest that we should place an embargo on teaching overseas students – just ask former USSR Officials how isolationism worked out for them!

All things have finite value

Our history shows that successive governments and businesses have failed to grasp (or have ignored) the ramifications of supplying knowledge and developing competitors who will later compete with us. (Suggestions – a taxation paid by the overseas government that would offset future unemployment and fund research that would create new opportunities for those displaced). One way to mitigate this competition and to gain new engineers would be to grant overseas "a" students a visa. We will, most likely, grant the visa anyway, so why not a few more to help our own economy?

Even on our local shores short-termism has created too many problems[6], take for example the Oil 'spill' in the Gulf; contamination of drinking water by pollution and hydraulic fracturing[7]. And for our future:-"...role of... investers..they are: "primarily financial engineers interested in the largest possible profit in the shortest period of time," who usually maintain "laser-beam focus on quarter-to-quarter earnings" – and they accordingly favour a short-term spike in the share price over long-term wealth creation. Indeed," [i]n most cases, the[se] investors have nointerest at all in the long-term economic success of the enterprise."[8] To this statement we must be cautious - for there are some who have no interest in the long-term economic success of either the enterprise or of this country.

One of the many principles that Bill Gates has instilled in us is the value and necessity of the "Undo" button. We should not implement a technology unless we have a proven way to reverse its effects.

THE RISE OF THE NICHE

How many times did our parents tell us: "You can't be good at everything!" So does this also apply to countries? India carved out a niche in software design, African countries have carved out a niche in mobile phone applications, and the list goes on.

Necessity – the Mother of Invention
Ideas and products still depend on climate, geography, knowledge, the environment. The communication infrastructure of Africa is focused more on mobile phones than on internet. We could expect such a skew in resources to create a deficiency but the driving need for financial, technical, medical and social application specific to Africa more than offset that initial disadvantage and has created a driving strength and ability to "do it without outside help". Africa has become a

There is a place in the world for a Niche, where a product or service is so special or unique that it can only be produced by low labor costs, special skills, specialist equipment or unique environmental conditions.

center of expertise in creating phone applications,[9] proving that things are not always structured and deliberate: and that serendipity also has its part to play.

World Trade and the Niche[10] - What is Value

Taken from "The Concise Encyclopedia of Economics International Trade" - by Arnold Kling, David Ricardo developed and published one of the first theories of international trade in 1817.

> "England," he wrote, "may be so circumstanced, that to produce the cloth may require the labour of 100 men for one year; and if she attempted to make the wine, it might require the labour of 120 men for the same time....
>
> "To produce the wine in Portugal, might require only the labour of 80 men for one year, and to produce the cloth in the same country, might require the labour of 90 men for the same time. It would therefore be advantageous for her to export wine in exchange for cloth. This exchange might even take place, notwithstanding that the commodity imported by Portugal could be produced there with less labour than in England.
>
> "If a painter takes twenty hours to paint a house, and a surgeon could do the job in fifteen hours, it still makes sense for the surgeon to hire the painter. The surgeon can earn enough money in a few hours of surgery to pay for the entire house-painting job. We say that the surgeon's comparative advantage is in doing surgery, while the painter's comparative advantage is in painting houses. Ricardo's theory of comparative advantage explains why a surgeon will hire a house painter and why a lawyer will hire a secretary."

This model relies on man hours as the factor for determining 'cost' but how do we determine what someone may be willing to pay for a product or service? – how do we assess 'value'?

Value

The 'value' of a product (as perceived by the customer) is the key to profit. Value, always hard to define is a rare combination of Need, Rarity and Desirability. Of these three factors Need will always be the dominant driver in poor economies while Rarity and Desirability are key drivers in rich economies.

Selling to poor economies can provide a secure income stream but, by definition, there is little disposable wealth so profit margins will be small. Selling to rich economies is a different animal. An object may be highly prized because it is scarce like gold and diamonds. (Note that diamonds exist in huge quantities but their abundance has been stifled by cartels for more than 200 years, which makes diamonds a synthetic market.)

The lessons we may take from this are: There is a place in the world for a Niche, where a product or service is so special or unique that it can only be produced by low labor costs, special skills, specialist equipment or unique environmental conditions. Current examples include aluminum (needs cheap – hydroelectric – power; cell phones (where labor is currently the driving cost). Future specialist products will, conceivably, rely on low gravity (space), high pressure (deep sea). Profit margin is usually greater when selling to 'desirability' but narrow markets can be volatile and subject to fads. Desirability does not always equate to high value

"To produce the wine in Portugal, might require only the labour of 80 men for one year, and to produce the cloth in the same country, might require the labour of 90 men for the same time. It would therefore be advantageous for her to export wine in exchange for cloth."

Mexico – 'the new China'

An Economic feature[11] points out that Mexico economy grew faster than Brazil's in 2011 and is about to exceed that growth. This may be because China's niche (low labor cost) is being transformed by its internal wages quadrupling in the last 10 years. This has made manufacture in Mexico (lower transport costs – better control, etc.) a very attractive alternative.
In the last few years we have been aware that 'approved' manufacturing sites of many established products have been extended to locations in Mexico and also in the US, within walking distance of the border.

The Rise of the Machines

Due to their high capital cost and lack of flexibility the use of Robots was initially limited to high volume applications, like the auto industry and the assembly of small electronic parts and products. The future of robots will be interesting to observe. To the U.S. they will mean potential unemployment of skilled/semi-skilled: but for countries that have falling populations they could be the salvation.

> "The numbers speak for themselves. Currently, China has approximately 137 million people aged 65 or above. In 12 short years, this will balloon by another 100 million. The ratio of retirees to income earners will jump from 49 percent currently to 69 percent in 2030, assuming that the retirement age remains the same. By 2035, the median age in China will have increased from 35 to 45 years — equal to Japan's median age currently.
>
> "But China is not alone. South Korea's working-age population will also begin to shrink in 2015. Taiwan has already seen a sharp rise in the ratio of retirees to income earners, while the country's median age is projected to climb from 37 currently to 56 in 2050, which will make it the oldest population in Asia. Hong Kong and Singapore face similarly daunting demographics — although, in both cases, immigration could yet help mitigate the problem. Even Thailand is past its demographic prime, with the labor force expected to start contracting within the next 10 years."[12]

What Makes America Unique?

Enter that question into Google and we are informed:

- Land of Opportunity
- Policeman of the World
- Diversity
- Tolerance
- Intolerance

What will be America's Niche?

PC Software? Defence Products? Infrastructure? Areas like RTP (Research Triangle Park, North Carolina - USA) provide world class facilities for IBM, CISCO, GSK, RTI and many other companies. The value of start-up and soft start programs is accepted universally.

Perhaps this is a way for our future...

REFERENCES

1. http://seekingalpha.com/article/253948
2. http://www.aacu.org/leap/index.cfm
3. http://politicalticker.blogs.cnn.com/2010/02/03/cnn-fact-check-the-last-president-to-balance-the-budget
4. http://seekingalpha.com/article/253948
5. *In Compliance*, January 2013, Engineering Our Future, Section: Some Groups Will Survive Better
6. http://en.wikipedia.org/wiki/List_of_industrial_disasters
7. http://en.wikipedia.org/wiki/Deepwater_Horizon_oil_spill *please see images*

   http://en.wikipedia.org/wiki/Hydraulic_fracturing
8. Focusing On Corporate Short-Termism http://law.nus.edu.sg/sjls/articles/SJLS-Dec11-412.pdf
9. Top 10 Mobile Phone Apps in Africa http://afritorial.com/top-10-mobile-phone-apps-in-africa
10. *The Concise Encyclopedia of Economics International Trade*, Arnold Kling
11. "The Rise of Mexico," *The Economist,* November 24, 2012
12. http://www.cnbc.com/id/49472132

(the author)

GREGG KERVILL

Kervill started out as a physicist but has spent all of his career in electronics because, as he puts it, it was more fun. Gregg career as an electronics design engineer began in the industrial controls, consumer electronics, space and military markets. He completed a Diploma in Industrial Management (the forerunner of the MBA) in the 1980s with a thesis on the application of Kan Ban and JIT to highly variable product lines. Also in the 1980s, he became involved with product safety for military products, and became a CSA design verification engineer for Digital Corporation. In 1993, he formed GK Consultants Ltd, with whom he has maintained a web presence.

A registered consultant to the European Union (advising on Slovenia's entry to the EU), Gregg has contracted to NIST and the US-Consumer Electronics Association, and has advised the UK, Northern Ireland, Slovenia and Hong Kong governments. He has also provided pro bono support to Virginia Governor Mark Warner's VALET export program, as well as the planning and strategy committee of the City of Austin, Texas. Since 1995, he has lectured and consulted on three continents, published three engineering books, and created the first multi-media training software for electrical product safety. Currently he is developing web-based training material from world-class subject matter experts (SMEs) for the Phoenix Technical Group, an internet-based company with a presence in the US, UK, and Brazil.

EVENTS in Compliance

May 2013

7
Understanding Ground Resistance Testing
AEMC Instruments
Foxborough, MA
www.incompliancemag.com/events/130507_1

7
Industrial Control Panels UL 508A and Short-Circuit Current Ratings
UL Knowledge Services
Meridian, ID
www.incompliancemag.com/events/130507_2

7
Latchup Testing and Troubleshooting
ESD Association
Webinar
www.incompliancemag.com/events/130507_3

7 - 8
ESD Association Korea Regional Tutorial Program
ESD Association
Seoul, Korea
www.incompliancemag.com/events/130507_4

7 - 9
Designing Safety-Related Machinery Control Systems in Accordance with ISO 13849 and IEC 62061
UL Knowledge Services
Jacksonville, FL
www.incompliancemag.com/events/130507_5

9
EMC Fest 2013
Southeastern Michigan IEEE EMC Society
Canton, MI
www.incompliancemag.com/events/130509

13 - 16
Military Standard 810G (MIL-STD-810G) Testing
Cincinnati Sub-Zero Products
Cincinnati, OH
www.incompliancemag.com/events/130513

14 - 16
Fundamentals of EMC Compliance Testing
ETS-Lindgren
Austin, TX
www.incompliancemag.com/events/130514_1

14 - 16
ESD Association Northeast Local Chapter Regional Tutorial Program
Teradyne Inc.
North Reading, MA
www.incompliancemag.com/events/130514_2

15
Principles of Transmission Lines, Crosstalk and Cable Screening
The University of York
United Kingdom
www.incompliancemag.com/events/130515

16 - 17
Automotive Electronic Design Techniques and Analysis Required to Meet EMC Requirements
Jastech
Novi, MI
www.incompliancemag.com/events/130516

20 - 22
Advanced EMC Measurements
The University of York
United Kingdom
www.incompliancemag.com/events/130520_1

20 - 23
7th Annual International Electrostatic Discharge Workshop (IEW)
ESD Association
Warrenton, VA
www.incompliancemag.com/events/130520_2

21 - 23
Measurement, Control and Laboratory Use Equipment: Designing for Compliance to IEC 61010-1 3rd Ed.
UL Knowledge Services
Northbrook, IL
www.incompliancemag.com/events/130521

22
Industrial Control Panels UL 508A and Short-Circuit Current Ratings
UL Knowledge Services
Philadelphia, PA
www.incompliancemag.com/events/130522

23
An Introduction to Validation, Verification and Measurement Uncertainty in EMC
The University of York
United Kingdom
www.incompliancemag.com/events/130523

30
VF-TLP, An Introduction to Capabilities and Applications
ESD Association
Webinars
www.incompliancemag.com/events/130530

June 2013

4
Understanding Ground Resistance Testing
AEMC Instruments
Seattle, WA
www.incompliancemag.com/events/130604_1

4-5
Grounding and Shielding for System Level Noise Reduction
UL Knowledge Services
San Jose, CA
www.incompliancemag.com/events/130604_2

4-5
Design for Automotive EMC Compliance
LearnEMC
Detroit, MI
www.incompliancemag.com/events/130604_3

4-7
MIL-STD-461F
WL Academy
Gaithersburg, MD
www.incompliancemag.com/events/130604_4

EVENTS in Compliance

6
HMM – System Level Testing of Components
ESD Association
Webinar
www.incompliancemag.com/events/130606

7
System Engineering Approach on How to Design, Validate, and Simulate IC Decoupling
Jastech
Novi, MI
www.incompliancemag.com/events/130607

11-13
Overview of Radiated Immunity/ Emissions Test Facilities
ETS-Lindgren
Austin, TX
www.incompliancemag.com/events/130611_1

11-16
ESD Association Meeting Series
ESD Association
St. Louis, MO
www.incompliancemag.com/events/130611_2

12
The EMC Directive and Technical Documentation
The University of York
United Kingdom
www.incompliancemag.com/events/130612_1

12
Industrial Control Panels UL 508A and Short-Circuit Current Ratings
UL Knowledge Services
Maumee, OH
www.incompliancemag.com/events/130612_2

PRODUCT Showcase

Your Source for Product and Service Solutions

(Authors)

RANDY IVANS
is UL's Principal Engineer in the high tech and telecommunications area. He is responsible for the development, implementation and maintenance of various UL Standards and certification programs including UL's NEBS Mark program. Randy is a member of the National Electrical Code, NFPA 70, Code Making Panel No. 16 that is responsible for Chapter 8 covering communications systems. For Randy's full bio, please visit page 29.

NIELS JONASSEN, MSC, DSC,
worked for 40 years at the Technical University of Denmark, where he conducted classes in electromagnetism, static and atmospheric electricity, airborne radioactivity, and indoor climate.
Mr. Jonassen passed away in 2006.
For Mr. Jonassen's full bio, please visit page 20.

GREGG KERVILL
started out as a physicist but has spent all of his career in electronics because, as he puts it, it was more fun. Gregg career as an electronics design engineer began in the industrial controls, consumer electronics, space and military markets. He completed a Diploma in Industrial Management (the forerunner of the MBA) in the 1980s with a thesis on the application of Kan Ban and JIT to highly variable product lines. For Gregg's full bio, please visit page 47.

BRIAN LAWRENCE
began his career in electromagnetics at Plessey Research Labs, designing "Stealth" materials for the British armed services. In 1973 he moved to the USA and established a new manufacturing plant for Plessey to provide these materials to the US Navy. For Brian's full bio, please see page 14.

MATT MAROTTO
is currently the North American Wireless & EMC Quality Manager for UL. In 2008, Marotto served as Global NEBS Program Development Manager and was responsible for developing and implementing UL's NEBS Fastrack Program, which enables international Telecom manufacturers to perform NEBS and telecom related testing in their own laboratories under the witness of UL staff. For Matt's full bio, please visit page 29.

AL MARTIN
holds a BEE degree from Cornell University, and a PhD from UCLA. Al joined Raychem [now TE Connectivity] in 1975, where he was initially involved with shielding effectiveness and surface transfer impedance measurements. In 1989 he joined Raychem's Polyswitch Division, where he currently manages the compliance test program. For Al's full bio, please visit page 39.

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. For Geoff's full bio, please visit page 23.

WAYNE TUSTIN
founded the Equipment Reliability Institute, Santa Barbara, California, in 1996. This specialized engineering school offers 3-day introductory courses about random vibration and shock testing. Concurrently, he is developing an iBook tablet version of his 2005 text ISBN 0-9741466-0-9. For Wayne's full bio, please visit page 33.

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.

(Advertisers)

Advertiser Name	Page	Advertiser Name	Page
A.H. Systems	C2	IEEE EMC Chicago Mini Symposium	18
AR	7	Monroe Electronics	49
Dexmet Corporation	9	NPSS Vendors Night	49
Dutch Microwave Absorber Solutions	19	Panashield Inc.	17
E. D. & D., Inc.	23	Rigol Technologies	11
ETS-Lindgren	C3	Rohde & Schwarz	3
Henry Ott Consultants	13, 49	Teseq	C4
IEEE EMC 2013 Symposium	21	Washington Laboratories Academy	15, 27

Reduce Test Complexity. EMCenter™ Makes It Simple.

TILE!™ Compatible

Getting ready to test used to mean racking equipment, attaching lots of cables, managing a library of instrument drivers, and hoping everything would run smoothly.

EMCenter changes all of that. It brings everything together in one ready-to-use platform with touch screen, microcontroller, I/O, and up to seven interchangeable card-mounted RF test instruments that slide into a common backplane. Select the card modules you need for a particular test, then swap them out to create a new configuration for a different test later. For more capability, EMCenter's I/O ports – USB, Ethernet, RS-232, and IEEE-488 – let you link to external instruments like receivers and amplifiers.

EMCenter can be used as a standalone device, or used in combination with popular test management software like TILE! Visit our website for more information.

Bring EMCenter into your lab and reduce test complexity.
It's that simple.

Enabling Your Success™

ETS·LINDGREN™
An **ESCO Technologies** Company

www.ets-lindgren.com/EMCenter

Offices in the US, Brazil, Finland, Germany, France, UK, India, Japan, Singapore, China, Taiwan

COMPLIANCE 5 –
THE EMC TEST SOFTWARE THAT PASSES EVERY TEST

Compliance 5 automates your EMC test laboratory. Flexibility is the keyword here. These Windows-based programs control RF emissions and immunity tests for every application, from pre-compliance development through accredited testing. Compliance 5 comes in a wide range of performance packages to suit your unique requirements; and Teseq's on-site support and training will ensure your lab is up and running as quickly as possible.
What does this mean? – Compliance 5 is an advantage for every test laboratory!

Test our results:

- ✓ **Emissions and Immunity versions with optional site licenses**
- ✓ **Commercial application is standard**
- ✓ **Optional military and aerospace applications**
- ✓ **Supports all manufacturers' test instruments**
- ✓ **Can be individually configured for your own test methods**
- ✓ **Automated EUT monitoring**
- ✓ **Global support network**

Teseq Inc. Edison, NJ USA
T + 1 732 417 0501 F + 1 732 417 0511
usasales@teseq.com www.tesequsa.com

jsj a TESEQ Company

MILMEGA a TESEQ Company

TESEQ Advanced Test Solutions for EMC