Volume 13, No 4

PRODUCT SAFETY ENGINEERING NEWSLETTER

What's Inside

Editor's Message

Dear Readers,

It is exciting that the holidays and New Year are coming soon! As the Editor of Product Safety Engineering Society Newsletter, I feel pleased and proud to see the growth of the society and 2017 has been such a fruitful year. As the General Chair of 2017 IEEE ISPCE-TW, I am honored to be participating in the spread of the Flagship ISPCE 2017 in San Jose.

Several reports of new events were collected in this last issue of 2017, that is, a new regional symposium, SPCE 2017, was held in Boston in November and the detailed report has been provided by the General Chair, Steven Brody. In addition, there are so many goings on in the Madras Chapter, according to the reports on the inspiring workshops and technical talks given by Dr. V.JAYAPRAKASAN. Also, John and Murlin got benefited greatly by attending the EMC+SIPI 2017 conference in Washington, D.C. and have shared the comments with us. Make sure you do not miss these articles which present an overview of exciting events.

Once more, I would like to welcome any kinds of contributions or feedback which may help improve the Newsletter. It is expected that with our teamwork, the Newsletter will become something you cannot wait to receive every three months.

I wish you all a happy New Year!

Please feel free to communicate with me at any time.

Wen-Chung Kao
jungkao@ntnu.edu.tw

Newsletter Committee

The Product Safety Engineering Newsletter is published quarterly during the last month of each calendar quarter. Closing dates for articles, news items, and advertising:

1Q issue: February 15
2Q issue: May 15
3Q issue: August 15
4Q issue: November 15

Volume 13, No. 4 - December 2017

The Product Safety Engineering Newsletter is published by the IEEE Product Safety Engineering Society.

President's Message

Hi,

I'm pleased to report it's been a great year for the Product Safety Engineering Society. We have had a lot of activities accomplished and numerous others set in motion. Activities like Collaboration efforts with other Societies, Associations and Industry; New Member Initiative; Roaming Conferences; Education Activities; Virtual Chapter work; new Chapters starting and so much more.

We continue on our mission of *Fostering development and Transferring Product Safety and Compliance Knowledge* with our Conferences –

Our Flagship ISPCE 2017 in San Jose, California was a huge success with a record-breaking attendance. SPCE 2017 in Boston was set as the first location of our new "Roaming Conference", but was so well received it will be back in Boston in 2018. ISPCE-TW 2017, held in Taipei, Taiwan more than doubled the presentations and papers from last year and is setting up to be another great event for the Asian region.

Compliance 101 has now become a reality and the Planning Committee is busy developing the overall plan that includes training modules, presentations, videos, webinars, etc. The priority will be the training modules and presentations, as we've been selected to conduct a half-day training seminar at the Applied Power Electronics Conference and Exposition (APEC) in San Antonio, Texas in March, 2018.

I would like to take this opportunity to welcome our newly elected Board of Governors – Michael Anderson, Basni Patel, Darren Slee and Lei Wang, I look forward to working with each of you. I would also like to thank our exiting Board of Governors for all their efforts in helping the Society fulfil its mission. In particular, Kevin Ravo, our immediate past President, has given me tremendous mentorship as I navigated this completely new territory of leading PSES. Kevin's guidance and help, along with all the work he's done for our Society, is greatly appreciated. Steli Loznen and Thomas Lanzisero also have their terms ending 2017 and we all appreciate everything you've done to help shape Product Safety Engineering Society and hope you continue to be involved in the future.

Your Board of Governors is always looking for opportunities on how to better serve our members. Your comments and suggestions are always appreciated and welcomed. One of the many benefits that the Product Safety Engineering Society offers is the Fellows Elevation Program in the IEEE. One our members, Pete Perkins, was just elevated to this prestigious level. Congratulations to Pete Perkins!! The IEEE Fellow is a distinction reserved for select IEEE members whose extraordinary accomplishments, in any of the IEEE fields of interest, are deemed fitting of this prestigious grade elevation. Pete, your vision, efforts and knowledge are greatly appreciated, and this award is very well deserved.

As you see we have a lot moving forward. If you're passionate about safety and helping us help our members let us know!! The more we work together the better our society becomes.

I wish everyone a Happy Holiday season.

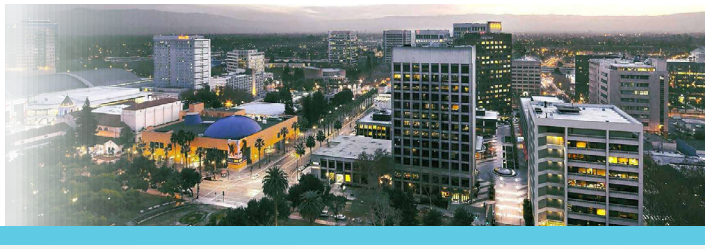
Be safe,
John

ISPCE 2018

IEEE SYMPOSIUM ON PRODUCT COMPLIANCE ENGINEERING

SAN JOSE, CALIFORNIA, USA

MAY 14-16, 2018



ORGANIZERS

General Chair

Murlin Marks
PSES

Technical Program Co-Chairs

Leszek Langiewicz
HP

Grant Schmidbauer
Nemko, USA

Symposium Co-Chairs

Steve Brody
Product EHS Consulting

Bansi Patel
PSES

IMPORTANT DATES

Indicated deadlines require that the associated documents be loaded into the submission portal, EDAS, (**http://edas.info**) by the due date:

January 1, 2018
Formal Paper/Reviewable Presentation Submission Deadline

February 1, 2018
Acceptance Notification Deadline

March 16, 2018
Final Camera-ready Paper/ Presentation Submission Deadline

Please visit:
psessymposium.org

The IEEE Product Safety Engineering Society hosts an annual premier symposium, ISPCE (IEEE Symposium on Product Compliance Engineering), on all relevant topics for professionals, practitioners, and innovators in the areas of product safety and compliance engineering. Join us in San Jose for **ISPCE 2018** for 3 days of technical sessions and exhibits!

PAPER SUBMISSION

Please go to the Submission page on the ISPCE website for details & comprehensive submission instructions, including separate formal paper and presentation templates.

Formal papers & presentations not submitted per submissionm instructions by the initial deadline may need to be held over until next year depending on the number of submissions.

Please note, when serving as an educational presenter during ISPCE 2018, speakers are permitted to introduce themselves and make reference to the company they represent, or their company activities, as is necessary for context within the course of their presentation. Company sales or other promotional activities should be reserved for other times.

TOPIC AREAS

The IEEE Product Safety Engineering Society seeks original and unpublished formal papers, presentations (without formal papers), workshops, and tutorials on all aspects of product safety and compliance engineering including, but not limited to:

- **Global Market Access & Regulations, Compliance Management**
- **EMC & Wireless Compliance**
- **Environmental & Energy Regulations**
- **Batteries & Energy Storage Systems**
- **Medical Devices**
- **Compliance 101**
- **Global Hazardous Locations**
- **Test Methods & Ensuring Quality of Test Results**
- **Hazard Based Safety Engineering Safety Science**
- **Forensics, Failure & Risk Analysis, Assessment & Management**
- **Legal, Regulations, Directives & Consumer Protection**
- **Emerging Technologies & Innovations**
- **Functional Safety**

PSES

IEEE

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IEEE 2017 ISPCE-TW

IEEE International Symposium on Product Compliance Engineering-Taiwan

December 21-22, 2017,
National Taiwan Normal University, Taipei, Taiwan

Call for Paper

http://soc.aet.ntnu.edu.tw/ieeeispcetw/index.php

The conference topics involve:

*Inherently safer products and equipment

*Product Safety services

*Training and continuing education

*Regulations and standards

*Risk management

*Workplace product safety

*System and Software safety

*Human factors

There should be some invited speakers, submitted peer reviewed papers, tutorials, and product demonstrations.

The deadline for submitting a full manuscript is November 15. All the submissions will be peer reviewed for the quality and originality. Please consider submitting your papers before the deadline. The conference will be the most important IEEE PSES conference in Asia.

Paper Submission: http://soc.aet.ntnu.edu.tw/2017ISPCE-TW/users/register.php

Chapter News

By Murlin Marks,
Life Senior IEEE, Past President PSES

Chapter News and Notes

It's hard to believe that 2018 is just around the corner! Time to think about what has been accomplished in 2017 and what we can do in 2018. I hope every chapter can provide a stimulating program for the PSES members in their respective areas.

News from the chapters:

Central New England – In November, Steve Brody pulled off a great conference at the first SPCE conference in Boxboro. This was our first "regional" conference and this year's success ensures we will have one next year. Please let Steve know your ideas for next year's event.

At SPCE2017: Dr. Nancy Leveson, Professor of Aeronautics and Astronautics at MIT, delivers the Keynote: "Building Safety (and Security) into Your Products"

At SPCE2017: Grant Schmidbauer discusses the impact of IEC 62368-1

Madras, India Chapter – Congratulations to the Madras Chapter for having an official IEEE Student Branch! Our Madras chapter has an active program with recent presentations on Fire Safety Awareness and the Importance of Multi-rate Signal Processing for Digital Communication.

Madras Chapter Chair, Dr. V. Jayaprakasan, received the IEEE PSES Chapter of the Year 2016, from the IEEE Madras Section Chairman during the AGM Meeting held on July 23rd 2017.

North [New] Jersey Joint EMC/PSES Chapter – Dan Roman reports that his chapter will have a December meeting hosted at Sony's facility in Teaneck NJ. The presentation will be given by a Sony attorney who will describe product safety for consumer electronics and information technology equipment, and the product liability defense thereof.

Orange County had an October meeting with a presentation by Homi Ahmadi discussing product recall.

San Diego Chapter had a November meeting with a presentation by Mark Frankfurth on the Machinery Directive value and potential improvements to the Machinery Directive.

Santa Clara Chapter had a November meeting with a presentation by Keith M. Beers, Ph.D., P.E., and hosted by Exponent Inc. His topic was the Safety of Lithium-Ion Batteries.

That's all the news I have! Please, chapter reps, take and send me photos so everyone can see what you and your meetings are like!

* * * *

Chapter of the Year – I hope every chapter can submit the form for Chapter of the Year 2017 (http://ewh.ieee.org/soc/pses/Chapters/PSES-Chapter-of-the-Year-Award-Questionnaire-2017-1.0.docx) Even if you don't think you've done great things, please fill out and submit the form. At the very least, you might get some ideas for 2018.

Chapter Annual Meeting – Our CAM will be at ISPCE2018 in San José, California USA in May (http://www.psessymposium.org) Let's have every chapter represented! The meeting – and indeed the whole conference – is your opportunity to exchange ideas about how to make great chapter programs. Chapters represent the best opportunity for our colleagues to build professionalism and to network with others in our field. Please encourage your colleagues to attend the conference and the CAM.

Also, please let me know if you would like to help me with the CAM. We could use your help! The meeting will be all the better if we can get a few more leaders involved with this annual activity.

Message from Steven Brody – General Chair, SPCE 2017

This year, in addition to the flagship ISPCE Symposium held in San Jose each May, we have added a new regional symposium. The event was a 2 day SPCE held in the Boston area, specifically at the Regency Boxboro in Boxboro, MA, in early November.

The Symposium was kicked off with our keynote address from Dr. Nancy Leveson, Professor of Aeronautics and Astronautics, MIT. Dr. Leveson's presentation was about STPA – System-Theoretic Process Analysis – a new and more powerful approach to safety based on systems theory that can be used in early products concept analysis. Dr. Leveson said that STPA is and has been successfully used on hundreds of products in most industries world-wide and that it works for hardware, software, human-automation interaction, management/operations aspects of safety, as well as cyber-security. Dr. Leveson's presentation was a great start to the Symposium.

This was followed by 26 presentations over the two days which covered a variety of topics including EU REACH, Radio Equipment Directive, Medical Products, Technical Construction Files, Aircraft Lightning Strike Testing, IEC 62368, Measurement Uncertainty, Battery Safety, Functional Safety and related standards, Telecom Safety Regulatory Updates, Global Market Access, and of course our signature Compliance 101.

The Symposium was held in the more relaxed atmosphere of the hotel atrium rather than in a large ballroom, and there were two breakout rooms for the presentations.

The Symposium was considered a success and as a result it will become an annual event to be held in the Boston area the first or second week in November, while the main ISPCE will be held in San Jose in May of each year.

The success was due to the exhibitors and the attendees, all of which was based on the excellent work of the Symposium Committee:

* Bansi Patel, Co-Chair
* Lei Wang – Treasurer
* Grant Schmidbauer – Technical Program Chair
* Daniece Carpenter – Marketing Chair
* And many others in support roles as needed

Thanks to all who participated and I look forward seeing you at ISPCE 2018 in May and at SPCE 2018 in November.

News about Technical Activities

By Silvia Díaz Monnier,
VP of Technical Activities, IEEE PSES

News about VP Technical Activities

If you are interested in becoming involved in any technical issue, let me know, and we can discuss how you might get involved. You can contact me at silviadiazmonnier@ieee.org. Take advantage of this great opportunity for your professional growth!

PSES is working on a Distinguished Lecturer Program. The program will start running 2018. IEEE Distinguished Lecturers are engineering professionals who help lead their fields in new technical developments that shape the global community. These experts:
* Specialize in the field of interest of the Society.
* Travel to various technical and regional groups, such as Society Chapters, to lecture at events.

News about Technical Activity Committees

We currently have very active Technical Activities Committees (TC). Below you will find information about what are they working on and how to participate and get involved in these exiting technical activities.

Currently we are working in the formation in a new Environmental TC since there is a lot of interest in this topic. More information about this and about Technical Activity Committees can be found on PSES web page http://ewh.ieee.org/soc/pses/technical.html and in next editions of PSES Newsletter.

Risk Analysis TC chairperson position is open, if you are interesting in stepping up and leading this activity, please contact me.

If you are interesting in taking part of a technical committee or looking to start a new one, please contact me (Silvia Díaz Monnier) at silviadiazmonnier@ieee.org. The more people who participate the more we can accomplish as professionals and as a society. Spread the word - invite others to join PSES technical activities!

Education Activities

The committee started his activities after the Symposium. Steve Brody (sbrody@ieee.org) is the chair of the committee. The activities will cover the needs for education and training in Product Compliance and Product Safety.

Audio/Video, Information and Communication Technology Technical Committee

The IEEE PSES Technical Committee for Audio/Video, Information and Communication Technology Equipment continues to be robust, with 30 members actively participating in our monthly teleconferences. At our meetings we discuss and debate the many safety and regulatory challenges facing our industry, including the implementation and continued development of our new Standard for Safety IEC 62368-1. The safety of lithium ion batteries as used in IT products has also been a topic this year. New members are welcome to join our monthly one hour teleconference. Contact Gary Schrempp at Gary_Schrempp@Dell.com for details.

Forensic and Failure Analysis Technical Committee

The Forensics and Failure Analysis Technical Committee (FFATC) leadership group is moving forward with renewed energy to elevate the committee in its mission of attracting talented failure analysis engineers to participate in the committee, the PSES, and strengthen the IEEE as a whole. The leaders are actively contacting colleagues to increase membership in the committee. Please think about joining us. Failure analysis related topics are discussed to generate ideas and opportunities

to publish for the PSES and increase your standing in the world of failure analysis engineering. Recent discussions included topics such as e-cigarettes, electrocution hazards, hoverboards, and obstacles to lithium ion battery transport for failure analysis.

The Forensic and Failure Analysis TC meets via conference call monthly. Meetings are generally held on the last Wednesday of the month, 11 AM Pacific Time / 2 PM Eastern Time.

For information about the FFATC contact Daren Slee at DSlee@case4n6.com.

Telecom Safety Technical Committee

The Telecom Safety TC meets via conference call monthly. For information about the TSTC contact Don Gies at ddgies@verizon.net. Meetings are generally held on the second Wednesday of the month.

PSES Board of Governors Member Steli P Loznen is a recipient of the 2017 IEC 1906 Award.

Created in 2004 by the IEC Executive Committee (ExCo), the 1906 Award commemorates the IEC's year of foundation and honors IEC experts around the world whose work is fundamental to the IEC.

The Award also recognizes exceptional and recent achievement - a project or other specific contribution - related to the activities of the IEC and which contributes in a significant way to advancing the work of the Commission.

Close to 20 000 experts from industry, commerce, government, test and research labs, academia and consumer groups participate in IEC Standardization work. Each year, a maximum of five 1906 Awards may be granted per TC, including its subcommittees.

In 2017 **Steli P. Loznen** from Israel is among the 187 experts from 25 countries to receive the 1906 Award. Steli Loznen is active in TC 62 – Technical Committee for Electrical equipment in medical practice from 1994 as Working Group (WG) Convener in SC 62A and Project Leader for IEC/TR 62354 - General testing procedures for medical electrical equipment.

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Senior Member News

By Mariel Acosta, VP of Member Services, IEEE PSES

In the November IEEE Senior member review meeting, three of our society's member elevated their status to IEEE Senior member. Congratulations!

Mike Campi
Paul Knapp
Richard Pescatore

With the 3 new additions, we have reached 12 newly inducted IEEE Senior members in our society for 2017. Unfortunately we are behind 2016 numbers by 2. If you have drafted your IEEE Senior submission, consider taking the time to finish it.

In better news, our society is celebrating the elevation to IEEE Fellow of one of our own, Pete Perkins. Pete continues to be one of our most valuable members, he is always willing to help our society grow, by providing a technical article for the newsletter or a presentation for the symposium or a chapter meeting. Becoming IEEE Fellow is a very difficult and time consuming process, we are all very happy that such a small society has gained another IEEE Fellow.

IEEE PSES member spotlight-Meet your IEEE PSES colleagues!

As part of a new initiative, we will be highlighting some of our colleagues in IEEE PSES. On this installment you will find 3 of our newer IEEE PSES senior members.

Roderick Muttram

Professor Roderick (Rod) Muttram is a system and safety engineer with over 40 years' experience in four industry sectors.

After early roles in the Nuclear and Heavy Process industries he joined defense contractor Ferranti in 1980 where he became a Divisional General Manager then Group Director, Engineering and Quality with responsibility for seven companies. He joined Thorn EMI Electronics in 1990 as Director and General Manager, Defense Systems Division, a high-tech sensor and systems integration company.

Headhunted to join Railtrack in late 1993 as Director, Electrical Engineering and Control Systems. Promoted to the main Board of Railtrack Group PLC (FTSE 100) in 1997 as Director, Safety and Standards. Chief Executive of independent Railtrack subsidiary 'Railway Safety' from 2000 to 2003 at the end of which he set up the Rail Safety and Standards Board (RSSB). Network Rail replaced Railtrack in 2002. Held various external posts during this period including Chairman of the European Rail Research Institute (ERRI) and Vice-Chairman of the Association Européenne pour l'Interopérabilité Ferroviaire (AEIF).

In 2003, joined Bombardier Transportation (the world's largest transportation equipment supplier). Held various Vice President level posts at Bombardier both at Headquarters and within an Operating Division and was a lead auditor for critical projects worldwide. Rejoined the AEIF as an industry Director and was vice-chair of the European Rail Research Advisory Council (ERRAC).

In May 2012 he established Fourth Insight Ltd, an engineering consultancy. As well as being a Senior Member of the IEEE, Rod is a Fellow of the UK's Royal Academy of Engineering, the Institution of Engineering and Technology (IET) and the Institution of Railway Signal Engineers. He was appointed an Advisory Professor at Beijing Jioatong University in 2016 where he is a member of their International Advisory Board.

George White, P.E.

George White is an owner of a Forensic Engineering firm that investigates fires and explosions for attorneys and insurance companies. Some of those investigations develop into Product defect cases,

construction defect cases, or personal injury/wrongful death cases. He also investigates Commercial & Industrial equipment failures for Boiler & Machinery/Machinery Breakdown insurance carriers.

He has presented over 200 technical presentations at a variety of engineering, Facility Management, Equipment Rental, legal, and insurance groups over 28 years.

George's experience in failure analysis was developed over the years in a variety of roles in the following businesses: Mechanical Contracting, HVAC Controls, Operations and Maintenance/Facility Management, and Industrial equipment rental.

George earned his bachelor's degree in electrical Engineering from Vanderbilt University. He is licensed in California as both an Electrical Engineer and as a Mechanical Engineer.

Dr.S.Vijayakumar

Dr.S.Vijayakumar has post graduated in the field of M.Tech. - VLSI Design from VIT University, India in the year 2010. He has completed his research (Ph.D) at Anna University India. He is an active member in IEEE since 2014. He is volunteering in the activities of IEEE PSES Madras Chapter and coordinated in various events of the PSES Society as Treasurer in the year 2015-2016. Now he is the Secretary of the Society and elevated as Senior Member (2017). He is glad about the PSE Society's achievement as the Chapter of the year award - 2016 in which he is also a part to enhance the activities. He is the member of other Professional Societies like IEICE, ISTE, IAENG, IRED etc.., He has associated with many reputed International Journals as reviewer to evaluate the articles such as IEEE Transaction on VLSI, Tailor & Francis – Int. Journal of Electronics, Springer – Circuits, Systems and Signal Processing, IET – Electronics Letters, Tailor & Francis – Auto-Soft Journal.

Dr.S.Vijayakumar has extended his support to academic by playing key role as Conference Session Chair/Technical Program Committee member and Jury for numerous technical conferences, symposium and workshops like NCS'2016-Beijing China, ICC-2016-Wuhan China, CEIS-2017 – Xiamen China, AICE-2017- Suzhou China, Seven International Conferences from 2011 to current year by ICSIE – India. He has also chaired, Juried the Conferences and Symposiums such as ICCET, IIASE, PDCON, ICRAETPS which are held during this year (2017) in India. Many events are supported by PSES also. He has given invited and guest lectures on trending topics like VLSI Design (TEQIP Sponsored), Arduino Etimology, Outcome Based Education. He, as an academia, coordinated the Symposiums, Seminars, FDP and Workshops at the places he employed. He is involving himself to motivate the budding Engineers over 13 Years as an Academia and 5 Years in Industries. He is a recipient of VLSI Fellowship award given by IEEE and VLSI Society of India to attend the International Conferences twice during 2011 (IIT Madras, India) and 2014 (IIT Bombay, India). Dr.S.Vijayakumar has received best paper awards in the conferences held by IETE – Amity University, India during 2013 and ICSIE, Chennai - India during 2014. He has published his research articles over 9 International & reputed impact factor Journals and 14 articles in Conference Proceedings. His areas of interest includes: VLSI Design, Micro & Nano-Electronics, Embedded Systems, Nano Technology, RF & Microwave Engineering and Reconfigurable Computing.

Wondering how to take the next step to elevate your status to Senior?

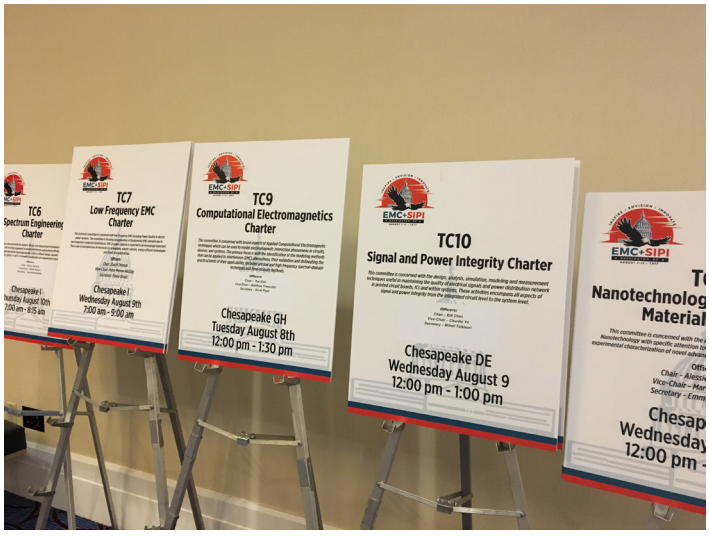
If you want to start the membership elevation process to senior member grade, you will need:
-IEEE member grade level. (Affiliate and associate are not IEEE members and are not eligible for membership elevation to Senior IEEE members)
-10 years working on IEEE designated field AND at least 5 years of significant experience.
-3 references of IEEE senior members. You will need their IEEE numbers. I recommend you have an updated resume at hand, so you can send it to your references so they can write better recommendations.
-Log on to your IEEE account and start the process.

Back to the Past – EMC+SIPI 2017

By Murlin Marks,
Life Senior IEEE, Past President PSES

In August, John Allen and I manned a booth at the EMC+SIPI 2017 conference in Washington, D.C. The EMC Society is a PSES "Sister Society" with which we have overlapping interests. More than that, the PSES evolved from beginnings in the EMCS. From the late 1980's until PSES was formed in 2004, "product safety" was covered in an EMC Technical Committee, TC8.

In the hallway near the technical committee meetings there were posters of each TC, with TC8 missing between TC7 and TC9. Where'd it go? It became us: PSES! When PSES became official in 2004, TC8 was terminated. Richard Georgerian was its last chair. This history shows we are deeply connected with EMCS. Except for Kevin Ravo, all our past presidents were at the EMCS conference in Washington.



In a way, it was like a homecoming for me: seeing so many colleagues who I knew when we had our Product Safety (sic ["Engineering" was added when we became an IEEE society]) Workshop on Fridays at the tail end of the EMC Symposium each year. Our very first conference, in 2004 built on that time slot, starting on the Friday at the end of the EMCS Symposium in Santa Clara, California.

John Allen

John Allen and Frank Sabath_EMCS President

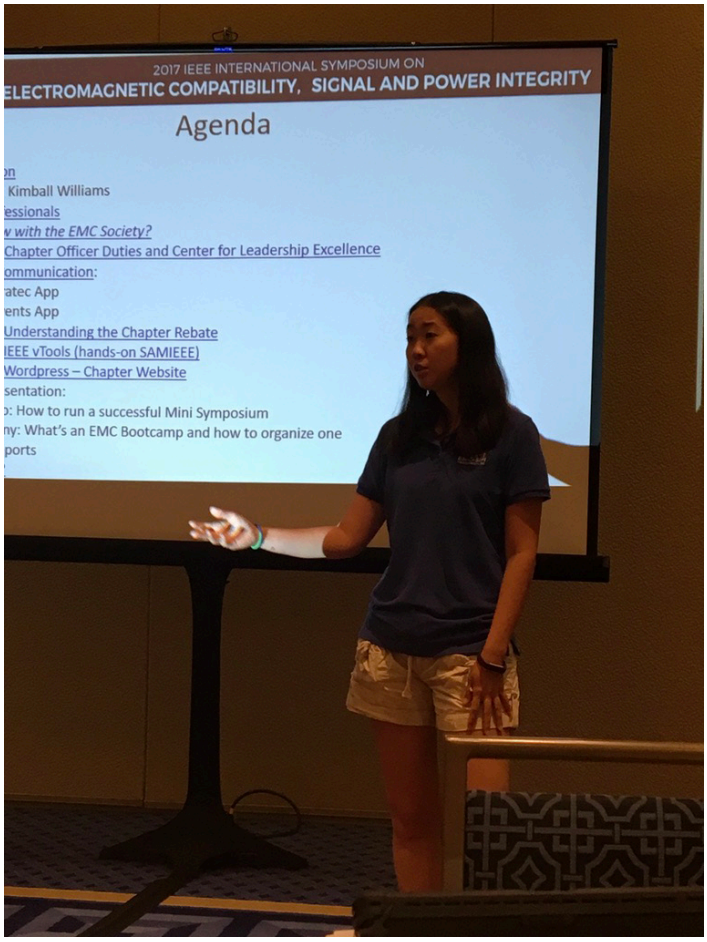
At EMC+SIPI 2017, John and I enjoyed meeting many new EMC folks, as well as the "old-timers". A number of attendees were interested in product safety and regulatory engineering and planned to attend future PSES conferences. Our conference is certainly more applications oriented than the more academically oriented EMC conference. John and I were surprised at the number of people who came by our booth and said how much they had enjoyed ISPCE2017.

Jim Bacher

Murlin Marks

Mark Maynard

John and I attended the "Chapter Chair Training Session and Dinner" on Monday evening that started at 6pm and went on … past 8pm. Caroline Chan is my counterpart as Chapter Coordinator, and Vignesh Rajamani is their VP of Member Services. We were impressed with their programs. Many of their chapters are quite active.



Caroline Chan EMCS CAM

Jerry Ramie and Richard Georgerian_photographers

Grant Schmidbauer (Grant.Schmidbauer@nemko.com) is our contact with the EMCS sister society program. Please let him know your ideas on how our two IEEE societies might work together.

Report on Technical Talk & Workshop

By Dr. V. JAYAPRAKASAN,
Chairman, IEEE PSES (Madras Chapter)

Importance of Multi-rate Signal Processing for Secure Communication

A Technical Seminar "Importance of Multi-rate Signal Processing for Secure Communication" was organized on 9th August 2017 at Adhiparasakthi College of Engineering, GB Nagar, Kalvai - 632 506, Vellore Dt. in association with IEEE Communications Society and IEEE Product Safety Engineering Society, Madras Chapter. Dr. S. Sreenivasa Rao Madane, Principal welcomed the guest and delivered the Presidential address.

Dr. V. Jayaprakasan, Chairman, IEEE PSES (Madras Chapter) presented a session on "Importance of Multi-rate Signal Processing for Secure communication." During his presentation he explained about the wired and wireless communication concepts with the hasty growth of internet, voice and information centric communications. To make the use of the available limited bandwidth and cope with the difficult channel environment, several standards have been projected for a variety of broadband access scheme over different access situation (twisted pairs, coaxial cables, optical fibers, and unchanging or mobile-wireless). In addition he elaborated the advancements of multi-rate signal processing methodologies with interpolation and decimation concepts that are aggravated by the latest design trend. Finally he highlighted the IEEE Membership benefits to the students and motivated the participants to become members of IEEE and Societies of their professional interest.

Mr. G. Elaiyaraja, HOD/ECE delivered the vote of thanks. More than 40 students attended and got benefited through this seminar program.

Importance of Switching and Routing Concepts in Computer Communication using Cisco Packet Tracer

The Department of Electronics and Communication Engineering of Sreenivasa Institute of Technology and Management Studies - Autonomous, Chittoor Organized a Two Days hands-on workshop on "Importance of Switching and Routing Concepts in Computer Communication using Cisco Packet Tracer" on 11th and 12th August 2017 in association with IEEE Product Safety Engineering Society (Madras Chapter).

Dr. P. Ramesh Kumar, Principal, SITAMS presided over the inaugural session and insisted the students to get more exposure of Recent technologies related to Communication and Networking. Prof. R. M. Sulthani, HOD/ECE gave the welcome address and he delivered a brief introduction about the workshop. Dr. V. Jayaprakasan, Chairman, IEEE-PSES (Madras Chapter), in his technical speech, briefed about the OSI Seven Layered Structure and addressed different concepts used in the Network-

ing. In addition he explains different routing protocols used to transfer the data packets from one device to another device. Mr. C. Kumar, Associate Professor/ECE & GTEC: Cisco Netacad Contact, Ganadipathy Tulsi's Jain Engineering College, Vellore during his technical session, he delivers the important role of Cisco Networking Devices in data communication and networking using Cisco Packet Tracer Simulation Tool and different Networking concepts and configurations.

Finally Prof. R. M. Sultani appreciated the participants and distributed the certificates to all the participants. More than 70 students from SITAMS got benefited through this workshop program.

Programmable Logic Controller-PLC

The Department of Electrical & Electronics Engineering of Annai Mira College of Engineering & Technology, Vellore conducted a One day hands-on workshop on "Programmable Logic Controller-PLC" on 21st August 2017 in association with IEEE Product Safety Engineering Society, Madras Chapter and Mira's Electrical Engineers & Technical Association (MEETA).

Thiru. S. Ramadoss, Chairman and Thiru. G. Tamothiran, Secretary led the session with the inaugural function by addressing the students. Dr. T. K. Gopinathan, Principal, presided over the inaugural session and insisted the students to get more exposure of Recent technologies related to Electrical & Electronics Engineering and also the role of PLC in current scenario. Prof. D. Saravanan, Vice Principal & HOD/EEE gave the welcome address and he delivered a brief introduction about the workshop.

Mr. Sarathy (Application Engineer) & Mr. Philip (PLC Programmer), from E-Trainers, Coimbatore, briefed about the importance of PLC in industrial application with different addressing concepts used in the programming and interacted with the students to clear their doubts. In addition they delivered the basic programming using PLC with presentation. Later on the students were given hands-on training with PLC Kit. Finally chairman & Secretary distributed the certificates to all participants. Through this workshop 30 students from AMCET got benefited and finally student representative delivered the vote of thanks to the gathering.

Importance of Multi-rate Signal Processing for Digital Communication

A Workshop on "Importance of Multi-rate Signal Processing for Digital Communication" was organized on 9th September 2017 at Syed Ammal Engineering College, Ramanathapuram in association with IEEE Communications Society and IEEE Product Safety Engineering Society, Madras Chapter. Dr. Chinnadurai Abdullah, Correspondent, SAEC has presided over the function. Dr. P. Marimuthu, Principal has welcomed the gathering. Dr. M. Periyasamy, Vice-Principal has briefed the Technical activities performed by the college during recent time. Felicitation address has been given by Dr. R. Dhanasekaran, Director-Research.

Dr. V. Jayaprakasan, Chairman, IEEE PSES (Madras Chapter) managed the sessions on "Importance of Multi-rate Signal Processing for Digital communication." During his presentation he explained about the fundamental concepts of establishing wired and wireless communication with the fast growth of internet, voice and information centric communications. To make the use of the available limited bandwidth and cope with the difficult channel environment, several standards have been projected for a variety of broadband access scheme over

different access situation (twisted pairs, coaxial cables, optical fibers, and unchanging or mobile-wireless). In addition he elaborated the advancements of multi-rate signal processing methodologies with interpolation and decimation concepts and the different implementation structures of FIR Interpolators and Decimators. Finally he highlighted the IEEE Membership benefits to the students and motivated the participants to become members of IEEE and Societies of their professional interest.

Dr. G. Mahendran, HOD/ECE delivered the vote of thanks. More than 60 students attended and got benefited through this workshop program.

Control System Design for Safety Automation

The Department of Electrical and Electronics Engineering of Sengunthar College of Engineering, Tiruchengode conducted a technical talk on "Control System Design for Safety Automation" at Seminar Hall of Sengunthar College of Engineering on 9th September 2017 in association with IEEE Product Safety Engineering Society (Madras Chapter).

Prof. A. Baladhandapani, M.A., M. Phill., Secretary & Correspondent, Sengunthar Group of Institutions, delivered the special address. Er. A. B. Madhan, M.E., Chief Executive Officer, Sengunthar group of Institutions & Er. Aravind Thirunavukkarasu, M.C.A., M.E., Director-Corporate Relations & Training, both presented memorable felicitation. Dr. R. Satish Kumar, M.E., Ph.D., Principal, Sengunthar College of Engineering, presided over the inaugural session & welcome address.

Dr. I. Thangaraju, M.E., Ph.D., Assistant Professor, Department of Electrical and Electronics Engineering, Government College of Engineering, Bargur conducted the session. He discussed elaborately about the design of closed loop control systems, importance of time response for industrial automation and Controller design using the root-locus method and its usefulness for safety Automation.

Initially Prof. E. Geetha, M.E.,(Ph.D.), HOD/EEE delivered the chief guest introduction. The Coordinator of the program Mr.A.Muthuraj, AP/EEE delivered the vote of thanks. More than 100 students got benefited through this program.

Fire Safety Awareness Program

IEEE Product Safety Engineering Society, Madras Chapter Organized a Fire Safety Awareness Program for School Students in association with Student Branch of Ganadipathy Tulsi's Jain Engineering College and Fire & Rescue Department of Tamil Nadu Government, Vellore on 17th October 2017 at Koona Presidency Matric School, Vellore. This event was sponsored by IEEE – PSES, Madras Chapter.

Mr. P. Vinayagam, Superintendent of Police, Fire & Rescue Department, Vellore District, headed the event. A Team of Firemen Mr. K. Partheeban, Mr. K. Kumar, Mr. C. Arumugm, Mr. J. Thanigaivel and Mr. T. Sathishkumar were leaded this event and provides the suggestion to the school students about how to fire the crackers safely during Diwali festival session. Mr. P. Vinayagam spoke about the fire safety to the students on equipments. GTEC-IEEE PSES Student Chapter Chairman, Ms. S. Prathyusha and her team members were presented on this Occasion. The Event was organized by Dr. A. Manimegalai, IEEE SB Counselor & Mr. C. Kumar, EC Member of IEEE PSES.

Nanotechnology – Etimology, Trends & Safety for Future Generation

The School of Computer Science and Engineering (SCOPE), VIT University, Vellore has conducted a technical talk on "Nanotechnology – Etimology, Trends and Safety for Future Generation" at Smart Class Room, Silver Jubilee Towers (SCOPE) of VIT University on 10th November 2017 in association with IEEE Product Safety Engineering Society, Madras Chapter.

Prof. A. Krishnamoorthy, Coordinator of the event has delivered the welcome address. Dr. T. Arunkumar, Dean – SCOPE has presided over the inaugural session and encouraged the students to involve themselves in the field of Nanotechnology which offers platform for advanced research. Dr. R. Senthilkumar, Head of Software Systems Department felicitated the Chief Guest.

Dr. S. Vijayakumar, Secretary - IEEE PSES (Madras Chapter), the Chief Guest of the technical talk has rendered the brief history of Semiconductors, the evolution of nanotechnology and its applications in variety of core fields like Research, Education, Medical and production to the Students. The audience gained the knowledge on the potential of the nanotechnology, the thrust areas for prototyping new inventions as well as the concern over global safety for future generation.

Dr. V. Vijayarajan, Professor in SCOPE along with the faculty team organized this event. Professor R. Kannadasan has delivered the vote of thanks. Over 50 students got benefited from this event.

Series of Technical Talk on "Codes and Standards Week

The School of Electrical Engineering, Vellore Institute of Technology organized a series of technical talk on "Codes and Standards Week" at Ambedkar Auditorium, VIT, from 4th – 9th Dec 2017 in association with IEEE Product Safety Engineering Society and IEEE Industry Applications Society of Madras Chapter. Dr. Anand A.Samuel, Vice Chancellor, VIT has presided over the function. Prof. P. Arulmozhivarman, Dean/SELECT has welcomed the gathering and motivated and congratulated the School of Electrical Engineering for conducting many technical activities and encourage the students to utilize the facilities offered by the School. Brief points related to Standards and its growing requirements have been shared among the audience by Prof. Palanisamy, HOD, Energy and Power.

On Day-1, Dr. S. Venkatesh, Associate Professor and Dr. S. Umashankar, Associate Professor, & Vice Chair – IEEE Young Professional, Madras Chapter has organized the

event and they gave a Key note talk on “Foundation and Relevance of Standards and Codes for Engineers - an Overview”. They have delivered the Overview of various standards and codes followed in the Electro technical Domain. Over 120 students participated in the event.

On Day-2, Dr. V. Jayaprakasan, Chairman-IEEE PSES, Madras Chapter, India has given a Key note talk on “IEEE Standards related to Wired and Wireless Communication”. He has delivered the key points on various standards and codes followed in the Wired and Wireless Communication.

On Day-3, Mr. B. SatishKumar, SMISA, Domain Specialist, Yokogawa IA Technologies, Bangalore has given a Key note talk on “An overview of ISA Standards and Regulations in Engineering”. He has delivered the key points on various standards and codes followed in the Automation and Control Engineering.

On Day-4, Mr. G. Swaminathan, Manager, Schneider Electric, Bangalore has given a Key note talk on “Grid codes and Standards in Grid integrated PV Systems”. He has delivered the key points on various standards and codes followed in the Solar PV systems integrated to Grid.

On Day-5, Dr. S. Gopal, Executive Director, W. S. Test Systems, Bangalore has given a Key note talk on “Need for understanding high voltage and EMI/EMC Standards”. He has delivered the key points on various standards and codes followed in the Solar PV systems integrated to Grid.

The Risk Assessment Process

Part 2 of 5 in a series addressing the primary milestones to a safe machine

By Chris Soranno,
SICK USA

Introduction

When undertaking machine safety activities, it is always important to have a clearly structured process to be used as a guideline. With such a process in place, it is easier to ensure consistent results that coincide with the EH&S goals of an organization. A well-conceived risk assessment process is the answer to many of the pitfalls that disturb companies implementing safety measures. When the organization is multinational, the importance of a standardized approach is even more apparent.

To confirm that appropriate risk reduction measures have been taken, one must first assess the inherent risk(s) associated with a machine or process. "Risk Assessment," as it is aptly named, is the methodology of analyzing and evaluating the risks. When combined with a risk reduction process to eliminate, reduce, or otherwise address the risks, an organization can demonstrate that appropriate measures have been taken to suitably reduce the risk, while also ensuring that the measures applied are not grossly over dimensioned for the level of the associated hazards.

What is Risk Assessment?

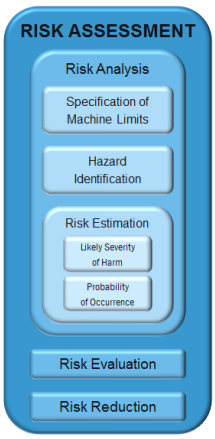


Figure 1: Components of Risk Assessment

As mentioned earlier, risk analysis and risk evaluation comprise the basics of risk assessment, while the addition of risk reduction measures ensure that the desired goal of safe machinery is achieved. To truly understand the nature of this methodology, however, it is important to further comprehend the details of these individual components.

In order to analyze risk, three elements must be combined and considered; the specification of the limits of the machine, identification of hazards, and risk estimation. Together, these attributes are considered to define a level of risk, which is then evaluated to determine whether the risk reduction objectives have been achieved, also known as achieving tolerable (or acceptable) risk.

Why Perform Risk Assessment?

As discussed in Part 1 of this series (Selecting Safety Standards for Machine Safeguarding Requirements), both the obligations as well as the market expectations regarding who is ultimately responsible for safety differ in various regions of the world. Regardless of the motivating factors to implement risk reduction measures, the common denominator is that the risk assessment methodology provides a consistent approach with a proven track record.

Although risk assessment is not a legal requirement of the Occupation Safety & Health Administration (OSHA) in the United States, the Administration places the legal burden for safety on the employer.

The General Duty Clause of the Occupation Safety and Health (OSH) Act of 1970 states in Section 5(a)(1):

> Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.

OSHA and other North American regulatory agencies do not dictate that a particular process is used to meet this legal obligation, but rather that the specific goals are

achieved. When an inspection or investigation occurs, organizations that have performed and documented a risk assessment are able to explain the actions taken, defend the timeline developed, and justify the protective measures applied. Without such a process in place, the results are subject to further scrutiny of the agency.

Additionally, a growing number of consensus standards require that a risk assessment be performed in order to assure compliance with the best practices available at the time of publication. While most of these standards are technically voluntary, the market expectation for safe equipment leads progressive organizations to apply these methodologies as if they are mandatory.

Technical Guidance from Standards

Furthermore, standards provide an abundant amount of information pertaining to the risk assessment process. As discussed below, many standards provide detailed outlines of the process, and in some cases, also provide clear models which can be applied. In other cases, standards dictate that design and application decisions be based on the results of a thorough risk assessment.

As the Part 1 of this series examined, many standards developing organizations use a three tiered structure of standards, often delineated as type-A, -B, and -C standards. To ensure the most thorough approach to risk identification and mitigation, it is imperative that both horizontal and vertical standards are used together to achieve the safest equipment and workplace attainable. As represented in Figure 2, type-A standards provide a general overview of hazard identification, while type-C standards probe deeper into the details as they apply to a specific industry or machine group. By applying this approach, the general requirements applicable to all machines will be addressed by the type-A standards while additional scenarios that may be specific to a subset of equipment will most likely be dealt with by the type-C standards, when available.

Figure 2: Coordinated Application of Standards

Elements of Risk

To better understand the risk estimation process, it is important to first explore the concept of risk. As defined by most authorities, risk is the combination of the severity of harm that can result from the considered hazard and the probability of occurrence of that harm.

Severity

Severity addresses the degree of injury or illness that could occur (such as slight, serious, or death), as well as the extent of harm (such as how many people could be affected).

Probability

Probability of occurrence is estimated taking into account the frequency, duration and extent of exposure; speed of occurrence; human errors; training and awareness; and the characteristics of the hazard. Occurrence probability of an incident is often further divided into three influencing factors of exposure of people to the hazard, occurrence of a hazardous event, and possibility of avoiding or limiting harm (either technical or human).

When evaluating **exposure** of a person to the hazard, some of the factors to be considered include:

- Need for access to the hazard (e.g., during normal operation, maintenance / repair, correction of malfunction, cleaning, etc.)
- Nature of access (e.g., manual feeding of material, clearing jams, etc.)
- Time spent in the hazard zone
- Number of people requiring access
- Frequency of access (typically measured over a single work shift)

Another influential element of probability is **occurrence** of a hazardous event. The occurrence of a hazardous event may result from either a technical or human origin, and factors to study include:

- Reliability / other statistical data
- Accident history
- History of damage to health
- Comparison of risks (either on identical or similar equipment)

The last meaningful component of probability to consider is **possibility** of avoiding or limiting harm, and factors to be taken into account include:

• Different people who can be exposed to the hazard (e.g., skilled versus unskilled)

-NOTE: Specialized training alone cannot be used as a means of reducing the probability if it cannot be assured that all exposed individuals will have an equivalent level of training or knowledge.

• How quickly the hazardous situation could lead to harm

• Awareness of risk, if any (e.g., identified in the user manual / information for use, awareness means, etc.)

• Human ability to avoid or limit harm (e.g., reflex, agility, possibility to escape, etc.)

• Practical experience and knowledge, if any, of the machinery or similar machinery

Considerations when Assessing Risk

When performing a risk assessment, there are a number of details that cannot be overlooked.

Concurrent Factors

As represented in Figure 3, both elements (severity and probability) are required concurrently for risk to be present. A potentially fatal hazard that no one is ever exposed to represents no risk, just as a common event with no severity of harm is not considered a risk.

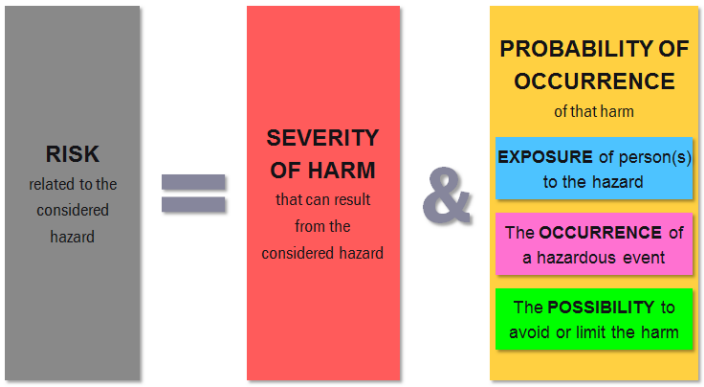


Figure 3: Elements of Risk

Design Effects on Severity

Other factors may affect the elements of risk above and must also be considered. For instance, the location of a hazard may drastically change the associated risk. Consider the hazard of a slip / trip / fall on a walkway as an example. If we can assume that the probability of such an occurrence is the same for a given task, we must acknowledge that the potential severity is much different if the walkway is at floor level as opposed to one that is elevated. Furthermore, the higher the elevation of the walkway, the more likely it is that the associated severity of harm will increase as well.

Conflicting Opinions

When estimating both severity and probability, the highest credible level shall be selected. If disagreement arises amongst the team performing the evaluation, a more conservative approach will ensure that sufficient attention and measures are applied to effectively reduce risk of harm.

Assume No Protective Measures Present

A key consideration that must also be factored in when performing a risk assessment is that hazards must be identified regardless of the existence of risk reduction measures. No machine should be considered risk free as shipped and guarded. To assure that all potential risks are addressed, hazard identification, as well as the subsequent risk estimation, should be conducted with all risk reduction measures (safeguards) conceptually removed. This will help assure that hazards are not ignored due to an assumption that a supplied safeguard is adequate for all tasks, including reasonably foreseeable misuse. During the validation and verification portion of the process, the performance of existing protective measures will be evaluated. If it is confirmed that these measures help meet the risk reduction goals, they can be retained as part of the final risk reduction solution.

Simply put, identifying the inherent level of risk for each hazard will ensure that the appropriate minimum requirements are established for the associated protective measures. With these requirements in place, existing risk reduction measures, if any are present, can be evaluated to determine their efficacy. If existing measures meet or exceed the minimum established requirements, the documented risk assessment will justify their presence; if they do not, replacement or supplemental measures are warranted.

Stakeholder Involvement

When evaluating equipment, it is also imperative that the relevant stakeholders are provided with early and ample opportunity for involvement. All too often have protective measures been implemented without buy-in from the individuals who actually have to live and work with the system, such as operators and maintenance

personnel. In many of these cases, exclusion of stakeholder feedback results in further modifications to the solution – with increases to both budget and time as common consequences. In other instances, these modifications may render the protective measures ineffective. When safeguards are modified – or even bypassed entirely – without proper due diligence through a verification and validation process, remaining components of the risk reduction strategy can create a perception of safety. An inaccurate perception of safety could increase the associated risk on a machine because individuals may assume that certain hazards are already eliminated or controlled. Without protective measures in place, an individual may be more likely to proceed with caution. Part 5 of this series will further address the concerns of perceived safety and the importance of the verification and validation process.

It is sometimes assumed that people without a safety background cannot add value to the risk reduction process. However, time and time again it has been proven that those who are most intimate with the process often have the most effective solutions to achieving the necessary level of risk reduction, while still providing means for required tasks to be performed.

TYPES OF RISK ASSESSMENT

Task-Based Risk Assessment

Generally speaking, there are two basic types of risk assessment. The first, known as task-based risk assessment, identifies task / hazard pairs based on expected and foreseeable interactions with the equipment. When applying this approach, it is common to begin by listing all affected personnel, defined as any role of individuals who may come in contact or proximity with the equipment under review. This list includes the usual suspects – such as operators, maintenance personnel, skilled tradesmen, and supervisors – as well as other less common groups – like administrative personnel, salespeople, and other visitors.

With a comprehensive list of exposed people in hand, the next step is to identify each task associated with each classification of person. In this usage, the word 'task' means any possible hazardous situation, whether it be from an expected job function of the person while completing their normal job duties or a foreseeable interaction which may result from readily predictable human behavior. When performing a risk assessment, it is important to identify which part(s) of the machine lifecycle are to be considered, as this will also affect the types of tasks which will be identified. Since each role may be associated with multiple tasks, the list will expand according to each pairing.

After all tasks have been identified for the equipment, all reasonably foreseeable potential hazards associated with each task are then identified. Various standards and documents are available to assist with the identification of hazards, but the common categories of hazards are those originating from the following sources, or any combination thereof:

- Mechanical
- Electrical
- Thermal
- Noise
- Vibration
- Radiation
- Materials / substances
- Ergonomics
- Environmental

Hazard-Based Risk Assessment

In a hazard-based risk assessment, the approach is to identify all potential sources of harm, regardless of whether or not they are directly associated with a foreseeable task related to specific affected personnel. Using any available C-type standards, information from similar machines, as well as the list above, a comprehensive inventory of all hazards must be compiled.

Comprehensive Risk Assessment

While a hazard-based approach may appear to save time by eliminating repetition of identical task / hazard pairs, a task-based approach provides a more systematic methodology to ensure that all foreseeable tasks are considered. Alternatively, a hazard based approach will ensure that hazards not related to tasks area also identified, such as hazardous environments, noise, and radiation. In order to provide the most comprehensive assessment of risk, it is recommended that a combination of these methodologies by applied.

ACCEPTABLE LEVEL OF RESIDUAL RISK

The risk remaining after risk reduction measures are taken is referred to as residual risk. As we will see, the residual risk is not evaluated to determine if it is accept-

able for a given hazardous situation until after protective measures have been implemented. Experience shows, however, that before the residual risk can be reviewed to determine if it is acceptable, the organization must first define what level of remaining risk is deemed acceptable or tolerable.

This concept, known as acceptable risk (or tolerable risk), is a somewhat subjective matter. Addressing this important discussion as early in the process as possible will greatly assist the team later in the process, so that a higher level of objectivity can be applied. If this discussion is postponed until after risk reduction measures have been applied, the subjectivity can be biased by the specific application or prejudices of the team.

Zero Risk

Before the discussion of tolerable risk can occur, it is important to first discuss the concept of 'zero risk.' While most EH&S professionals will always strive for 'zero risk,' it must be recognized that this concept does not exist in the real world. However, based on a good faith approach to risk reduction through the process of risk assessment, an organization can approach zero risk by achieving acceptable (or tolerable) risk.

This is not to say that the hypothetical concept of zero risk should be discarded. Instead, it must be balanced with the practicalities of reality. Based on the law of diminishing return, we know that beyond a certain point, there are progressively smaller benefits in output based on the increased application of a variable input to a fixed quantity. When this theorem is applied to safety in an industrial setting as represented in Figure 4, we realize that no organization is financially capable of achieving zero risk for every potential hazard present in the workplace. To achieve the correct balance, however, monetary cost alone should never be a justification for limiting risk reduction activities.

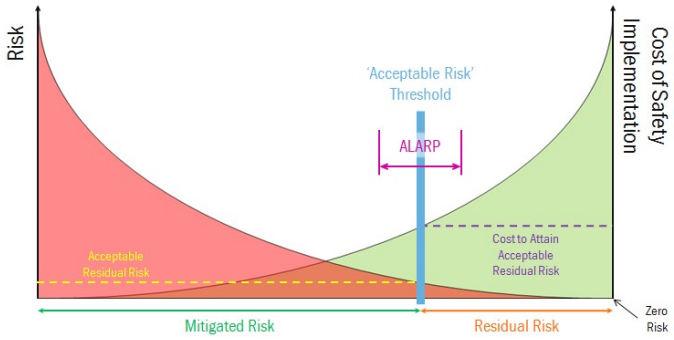


Figure 4: Law of Diminishing Returns Applied to Industrial Safety

Acceptable (Tolerable) Risk

Once the myth of zero risk is understood and accepted, the representatives of each organization must try to impartially define what level of residual risk is acceptable. This definition will help achieve a balanced level of safety, either within an individual facility or across many locations.

When characterizing acceptable risk, it is inevitable that the concept of As Low As Reasonably Practicable will arise. This principle, also known as ALARP, is a common best practice to judge the balance of risk and societal benefit. A component of this idea states that it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained, as discussed above in Figure 4. The ALARP concept arises from the fact that infinite time, effort, and money could be spent attempting to reduce the associated risk to zero. The fundamental factors to be considered include:

- Health and safety guidelines
- Specifications
- Applicable laws, directives, regulations, and standards
- Suggestions from advisory bodies (best practices)
- Comparison with similar hazardous events in similar industries

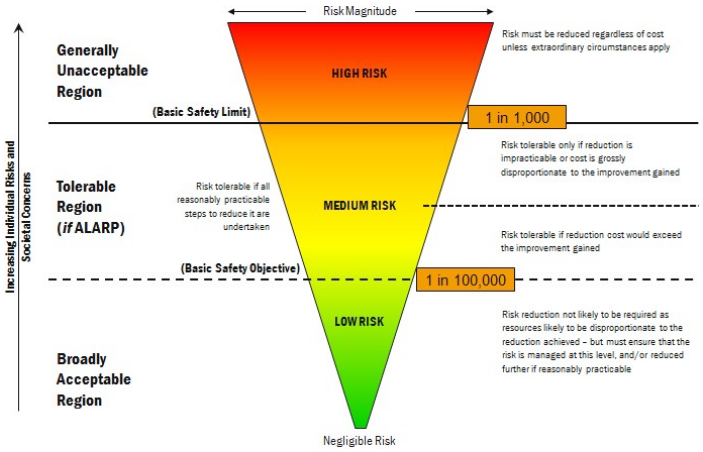


Figure 5: Basics of ALARP Principle

PREPARATION

Team Approach

When performing a risk assessment, it is important to utilize a diverse team of individuals. As with most other reviews, multiple sets of eyes are beneficial to ensure nothing is overlooked. Utilizing a multidisciplinary team of qualified individuals, each member can provide al-

ternate viewpoints based on their own experiences and perception of risk. Furthermore, collaboration amongst the team through a consensus process will foster appropriate discussion and resolution of any concerns that arise. Roles to consider when forming the team include:

- Operators
- Maintenance personnel
- Safety manager
- Engineers
- Forman / supervisors
- Production personnel
- Material handlers
- Quality control personnel
- Equipment manufacturer / supplier / integrator representatives
- Qualified safety specialists

Collect Relevant Information

To aid the team in an effective assessment of risk, it is advantageous to gather information relevant to the application. As previously mentioned, any available risk data–from previous risk assessments on the same or similar equipment, accident or incident history, and knowledge about damage to health–will provide guidance to the team. Furthermore, details regarding the intended use (as well as foreseeable misuse) of the equipment are important factors, such as materials to be used, limits of the equipment, and requirements related to the lifecycle phases to be considered.

Design considerations must also be included, as these may affect the risk as discussed earlier. Any information establishing the nature of the equipment (drawings, sketches, system descriptions, etc.), the layout and proposed system integration within the facility or a larger process, as well as energy sources will assist with the accurate assessment of potential risk.

Lastly, the human factor must also be acknowledged. An accurate list of all potentially affected personnel, as well as their respective level of training and experience, will aid the assessment process.

RISK ESTIMATION

Risk Scoring Systems

Another essential element of assessing risk is a risk scoring system. There are numerous models available on the market; some from international or domestic standards, others from commercially available software models or consultants, and countless others based on an amalgamation of those above. While there is no one 'right' model to use, it is important that a company try to standardize on a single model to be used throughout the organization. By normalizing the model used, the upper tiers of the organization will be able to better compare status of multiple locations on an apples-to-apples basis, while knowledge sharing and collaboration will be better facilitated at the plant level.

There are a number of factors to consider before selecting a unified model. First, an organization should consider the level of expertise already existing within the ranks of their EH&S department. Rather than invest in developing their own methodology–especially when considering the possible consequences associated with incorrect implementation, most companies without a high level of inherent proficiency either tend to outsource their risk assessment process or rely on existing models.

If selecting a prevalent model already available, one should also consider the stability of the model (has it been accepted by the market and stood the test of time?) as well as the process by which the model was developed (is the model from an industry standard based on the consent of all participants, or merely the opinion of a few individuals?). Additional aspects to take into account include choosing a model which:

- The team is comfortable with
- Best suits the EH&S objectives of the organization
- Can be easily and consistently applied to various types of equipment (repeatable)
- Has clear and discernable definitions for each risk factor and level per risk factor
- Best prioritizes actionable risk reduction measures
- Provides outputs understandable and actionable

As identified previously, there is an abundant list of resources which provide guidelines to performing risk assessment. Table 1 below identifies just some of the common consensus standards which provide guidance, direction, and in some cases scoring systems which can be used when performing risk assessment. As represented by this list, some of the standards solely address risk assessment–sometimes in reference to specific industries or machine types–while other standards include the premise to address other safety topics, such as occupational health and safety management systems, prevention through design, and functional safety of control systems.

STANDARD	YEAR AFFIRMED (REAFFIRMED)	TITLE	SCOPE	SCORING SYSTEM(S) PRESENTED
ANSI B11.0	2010	Safety of Machinery – General Requirements and Risk Assessment	Power driven machines, not portable by hand, used to shape and/or form metal or other materials by cutting, impact, pressure, electrical or other processing techniques, or a combination of these processes.	☑
ANSI B11.TR3	2000	ANSI Technical Report for Machine Tools – Risk assessment and risk reduction – A guide to estimate, evaluate and reduce risks associated with machine tools	Provides the procedures and methods to assess the risks associated with the design, construction, care and use of machine tools as included in the B11 series of machine tool safety standards. It serves as a guideline for suppliers and users of machine tools, providing a framework and procedure to identify tasks and hazards, and to estimate, evaluate, reduce and document the risks associated with these hazards under the various conditions of use of that machine or system.	☑
ISO 12100 [1)]	2010	Safety of machinery – General principles for design – Risk assessment and risk reduction	Machines assembled, fitted with or intended to be fitted with a drive system consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application. This also covers an assembly of machines which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole.	☐
ANSI / PMMI B155.1	2011	Safety Requirements for Packaging Machinery and Packaging Related Machinery	Packaging, processing and packaging-related converting machinery.	☐
ANSI / RIA R15.06 [2)]	1999 (R2009)	American National Standard for Industrial Robots and Robot Systems – Safety Requirements	Automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications.	☑
ANSI / AIHA / ASSE Z10	2013	American National Standard for Occupational Health & Safety Management Systems	Policy, organization, planning & implementation, evaluation, and action for improvement of employee health and safety.	☑
ANSI / ASSE Z590.3	2011	Prevention through Design: Guidelines for Addressing Occupational Hazards & Risks in Design & Redesign Processes	Design / redesign of work premises, tools, equipment, machinery, substances and work processes.	☑
AWS D16.3M / D16.3	2009	Risk Assessment Guide for Robotic Arc Welding	Arc welding robot systems.	☐
SEMI S10 [3)]	2007	Safety Guideline for Risk Assessment and Risk Evaluation Process	Micro- and nano-electronics industries, including: • semiconductors; • photovoltaics (PV); • high-brightness LED; • flat panel display (FPD); • micro-electromechanical systems (MEMS); • printed and flexible electronics; • related micro- and nano-electronics.	☐
MIL-STD-882E	2012	Department of Defense Standard Practice – System Safety	Identifies the Department of Defense (DoD) Systems Engineering (SE) approach to eliminating hazards, where possible, and minimizing risks where those hazards cannot be eliminated. This Standard covers hazards as they apply to systems / products / equipment / infrastructure (including both hardware and software) throughout design, development, test, production, use, and disposal.	☑
CSA Z432	2004	Safeguarding of machinery	Applies to the protection of persons from the hazards arising from the use of mobile or stationary machinery.	☑

STANDARD	YEAR AFFIRMED (REAFFIRMED)	TITLE	SCOPE	SCORING SYSTEM(S) PRESENTED
CSA Z1002	2012	Occupational health and safety – Hazard identification and elimination and risk assessment and control	Specifies requirements for the identification of OHS hazards, their elimination where practical, and assessment and control of risks associated with remaining hazards. This Standard is applicable to organizations of any size or type and can be applied at all stages in the lifecycle of a product, process, or service.	☑
ISO / TR 14121-2	2012	Safety of machinery – Risk Assessment – Part 2: Practical guidance and examples of methods	This Technical Report gives practical guidance on conducting risk assessment for machinery in accordance with ISO 12100 and describes various methods and tools for each step in the process. It gives examples of different measures that can be used to reduce risk and is intended to be used for risk assessment on a wide variety of machinery in terms of complexity and potential for harm. Its intended users are those involved in the design, installation or modification of machinery (for example, designers, technicians or safety specialists).	☑
EN 954-1 [4) 5)]	1996	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	Provides safety requirements and guidance on the principles for the design and integration of safety- related parts of control systems (SRP/CS), including the design of software. For these parts of SRP/CS, it specifies characteristics that include the performance level required for carrying out safety functions. It applies to SRP/CS, regardless of the type of technology and energy used (electrical, hydraulic, pneumatic, mechanical, etc.), for all kinds of machinery.	☑
ISO 13849-1 [5)]	2006	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design	Provides safety requirements and guidance on the principles for the design and integration of safety- related parts of control systems (SRP/CS), including the design of software. For these parts of SRP/CS, it specifies characteristics that include the performance level required for carrying out safety functions. It applies to SRP/CS, regardless of the type of technology and energy used (electrical, hydraulic, pneumatic, mechanical, etc.), for all kinds of machinery.	☑
IEC 62061 [5)]	2005	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems	Specifies requirements and makes recommendations for the design, integration and validation of safety- related electrical, electronic and programmable electronic control systems (SRECS) for machines. It is applicable to control systems used, either singly or in combination, to carry out safety-related control functions on machines that are not portable by hand while working, including a group of machines working together in a coordinated manner.	☑

NOTES

1)	ISO 12100-2010 was a consolidation without technical change to ISO 12100-1:2003, ISO 12100-2:2003, and ISO 14121-1:2007. ISO 12100:2010 was also adopted as an American National Standard, ANSI/ISO 12100:2012.
2)	This standard is intended to be formally withdrawn at the end of 2014. The new revision of this standard, ANSI/RIA R15.06-2012, does not include guidance or a model for risk assessment.
3)	SEMI is not an ANSI accredited Standards Developing Organization (SDO).
4)	EN 954-1 was subsequently elevated to ISO 13849-1 in 1999. In turn, ISO 13849-1 was revised in 2006, effectively replacing both EN 954-1 and the 1999 ISO revision as of 1 January 2012.
5)	While these standards are specific to functional safety requirements for control systems, the performance requirements established are based on the concepts of risk assessment using the risk factors from Figure 3.

Information listed is believed to be accurate at time of publication; subject to change at any time. Check with appropriate SDO for additional information regarding scope and content of standards listed.

Table 1: Examples of Standards Addressing Risk Assessment Methodology

Defined Limits of a Risk Scoring System

An effective risk scoring system will include well-defined criteria for evaluating the severity and probability factors which comprise risk. Without clear limits defined for the different levels of each factor, the team will often get diverted into discussions of what is 'serious' versus 'severe,' or 'likely' as opposed to 'unlikely.' Therefore, clearly defining the criteria for each level will facilitate more efficient use of time during the process.

Additionally, a successful risk scoring system will also include distinct minimum performance requirements for the risk reduction measures associated with each level of identified risk. Sometimes referred to as the 'bridge' between the risk assessment and risk reduction elements of the process, this fundamental component is what drives the upcoming step of risk evaluation.

Assess Initial Risk

Once the foreseeable hazards have been identified and a risk scoring system has been selected, the process requires estimation of the inherent risk level of the equipment – assuming no protective measures are in place – to determine the initial risk level of the system. The **initial risk level** (sometimes also referred to as 'Risk In') creates a baseline for the system. Based on the 'bridge' discussed above, the initial risk level establishes the minimum performance criteria for effective risk reduction measures.

Risk Evaluation

The risk evaluation process is a judgment to determine if the risk reduction objectives have been achieved based on the results of the risk analysis. This process begins with a comparison of any existing protective measures to the minimum performance defined by the risk scoring system to determine if the expectations have been achieved, if not exceeded.

As mentioned earlier, existing measures for risk reduction which are already in place on the equipment during the preliminary risk assessment are to be ignored when identifying the initial risk level. During the risk evaluation, however, the efficacy of these elements can be measured to determine if the defined goals have been met. When this happens, the risk assessment process can be used as justification that further safeguarding measures are not required.

In the event that the minimum requirements have not be met, risk reduction measures must be applied to either replace or supplement any measures already present, or fill gaps not previously addressed. Following the application of protective measures in accordance with the risk reduction process (briefly discussed below), the resulting risk must again be evaluated using the process described here. This resulting risk, known as the residual risk level, must be sufficiently lowered to a tolerable level. Multiple cycles of this process may be required before acceptable risk is achieved, but experience and expertise with risk reduction options will help streamline this part of the overall process. As addressed earlier, clearly defining tolerable levels of risk before the need arises will ensure that reasonable objectivity is applied at this stage of the process.

Risk Reduction

Risk reduction is the part of the risk assessment process involving the elimination of hazards or selection of other appropriate risk reduction measures (protective measures) to reduce the associated risk by addressing either or both the probability of harm or its severity. Risk reduction measures, also known as protective measures or safeguards, are any action or means intended to achieve risk reduction. Conventional risk reduction measures include the following:

- Inherently safe design through elimination or substitution (e.g., automating the process to limit exposure)
- Guards
- Safeguarding devices (e.g., presence sensing devices, interlocks, two-hand controls, etc.)
- Complementary equipment
- Awareness devices including warnings
- Safe work practices / procedures
- Training or other administrative controls
- Personal protective equipment (PPE)

These measures can be implemented by the designer (supplier or integrator), typically through inherently safe design, safeguarding and complementary protective measures, and information for use, as well as by the user (employer), often with additional safeguards, safe work procedures, training, supervision, administrative controls and personal protective equipment.

The selection of risk reduction measures is best implemented by means of a hierarchy of controls, which is based on the effectiveness of protective measures. An iterative process of applying the hierarchy, combined with

repetitive risk evaluation, will ensure that an acceptable level of residual risk is achieved. Further discussion of the hierarchy of controls will be discussed in the next white paper in this series.

Documentation

In addition to the regulatory requirements for documentation, organizations should also consider the expectations of the consumers and the local market. In a global marketplace, concise documentation of the process and results provides many benefits, such as establishing baseline expectation for tolerable risk, standardized methods for risk reduction, and overall efficiency by building on past experiences. For end users, documentation of the risk assessment process is a tremendous aid to explain and substantiate the process applied, including the timeline implemented and the investments made toward reducing risk. For suppliers, documentation can be used as a competitive advantage in the market place where safety continues to garner increasing attention.

Various standards and guidelines outline the minimum expectations of what should be included in documentation, but it is important to note that purchase agreements between organizations may dictate additional requirements. At a minimum, one should consider including the following in the documentation of the risk assessment:

- Information of the machinery addressed by the assessment, including specifications, limits, and intended use
- Any relevant assumptions which have been made (e.g., loads, strengths, safety factors applied during the design)
- Information used as a basis for the risk assessment
- Names of the risk assessment team
- Date(s) of the risk assessment
- All identified hazards and associated tasks, if relevant
- Initial risk levels associated with the machinery (based on the assumption that no protective measures are present)
- Risk reduction measures implemented to eliminate identified hazards or to reduce risk (e.g., from standards or other specifications)
- Residual risk levels associated with the hazards
- Validation of the risk reduction measures, including the responsible individual(s) and the date of validation
- Supplier documentation should also include recommendations for additional risk reduction measures (to be implemented by the user, system integrator or other entity involved in machine utilization)

The documentation of the risk assessment process will best serve its intended purposes when retained for the life of equipment, and include any subsequent modifications which may require repeating the process.

Change Management

Contrary to what some may think, risk assessment is a living process with no definitive end until the equipment lifecycle has concluded. At a minimum, best practice suggests that the risk assessment cycle should be a continually ongoing event, and should take place at least annually to ensure minor modifications to the equipment or process have not inadvertently increased the residual risk associated with the equipment. Even without modifications, age (including wear and tear) can have a detrimental effect on the risk reduction system. As an example, the stopping performance of a machine will inevitably increase over time; beyond a certain point, this increase will render certain safeguards (such as presence sensing devices or two-hand controls) ineffective. In addition, other events within the lifecycle of a machine should also automatically trigger a new risk assessment, including when the following activities occur:

- Existing equipment is automated
- A new process is created by utilizing previously used components
- An existing machine is repaired / refurbished with comparable components
- An existing machine is reconfigured
- An existing machine is moved to a new facility or a different space in the existing facility but not reconfigured
- Components are added to or removed from the system
- Equipment in an existing system is modified or replaced with new equipment that has new features that are not comparable to the original equipment
- Components in an existing system are modified or replaced with new components that have new features that are not comparable to the original components

Easy and ready access to past risk assessment documentation will further assist with the management of change process.

Conclusion

Although not a legal requirement in all world markets, the risk assessment process is a clearly defined methodology to ensure that acceptable levels of machinery safety are achieved. Even for organizations with limited resources, the benefits of a pragmatic assessment pro-

cess are easily rationalized by ensuring a consistent approach to risk reduction. With clearly defined limits for risk factors, acceptable risk, and minimum performance expectations, a company can ensure that enough protective measures have been applied while also preventing over-dimensioning.

Achieving balance between the ideology of safety, the realities of existing production concerns, and ever-present budget constraints can be intimidating. Rather than trying to short-cut the process and jump right into implementing protective measures, progressive companies realize that a systematic approach to outlining the process and goals is an essential prerequisite to meet EH&S goals and market expectations in a cost effective manner. As with any new process, evaluating internal competencies and supplementing them with external resources when required will help ease the initial discomfort.

This white paper is meant as a guideline only and is accurate as of the time of publication. When implementing any safety measures, we recommend consulting with a safety professional.

For more information about the risk assessment process, contact SICK Safety Application Specialist Chris Soranno at chris.soranno@sick.com, or visit our web site at www.sickusa.com.

TOUCH CURRENT measurement; Showing how it works

Part 3 of 3 Testing protocol and summary

By Peter E Perkins,
IEEE Fellow

The introduction to switching electronics has increased the concern as to the effects of these devices on the electrical infrastructure. There is concern that the switching spikes which are fed back into the supply system are affecting the long-term reliability of the infrastructure; these switching spikes initiate electrical discharge in small voids in insulation and are speeding up the rate of partial discharge which speed up the insulation failure, additionally, the triplen harmonics generated are captured in delta transformer windings and heat the windings which speed up insulation failure. The measurement of TOUCH CURRENT is one important element in measuring these feedback switching events and providing a specified maximum level of feedback from equipment in the earth/ground. Another growing issue relates to electronic protection devices, e.g. GFCIs, don't play well with switching electronic loads and the load won't work in some situations.

The assessment of protection against electric shock includes making a measurement of the accessible residual current available to the user under normal, abnormal and fault conditions. This residual current, TOUCH CURRENT, is limited to a small value protecting harm or damage to the user.

This TOUCH CURRENT measurement limit is specified in product safety standards. Commonly used standards for electronic equipment e.g. IEC/EN/UL 60065 'Audio, Video and Similar Electronic Apparatus - Safety Requirements, IEC/EN/UL 60950 'Information Technology Equipment - Safety Requirements', IEC/EN/UL 61010 'Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use', IEC 62368, 'Audio/Video, Information and Communication Technology Equipment' and IEC 61204-7 'Low-voltage switch mode power supplies – Part 7: Safety requirements'.

All of these product standards draw on the IEC Basic standard IEC 60990, 'Measurement of TOUCH CURRENT and protective conductor current' which describes the measurement circuit details plus the various conditions and details under which the measurement is to be made. The circuit discussion will show how the adjustment has been made for higher frequency current from the traditional electrical body model historically used.

This paper reviews a demonstration showing the setup and conditions for making proper TOUCH CURRENT measurement for some products with emphasis on the proper procedure and interpretation of results; common mistakes in making this measurement will be discussed. The demonstration is augmented by additional examples and explanation.

There is a need to quickly expand peak TOUCH CURRENT measurements to all electronic switching equipment and a maximum limit of 7.1mApk applied in all cases to provide a sound basis for all of these issues.

Testing discussion:

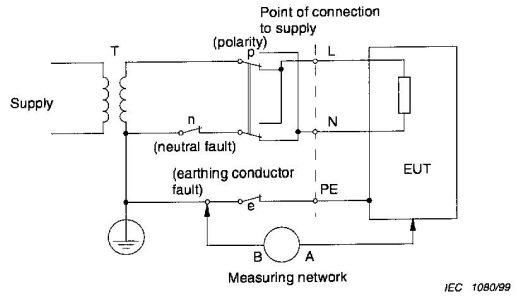


Figure 6 – Test configuration: single-phase equipment on star TN or TT system

Figure 1: IEC 60990 Single phase test configuration reproduced

On the significance of opening the earth/ground, several clarification points to be made are:

(1) The fact that the earth/ground can be missing is not always well recognized; there is ongoing confusion as to whether this is a single FAULT. The earth/ground can be missing because the installation was not correctly wired or the user can inappropriately connect the EUT into an unearthed/ungrounded system for operation. In either case this is considered an ABNORMAL operational state outside the control of the product, not a FAULT condition. The product must be safe even when operated in this unexpected environment. Meeting the TC limit ensures that the product is safe to use under these conditions.

(2) The EUT is still earthed/grounded during the test – only through the meter circuit; this indirect earthing/grounding is required to make the measurement. The value of the current that flows is measured to ensure that anyone touching an unearthed/ungrounded product will not receive an undue electric shock as specified in the product standard.

The fault conditions are introduced after the abnormal is in place.

Testing protocol:

This is a generalized test protocol as found in most product standards.

-Measure voltage, if specified
-Measurement of eBurn then STARTLE-REACTION or LETGO-IMMOBILIZATION TOUCH CURRENT in the earth/ground conductor and from any exposed conductive parts under normal, abnormal and fault conditions.
-Controls switches: PE(earth/ground), l(line), n(neutral), p(polarity), g(phase) to be independently moved to each position. Abnormal conditions to be applied then faults.
-Read maximum value:
- RMS values for eBurn & sinusoidal TOUCH CURRENT
- Peak values for non-sinusoidal TOUCH CURRENT

The expected chassis voltage when the earth/ground is opened is half the line voltage. For universal worldwide use of the product this is about 130V. This means that even when the product safety standard requires the voltage to be measured first, line voltage operated products will still require the TOUCH CURRENT measurement. A simple switchbox implementation is shown in Figure 2; it has been used primarily for 60950 & 61010 testing. It allows for the needed tests to be done easily.

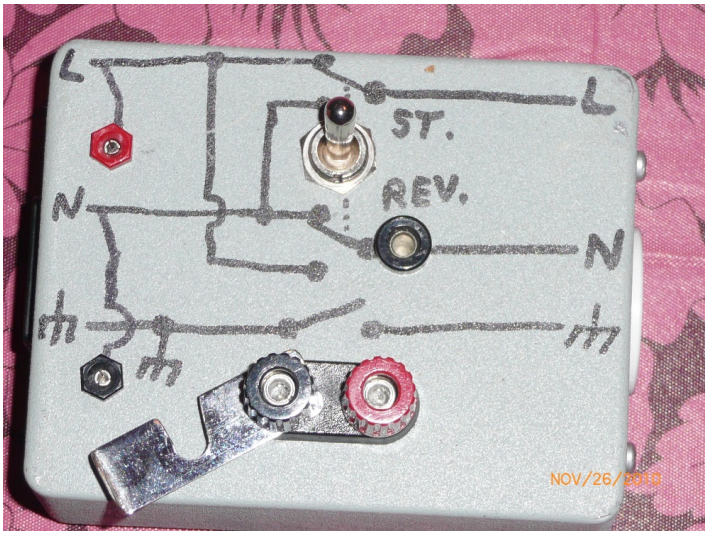


Figure 2: Switchbox implementing the testing changes required

Implication of measured results:

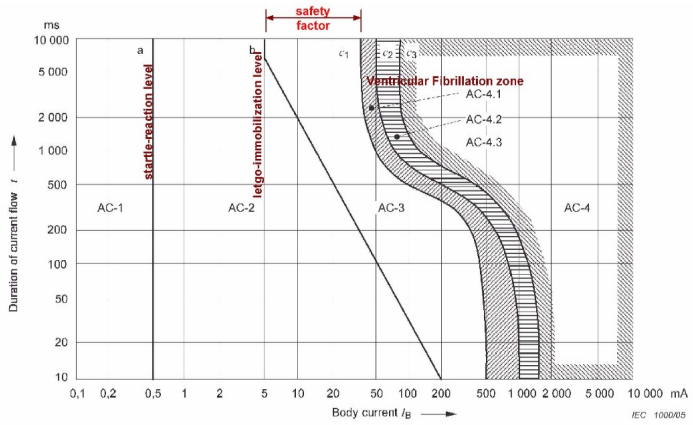


Figure 3: Annotated AC rms body current vs time from IEC 60479-1 showing effects limit lines

Figure 3 shows clearly the safety factor designed into the human body as described by IEC 60479-1 'Effects of current on human beings …' standard. This safety factor description was defined when most bipolar AC waveforms were sinusoidal. The standard also clearly deals with non-sinusoidal waveforms limiting their peak value to sqrt(2) of the rms value.

As we have shown here, with the advent of adequate switching components, the product power supply designs have moved further away from sinusoidal waveforms, the peak values are invading the safety factor space subjecting hundreds of millions of users to risk of VF and subsequent death.

The advent of Switch Mode Power supplies (SMPS) introduced non-sinusoidal TOUCH CURRENT. Early implementations had smaller deviations from sinusoidal and instrument makers developed 'true rms' digital meters to accurately work with these waveforms. Unfortunately, these waveforms introduced harmonics back into the power grid which led to a number of problems the most serious was that triplen harmonics would get caught up on the delta primary of distribution transformers and cause heating, burning up the transformers in severe cases. The cure was to introduce Power Factor Correction (PFC); this cured the power input harmonics issue but developed harmonics in the TOUCH CURRENT waveform. This situation is further acerbated by the introduction of additional switching to achieve energy efficiency, low power/standby, power goals.

TOUCH CURRENT effects are due to the peak value of the waveform, as reported by Dalziel and other early researchers. Sinusoidal measurements were used from the beginning because 1) waveforms seemed to be sinusoidal, and 2) measurement of peak current was difficult with the early test equipment generally available.

The use of peak TOUCH CURRENT measurements returns the control of the effects to actual body response and keeps the TOUCH CURRENT out of the safety margin between LETGO-IMMOBILIZATION and Ventricular Fibrillation (VF).

Any power supply at the LETGO-IMMOBILIZATION rms limit with a high pk/rms ratio TOUCH CURRENT can substantially invade the margin and unnecessarily expose the user to harm.

The source of TOUCH CURRENT in equipment is exacerbated by the needed inclusion of multiple switchers in the power supply each of which affect the measurement. The effect is also due to intentional capacitive filtering (overall EMI filtering plus local filtering) as well as unintentional stray capacitive coupling (components including power cords, transformers, circuit boards as well as surge suppressors) as the source of TOUCH CURRENT.

Here is another typical example from a collection of TOUCH CURRENT measurements:

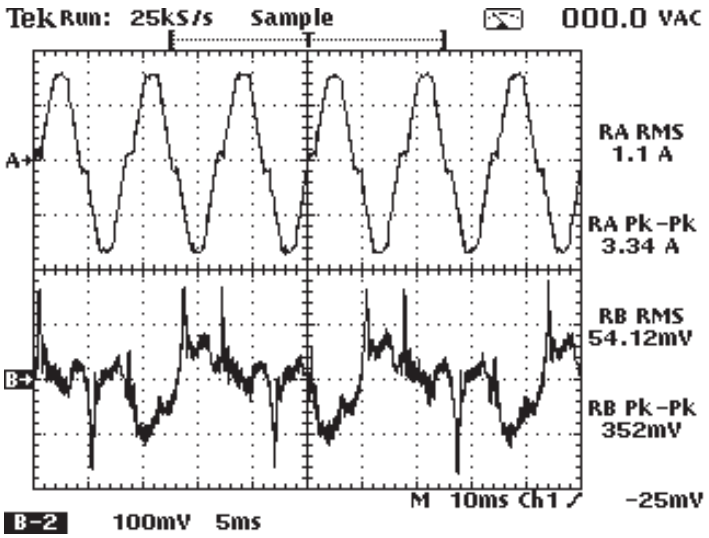


Figure 4: Example of a complex SMPS TOUCH CURRENT - waveform (B)

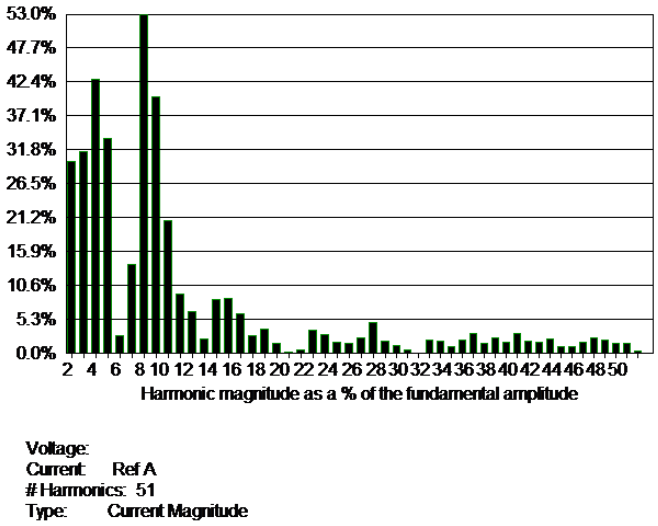


Figure 5: Harmonics (Fourier Transform) of Figure 38 TOUCH CURRENT (B)

Figure 4 is typical of SMPS with active PFC and shows a pk/rms ratio = 3.25 TOUCH CURRENT measured; pk/rms ratios > 4 are known and a pk/rms ratio of 6 or so has been reported in some measurements. This shows harmonics to 3kHz (the limit of the analysis program) but continuing small harmonics are expected at higher levels.

From this Figure 4 example, any 60950/61010 product at the 3.5mArms limit with this type of waveform would show 11.4mApk TOUCH CURRENT. This is 2.8x the 5mApk limit in these standards and well above the 7.1mApk that should be allowed in any case.

This intrusion into the safety margin indicated by the standards discussion is not acceptable for protecting humans. The use of peak TOUCH CURERNT measurements needs to quickly expanded to cover all products using switching electronics and the 7.1mApk limit applied in all cases.

The addition of Energy Efficiency control circuits will exacerbate this situation; examples have been presented already. Designers will be pressed to bring this under control while meeting other design goals.

Unintended consequences continue to arise from switching mains circuits. A developing problem is that these devices don't always play well with electronic protection devices and further study will probably invoke additional requirements on these devices.

Peter E Perkins is convenor of IEC TC108/WG5, which is responsible for IEC 60990, Measurement of touch current and protective conductor current, an IEC Basic Safety Publication applicable to all electrical products and product safety standards. He is an IEEE Fellow, has a BS in Engineering from the University of Portland and MSEE from Oregon State University and is Principal in PE Perkins, PE. He has more than 55 years' experience in the electronics industry, at Tektronix, Inc and now as a consultant to industry, specializing in product safety and regulatory affairs for most of that time. He has been continuously involved in giving technical presentations at PSES/ISPCE from the beginning. He can be reached at p.perkins@ieee.org.

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