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The Product Safety Newsletter

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Chairman's Message

Defending The Line

Congratulations to the Santa Clara Valley Chapter of the EMC Society for another excellent colloquium. The event was well attended and an impressive number of exhibitors were present. It was a good time for exchange of ideas and information. Which brings me to the point of this column. Some of the presentations and hallway conversations raised some interesting questions when juxtaposed upon each other.

1. I spoke with one of the central EMC Society leaders about promoting product safety papers for next years EMC Symposium. Product safety has not had much of a history or presence in the Symposia records over the years. Half a session at this years Symposium in Chicago is devoted to biological effects, a great topic. But the question arises, what technologies do product safety people have to report on? Are we the presenters or the audience listening to experts from other disciplines or sciences presenting safety-related information.

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The Product Safety Newsletter

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PSN Subscriptions,
Dave McChesney
1865 Farndon Avenue
Los Altos, CA 94024
fax: (408) 296 3256

Comments and questions about the newsletter may be addressed to:
The Product Safety Newsletter,
Roger Volgstadt (Loc. 55-53)
c/o Tandem Computers
10300 North Tantau Avenue
Cupertino, CA 95014
Fax No. (408) 285 2553

Editor: Roger Volgstadt
News Editor: David Edmunds
Activities Editor: John Reynolds
Page Layout: Ken Warwick
Subscriptions: Dave McChesney
Institutional Listings: Ervin Gomez
Distribution: John McBain

Officers of the Product Safety Technical Committees

Central

Chairman	Brian Claes	(510) 659 6574
		(510) 659 6852 (fax)
Vice-Chairman	Richard Pescatore	(408) 447 6607
Secretary-Treasurer	John McBain	(408) 746 5016
		(408) 746 5258 (fax)
Standards	Paul McDonald	(415) 592 5111
		(415) 592 6052 (fax)
Symposium	Murlin Marks	(408) 985 2400

Local

Chicago		
Chair	John Allen	(708) 238 0188
		(708) 238 0269 (fax)
Orange County/Southern California		
Chair/Secretary	Charlie Bayhi	(714) 367 0919
Vice-Chair/Treasurer	Ercell Bryant	(714) 589 0700
Program Co-Chair	Michael Dastmalchian	(310) 604 8739
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Letters to the Editor

Dear Editor,
The article "Designing Safety into Products" (Vol 6, Issue 3) was refreshing.

Much of our business is assisting product developers and designers from concept. In every case, except those in which marketing changes direction, the product passes first time through.

I should add, however, designing for safety can lead to over-kill and/or custom components, driving the cost of the product [up] (ie: is a TCO really needed in a heating device or can the heater be designed to open safely before there is a risk of fire or electric shock?).

The ultimate proof is in testing, testing, testing.

Although the up-front cost and time may seem unreasonable to a non-technical executive, designing Approval (and safety) into the product from concept will undoubtedly save many thousands of dollars in re-tooling, re-layout of PWBs, etc.

Laying out design criteria in regard to Approval, then testing hand made or machined prototypes has proven to be successful for many of our clients.
Best Regards,
John R. Allen

Dear John,
I appreciate your kind and encouraging remarks on the article “Product Safety as a Design Parameter”. I would comment on your items concerning safety “over-kill” and non-technical management’s lack of appreciation of safety considerations in design objectives. When the four elements listed under “How Safe is Safe Enough?” are satisfied, a reasonably safe product has been obtained. I would view any additional costs in the name of safety as possibly “over-kill” unless a convincing case can be made that the additional costs in fact enhance the safeness level of the product.

On the matter of non-technical management’s lack of appreciation of safety considerations, I find that both non-technical and technical managers need a better appreciation of mandated safeness levels, criteria for accepting safety risks, regulatory requirements and other safety accountability stipulations these managers have knowingly or unknowingly assumed. I cover these items in a second text, “Managing Product Safety Activities” which the PSNL may wish to include in this series.

Sincerely,
Paul W. Hill ❏

Designing Fire Prevention into Electronic Equipment

by Mike Grabois
Ascom Timeplex

Abstract: Malfunctions in electronic equipment are the primary source of office fires. One of the best ways to prevent fires in electronic equipment is to interrupt the circuitry's access to the power source. Fuses in circuits and some power supply features may do just that. There are also some useful design tips that may reduce fire hazard.

Why Does Fire Happen?
It is well known that electronic systems have a tendency to fail occasionally. A majority of the failures are caused by thermal stress. Thermal stress implies temperatures high above the normal operating level. High temperatures on components may ignite the plastic of the packaging and in turn the PCB material. This kind of occurrence is difficult to predict and prevent, however, with appropriate selection of high quality components the risk may be minimized.

How Does Fire Sustain Itself?
The section above shows how fire most commonly starts. Other possible causes include: a broken air conditioner that allows the room temperature to rise or arcing on an intermittent contact of high voltage components or broken wire. Another question is why sometimes, once started, the burning process subsides and results in component or PCB damage, or sometimes sustains itself, propagates to other components, system modules, furniture, and eventually creates a major catastrophe.

The source of any thermal stress in electronic devices is a dissipation of power on resistive components in the form of heat during the passage of electric current. Most of the materials composing the PCB or semiconductor components are, or at least should be, fire retardant. This means that once the source of the heat is removed, the fire will extinguish itself automatically within some time period. Therefore, when current path is intact and electric current is present, heating up of the conductive elements and burning process can be sustained. Once current path is interrupted, the power access to the heating elements is removed and burning should subside and eventually stop.

My observations indicate that in order for a fire to last, it needs to be constantly fed by a power source. The start of the heating and burning process may be caused by any component or a signal trace which are overheating and causing the melting of the epoxy on PCBs or insulation on wires. The burning process, once started, produces a short circuit between the power rails. The power layers in the multilayer boards are especially susceptible to this kind of event. Once the material in the vicinity of the short circuit is burned out, the short circuit and burning process propagate toward periphery, thereby sustaining it further. The burning of the PCB ingredients produces strong flames that may heat up the PCB of neighboring modules starting a similar process in them, until the whole

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Area Activities

by John Reynolds
voice: 415-390-1344
fax: 415-962-9439
e-Mail: 73771.1225@CompuServe.com

Portland-

The speaker for the March 15th meeting was Chuck Mello of Electro Test Incorporated (ETI). Chuck is the area Manager and Director of Training and Standards in the Oregon office. Chuck has been the Chairman of the City of Portland Electrical Appeals Board since 1991 and was President of the Oregon Chapter of the International Association of Electrical Inspectors (IAEI) for 1993.

The subject was Fault Currents, Withstanding Capabilities and Grounding. The presentation briefly addressed the facility as it relates to fault currents and grounding and what the interface between the equipment manufacturer and the facility needs to include.

Central Texas -

The February 23 meeting featured a presentation on 'Normas Oficiales Mexicanas, Official Mexican Standard NOM Procedures for Electrical Consumer Products' by Mr. George Jurasich of TÜV. Location: ROLM Corp., 2205 Grand Avenue Parkway in Austin. The social was at 6:30; meeting at 7:00 pm.

The March 23 meeting was on the subject of BABT approvals. Vic Baldwin reported sending out 80 faxes in an attempt to publicize their upcoming meeting, but unfortunately, only 8 people showed up. The poor showing may have been due to bad weather. A nomination committee was formed, with Bob Hunter as the chairman, to nominate officers for the chapter. Voting will occur in May. Bob Hunter of Bob Hunter Associates spoke on BABT Equipment Approvals Process and Vic Baldwin of ROLM spoke on the BABT Factory Approvals Process. Vic Baldwin and George Jurasich of TÜV Co-Chair the TC-8 committee.

Upcoming events:
April - The next Central Texas get-together will be a luncheon meeting and will occur on Saturday, April 30th at 12:00 noon in Arguile, Texas. This meeting will be a joint meeting with the Dallas/Fort Worth EMC Society. The first hour will cover European product safety

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Technically Speaking

by Richard Nute

Probably the single most frequently occurring and most misunderstood issue in electronic product safety is electrically-caused fire. I thought I would review fire processes in plastics materials (the most common flammable construction material in electronic products).

The kind of fire that we are concerned with can be defined as an uncontrolled combustion process, usually accompanied by flames.

There are two combustion processes, flaming and flameless. This discussion is limited to flaming combustion. Flaming combustion is the one with which we are most familiar, where luminescent flames appear directly above the fuel material.

Flaming combustion is a chemical chain-reaction process which takes place exclusively in the gas phase. Solids and liquids do not burn. Only gasses burn. If you look carefully at any flame, you will see that it appears ABOVE the fuel material. This demonstrates that a gas is burning. However, the gas is evolved from the solid or liquid by heating the solid or liquid to a “suitable” temperature.

Let’s examine the process by which a solid or liquid contributes to a fire. Consider igniting paper with a match (presuming the match is already lit).

To initiate the fire (flaming combustion), the solid material (paper) must be heated by a source (the match) whose temperature is greater than the combustible material’s “flame-ignition temperature”.

As the material is heated and the material temperature increases, chemical decomposition (pyrolysis) occurs. Pyrolysis is a chemical change (decomposition) within the material and is indicated by a change in color and by evolution of smoke. Typical products of pyrolysis are flammable gasses, non-flammable gasses, liquids, and carbonaceous residues.

As heat is continued to be applied to the evolved gas, the pyrolytic gas temperature continues to rise to the “flame-ignition temperature”. At this temperature, the flammable gasses, mixed

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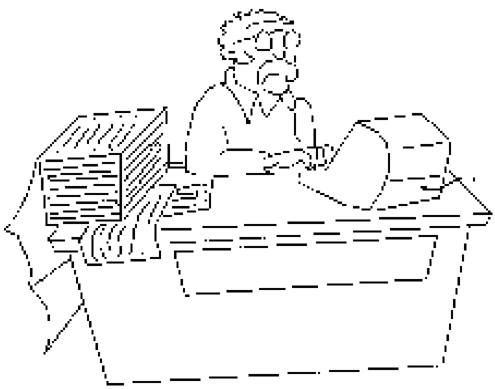
News and Notes



by Dave Edmunds
fax: (716) 422-6449

VDE Guide to the EMC Directive 89/336/EEC

The VDE Guide to the EMC Directive 89/336/EEC is now available in the U.S. through EuroPort. The guide consists of 308 pages and explains in detail the European Community Directive on EMC. As a guide to relevant standards, it has a section on interpreting Emission and Immunity Standards as well as sections on Harmonized Standards, BSI Publications Relating to EMC, Principal VDE EMC Specifications, and Principal US Commercial EMC Standards in addition to an action plan for achieving compliance.

Other VDE publications (in English) and international standards from IEC, ISO, DIN and others are also available from EuroPort. Call 508-526-1687 for more information and price quotations.

Information submitted by R. Volgstadt

USNC Nominates Candidate for IEC President

On January 24 the USNC officially named Mr. Bernard Falk, former NEMA President, as a candidate for the IEC President for the 1996-1998 term.

TC 76 Chairman

The Committee of Action (COA) of the IEC has reaffirmed Dr. B. Kleman term of office as Chairman of IEC TC 76 until March 1997.

IEC 825 Checklist

UL has copies of a checklist for IEC 825 first edition with Amendment 1 dated 1990. This checklist will be required when submitting a product that contains a laser to IEC 950. Clause 4.3.12 requires compliance to IEC 825.

Happy Birthday

Canadian Standards Association (CSA) was chartered in 1919, our congratulations on this occurrence of their 75 anniversary.

UL announces Generic Component Program

In a Subject 1950 letter dated January 31, 1994, UL announced several significant changes to the way they approach safety of low-voltage devices such as disc, tape and CD-ROM drives. In a 3 phase program, that has already started, UL has begun to evaluate low-voltage compo-

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Prevention of Fire in Equipment

by Paul W. Hill & Associates

[We are grateful to the author for providing another installment condensed from his book "Product Safeness As A Design Parameter", 2nd Edition, 1990. The text is a registered copyright of Paul W. Hill & Associates, Inc., and is reproduced with permission. Details about the purchase of the book may be obtained by calling (407) 368 2538.

Because of the amount of information in this article, only part of the article will fit in this issue. The second part will follow in the next issue of the Product Safety Newsletter. - Ed]

Fire as a hazard differs from electric shock in several important ways. First, fire usually involves more individuals per incident than electric shock. Electric shock almost always involves a single individual. Fire tends to involve many individuals in the general area of the incident because of smoke, evacuation of a building or spread of the fire to additional areas. Secondly, fire is responsible for property loss while electric shock rarely results in a significant loss of property. In addition, Consumer Product Safety Commission statistics indicate there are nearly as many deaths from fire as electric shock, but fires cause many more injuries.

General Concepts for Prevention of Fire in Equipment

Many people have a general misconception about the intent of safety standards concerning the flammability of equipment. The general misconception is that equipment must be essentially fireproof. In fact, in any general conflagration the equipment is not expected to survive intact or in any minimal operational state.

Product Safety standards require the following key fire prevention attributes in equipment:

1. Components and insulation materials within the equipment are adequately rated for the application.
2. Components are protected from over stressing current, voltage and thermal conditions.
3. Equipment enclosures are capable of containing ignitions within the equipment, should ignition occur.
4. The fire containment integrity of the equipment enclosure is maintained by limitations on the number and size of

enclosure openings.

Causes of Fire in Equipment

The major cause of ignition in electronic equipment is over stressed components. Charred resistors and scorched areas of printed circuit boards are common evidence of this. The component causing the ignition is either underrated for the application, or it was not adequately protected from over voltage, over current, or excessively high temperature conditions in the equipment.

Arcing is also a source of ignition in equipment. Arcing which is sustained or is of short duration but of high energy content can ignite adjacent materials if such materials do not have resistance to ignition characteristics. For this reason many structural parts and insulating materials have special ignition resistance requirements.

Temperature excursions which bring the equipment operating ambient to levels exceeding thermal ratings increase the risk of ignition. Product safety standards specify various abnormal operating conditions to evaluate the ability of over stress protective devices to prevent components and electrical insulation materials from exceeding thermal ratings.

Another factor which must be considered is the quantity of flammable consumables within the equipment such as lubricants, paper products and chemicals. These combustibles contribute to the "fuel load" once ignition has occurred. Fuel loads influence the intensity and duration of burning and increase the difficulty of containing, extinguishing or controlling a fire.

Adequate Component Ratings

Because over stress of components is a major cause of ignition in equipment, designers must select components which are adequately rated for the following characteristics:

1. Voltage operating range.
2. Current handling ability.
3. Component temperature limits.

Voltage operating range is the upper and lower operating voltages specified by the component manufacturer. These are the voltage limits for which the component is designed for continuous operation. Safety certification tests for adequacy of component ratings is a series of equipment operating tests performed with the mains input voltages increased to ten percent of the rated input voltage. The rated input voltage is that specified by the manufacturer on the equipment rating plate. For these tests the nominal frequency of the input voltage is not varied.

Components, wires and printed circuit board conductors must be capable of handling the currents likely to be encountered. This must include safe conduction of any fault current that is likely to be encountered until protective devices sense and react to the over current situation. Some faults may dwell at levels just below the activation point of fuses and thermal cut-out devices for long periods of time. This "cooking" of a component should be considered in its rating for the application.

Undersize conductors will heat rapidly when attempting to conduct currents not appropriate for the cross sectional area of the conductor. Product safety standards specify minimum acceptable conductor sizes or cross sectional area for various current conduction levels.

The thermal ratings of components should be given the same consideration as voltage and current ratings. Thermal ratings of components should be established by continuous operation in still air. This will establish the inherent thermal capability of the component whether it is cooled in operation by convection only or forced air.

Applicability of thermal ratings given by the component manufacturer should be verified in the proposed application. The influence of factors such as proximity to heat generating devices or the ability of the cooling mechanism to maintain components within thermal limits may be considerably different from static thermal performance.

Care should be taken to determine the temperature of cooling air passing around components in the enclosure. Cooling air which has been preheated by components up-stream in the air flow, could be considered as a possible thermal derating factor for temperature sensitive components.

Good design practice is to verify the adequacy of thermal ratings of components as used in the actual equipment application. The construction of a prototype enclosure, even as simple as a wood mock-up or model, with simulated cooling air or vents and internal partitions, can yield valuable information on the thermal performance of components in operating equipment.

Most product safety standards will set limits on the operating temperature of components which pose a risk of:

a) personal injury from burns, if parts are operator accessible, or
b) degradation of dielectric strength of insulation materials, or
c) ignition of consumable materials within the equipment.

Item a) concerns the surface temperature of parts accessible by operators and service personnel. The concern is not only the risk of skin burns but also the risk of injury resulting from involuntary or startle reactions when inadvertent contact is made with a hot surface.

Item b) concerns the operating temperature of parts and materials relied upon for protection from electric shock. These include insulating materials and structural parts supporting uninsulated conductors and providing required spacings between conductors. Included in these thermal requirements are minimum softening temperatures for plastic parts.

Item c) concerns flammable liquids and lubricants used in the operation of the equipment. Requirements for these materials are minimum flash point, quantities permitted within the equipment and prevention of accumulations of explosive air-vapor concentrations.

Temperature limits may be expressed as "temperature rise" above an assumed cold start ambient of 25°C. Temperature rise measurements are calculated from 25°C to the temperature obtained when the equipment has reached thermal stability. Thermal stability is taken to mean, after four hours of continuous equipment operation or when three consecutive temperature readings taken at 15 minute intervals show no significant change in temperature. The permissible temperature rise limits are given in safety standards for various materials, components and accessible surfaces.

Temperatures in product safety standards are normally considered surface temperature obtained by a thermocouple. However, for situations in which the thermocouple can not be placed at the point of measurement, such as the interior of a coil windings in transformers, the temperature measurement method may be specified as the change in resistance from a cold start to thermal stability. This is an appropriate measuring method when the internal temperature within the coil is more critical than its surface temperature.

Protection of Components From Over Stress

Components must be protected from abnormal operating and fault conditions which force components to dissipate energy beyond their inherent ability to do so. Over stress protection for components can be provided by:

a) fusing,
b) current limiting impedance in a circuit,
c) over current and over voltage sense and control circuitry, and
d) thermal cut-out devices.

It is unlikely that only one of these approaches will be satisfactory for comprehensive prevention of component over stress protection. A combination of methods is recommended, one for slow rise faults and a second for fast rise faults. A common example of this dual approach is the placement of a thermal cut-out in one of the coil windings of an input transformer and a fuse immediately ahead of the input winding. The fuse will respond to the overcurrent conditions, and the cut-out responds to the over temperature conditions.

A fuse is the most common approach to detection of overcurrent conditions and interruption of power to the components it is protecting. As a simple one element device it is considered extremely reliable in response to overcurrent conditions. It is often the reference when comparing the dependability of other overcurrent sense and control methods.

Disadvantages of the fuse are that it must be replaced after each rupture and the type and rating of the replacement is not fully controlled. Test and certification agencies will require that a fuse replacement warning be near the fuse location and repeated in service manuals. The warning must state that a risk of fire exists if the replacement fuse is not the fuse rating and type specified.

Differences between the North American and IEC fuse lengths and rupture characteristics may be a problem in certifying equipment. Certification difficulties can be eased if the fuse is not operator accessible, replaceable only by authorized servicing or is of the cartridge type which accepts either length fuse.

In some countries fuses must be sand filled or have ceramic bodies, in certain fuse ratings. This is the result of glass body fuses shattering when there is no substance to quench the heat of the arc and failure of glass casings to withstand the thermal shock when the fuse ruptures.

All fuses, circuit breakers and similar interrupt devices are required to be approved or recognized components.

Circuits which have permanent impedances which limit the current in a circuit are acceptable protective measures. Such circuits will be evaluated by abnormal operation and simulated fault tests to determine the degree of protection provided. The circuit impedance must be inherent in the circuit and not rely solely on one resistive element for the total protective impedance.

Circuits which detect and control over voltage or overcurrent conditions are an acceptable means of component over stress protection. Abnormal tests and simulated faults are used to evaluate the degree of protection provided. The reliability of the over stress sense and control circuits will be a major concern in equipment safety certification. The reliability of such circuits is expected to approach that of a fuse. The main issue is the overall reliability of the circuits composed of a number of components, contrasted to the single element fuse, and the fail safe attributes of the sense and control circuits.

Thermal cut-outs are those devices which interrupt power to a circuit when the cut-out device reaches a predetermined temperature. These devices may be non-reset, operating only once and require replacement, or manual reset and usable repeatedly. They may be a separate component or embedded in a component winding or enclosure. Automatic reset thermal cut-outs would be considered a thermostat and may not be viewed as a thermal protective device by testing agencies.

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Part II of this Paul Hill article on Prevention of Fire in Equipment will continue in the next issue of the PSN ❑

Area Activities
Continued From page 5

requirements; the second hour will cover EMC requirements. Contact Vic Baldwin at 512-990-6145 for directions. Vic urges those in the central Texas area to support their local chapter.

Santa Clara Valley Group -

The February meeting was held on Weds, Feb. 23 (rather than the usual 4th Tuesday) at Apple Computer in Cupertino. About 30 people attended, including folks from UL, CSA, TÜV Rheinland and the FDA. The speaker was Mr. Gene Panger of TÜV Product Service of Boulder, Colorado. Gene is a very enthusiastic speaker and we enjoyed his talk and lively discussions with the audience.

Gene's topic was Comparing the US's Food and Drug Administration and Europe's Notified Bodies. The similarities are that both were created to keep unsafe products from being marketed. The differences are the different focus and accreditation linkages (government, accreditation body, certification body, manufacturer and consumer) that comes from different approaches to manufacturing and sales. In general, he said that the US tends to think sale of a product is OK as long as it does no harm. In Europe, the product must do no harm but must additionally do what the manufacturer claims.

The third party certifier must be neutral and technically competent so that a trust can be established and maintained between the certifier and other interests such as manufacturing, professional groups, government, consumers and others.

If you would like more information, please contact Gene Panger, TÜV Product Service, (612) 631-2487.

The March meeting was held on Wednesday (this is becoming a habit!), March 23 at Windham Hotel in Santa Clara. This was a joint meeting with the IEEE System Software Society. The presentation was on Software Safety and Reliability by Dr. Norman Schneidewind, Professor of information sciences at the Naval Postgraduate School.

Upcoming events:
May 24 - Location to be announced. Brian Claes, LAM Research (and Chairman of the Product Safety Technical Committee) will speak on Forensics. Elections for Central Committee and the Santa Clara Valley Group.

Orange County/ Southern California Group -

The following topics were discussed at the February meeting:
Power Cords - UL and CSA to revise ITE standard to allow SP and SV types for floor standing and wall mounted units.

Job Openings - There were three openings listed in the newsletter. Please contact Charles M. Bayhi at 714-367-0919, for details.

Insulating Tubing - UL and CSA have rescinded the requirement to surface mark insulating tubing.

UL IAC Meeting - There was a UL/CSA meeting of ITE/Telecom joint Bi-National Standard on March 14-15. They reviewed the proposed standard, UL1950/CSA 950, 3rd edition.

CSA 950, 2nd Edition - published March 31st.

UL 1950 Bulletins to Power Supply Manufacturers - Power supply manufacturers are not automatically included in distribution of UL1950 bulletins. Contact UL to ensure you receive these updates.

Opto Couplers - UL has issued a Bulletin (Subjects 1577/1950) which requests manufacturers of R/C Optical Isolators voluntarily provide UL with clearance distances, creepage distances and distances through insulation of their devices.

UL Bulletin Subject 508B/1950 - UL is publishing an outline of Investigation for Relays Used in ITE, subject 508B.

UL Bulletin Subject 1950 - UL announces UL Generic Component Program. At a manufacturer's request, UL will provide a generic description in the Procedure for specific types of components. The R/C Directory will be expanded to include additional data for components. A manufacturer will be free to substitute any component as long as the information in the R/C Directory is within the restrictive limits of the description in the Procedure.

Nordic Acceptance of TÜV - According to information provided by Hal Keeling, the Nordic countries are now accepting TÜV. Corresponding to the terms of the European Economic Area (EEA), the foreign manufacturer must sign a declaration stating that his equipment meets the compulsory requirements for safety and EMC, based on data and/or reports from a recognized testing body or "competent laboratory".

Elections - Congratulations to the recently elected officers of the Southern California/ Orange County Group. They are as follows -
Chairman/Secretary - Charlie Bayhi
Vice Chairman/Treasurer - Ercell Bryant
Programs - Michael Dastmachian

Upcoming events:
April 3 - "ISO 9000 as applied to Product Safety, EMI and RFI". Speaker, Gilbert Walter of Safety & Compliance Eng. For details contact Ercell Bryant Tel: (714) 589-0700.

Chicago-

John Allen called to report that only has a handful of individuals that are interested in holding Product Safety Technical Committee meetings. Any help or advice in getting the Chicago group going would be appreciated. He can be reached at 708-238-0188. *[Perhaps a portion of a future column can be dedicated to publishing those good ideas and suggestions - Ed.]*

I would like to thank all the different groups that send me their meeting announcements and newsletters. They not only enable the writing of this column but they are encouraging to all the other groups.

John Reynolds
Area Activities Editor ❑

News and Notes
Continued From page 7

nents as commodities rather than as individual products. Eventually, a PC manufacturer will be able to specify that any R/C drive that draws no more than a defined maximum amount of power and that has certain minimum flammability characteristics can be used in a certain location in its product.

The first phase will allow component manufactures to voluntarily have their products tabulated in the RCD. In the second phase UL will mail a list of these component manufacturers to the end-use manufacturers who use them. The last phase will allow the end-use manufacturers to change their Reports to reflect the new descriptions.

Under the new system, a typical description might look like:
"Hard Disk Drive - R/C (NWGQ), input voltage 5/12 V d.c., loading current max. 1.5/0.5 amps, F/R minimum 94V-1, minimum clearance from uninsulated live parts 4.0mm."
The RCD will be changed to reflect manufacturer's name, model number of the com-

For Pamela & Roger Volgstadt

A Baby!

Rebecca Danae Volgstadt

born February 26, 1994

ponent drive, electrical rating, flame rating (typically of the bezel) and laser class, if applicable.

In the same letter, UL also announced expansion of its Listed Field-Installed Accessory Program. The expanded program will address drives that are intended for installation by non-service personnel (typically, retail store employees or consumers).

If you'd like more information about this bulletin or about the Generic Component Program/ Expanded Listed Field Installed Accessory Program, please contact Tom Burke at UL, Santa Clara (408-985-2400, X2286) or your local office.

The following material was obtained from the December, 1993 edition of the TMO Update, *published monthly by The Marley Organization. This publication is a confidential newsletter providing subscribers with information in the fields of government and non-government standardization. Contact The Marley Organization at 203-438-3801 for subscription information.*

Equal Treatment under NRTL

ANSI Accredited Committee Z34 Chairman and MET Laboratories Inc. (MET) President, Leonard Frier, as he has successfully done in the past, has become the advance advocate for U.S. independent conformity assessment third-party organizations by: (1) Filing a requested comment with OSHA's Nationally Recognized Testing Laboratory (NRTL) program that they assure equal treatment, (ie., through the U.S. Trade Representative), for the product's of U.S. NRTL clients in Germany before granting NRTL status to TÜV Rheinland of North America (TÜVNA), the wholly owned subsidiary of the German Government's notified body, TÜV Rheinland; (2) filing suit against Robert B. Reich as Secretary of Labor to have all OSHA NRTL references to "Underwriters Laboratories, Inc. and Factory Mutual Research Corporation" declared invalid as they, among other things, do not comply with the requirements imposed by OSHA on other NRTL's such as MET. This legal action follows numerous petitions to OSHA for "equitable treatment" by various NRTL's. It is apropos to state that the ACIL (American Council of Independent Laboratories) has filed similar comments to OSHA on the TÜVNA NRTL application, and OSHA has granted additional time for ACIL to detail still other arguments against granting the NRTL status. ❏

Please send any safety related articles to:
Dave Lorusso
EMC Corporation
171 South Street
Hopkinton, MA 01748
508-435-1000, x2130 (phone) or
508-435-5067 (fax)

Technically Speaking
Continued From page 6

with atmospheric oxygen, will self-ignite, and flaming combustion occurs. For the purposes of this discussion, the flame-ignition temperature of paper is taken as 451° F or 232° C.

Note that, for ignition, the GASSES must attain the "flame-ignition temperature," not the solid material (although the solid material must be heated sufficiently to evolve flammable gasses). Consider that gasoline produces gasses at room temperature, but those gasses do not burn spontaneously. Instead, the gas above a container of gasoline must be heated to its "flame-ignition temperature" before a fire occurs. Such a gas is very dangerous since a small spark is sufficient to achieve "flame-ignition temperature."

To sustain flaming combustion, the production of flammable gasses (pyrolysis), must be sustained. Heat for pyrolysis must be continually supplied to the solid or liquid material, either from an external source or from the flame.

Sustaining flaming combustion after the external heat source stops generating heat (i.e., the match is taken away) depends on the heat of the remaining flame.

If the heat from the flame exceeds the heat necessary for pyrolysis, flaming will be sustained. Likewise, if the heat from the flame is small, there will be less pyrolysis, the temperatures will decrease, and the fire will die.

So, a sustained fire is dependent on sustained thermal feedback from the flame to the solid material.

Considering the situation in terms of the law of conservation of energy, pyrolysis is an endothermic (heat-absorbing) chemical process; flaming is an exothermic (heat-producing) chemical process. If the exothermic reaction produces more energy than that required by the endothermic reaction, and there is adequate thermal coupling between the two processes, then fire will be sustained.

In addition to producing heat, the flame also produces combustion products, usually carbon monoxide, carbon dioxide, water vapor, other gasses produced by pyrolysis and flaming of the particular material, and solid carbonaceous residues. Some of the solids are carried off by convection currents, and some are left behind as ash.

Now, let's consider ignition of a plastic material from a non-flame source, i.e., electrical heating.

Electrically-caused fire is electrical heating of a material to ignition temperature followed by combustion. So, we'll now consider the situation of non-flame heating and ignition.

In the case of plastics, as the material is heated, first the plastic softens, often changes color, then produces smoke, then boils.

Published decomposition temperatures of common plastic materials range from 200° C for PVC to 500° C for PTFE, with most others in the 300° C range. My measurements suggest a decomposition temperature of 225° C for polyester.

If heating is continued, and since we have no flame from an electrical heat source, the combustible gasses evolved from the heated plastic will "self-ignite" at a temperature slightly higher than the "flame-ignition temperature." Typical plastic self-ignition temperatures range from about 350° C for polyethylene and polypropylene to 580° C for PTFE.

Sustained flaming combustion after the external heat source stops generating heat (e.g., the fuse opens) depends on the heat of the remaining flame.

For plastic materials rated HB, most of the pyrolytic gasses are flammable. The heat in the flame of such plastic materials usually is more than the heat necessary for sustained pyrolysis. After ignition, when the external heat source is removed from the material, flaming is sustained.

For materials rated V2, V1, V0, or 5V, most of the pyrolytic gasses are non-flammable. The heat in the flame of the remaining flammable gasses of such plastic materials is less than the heat necessary for sustained pyrolysis. After ignition, when the external heat source is removed from the material, the rate of combustion will decrease until extinction occurs.

The fire process is:

1. Fuel material.
2. Pyrolysis (an endothermic reaction requiring heat).
3. Pyrolytic products:
    a. Combustible gasses.
    b. Non-combustible gasses.
    c. Liquid products.
    d. Solid products.
4. Mixing of pyrolytic products with atmospheric oxygen.
5. Flame (an exothermic reaction producing heat).
6. Combustion products.
7. Sufficient thermal feedback from the flame to the fuel material to sustain pyrolysis.

(Smoke is an indicator of incomplete combustion. Incomplete combustion is due to insufficient pyrolysis or insufficient oxygen.)

With this background in the process of fire, we can address control and prevention of fire in electronic products.

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Some of the material presented here is the result of a collaboration of Dave Adams, Ray Corson, Kevin Cyrus, Richard Pescatore, and Brady Turner, all of Hewlett-Packard, and Bob Davidson and Don Mader of Underwriters Laboratories.

A good basic explanation of fire is a videotape entitled "Fire Concepts and Behavior," FL-46 VH, available from the National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts.

A good reference on burning processes of plastics is the "International Plastics Flammability Handbook," Second Edition, by Jurgen Troitzsch, published by Hanser Publishers, Munich. Distributed in the USA and Canada by Oxford University Press, New York, ISBN 0-19-520797-1. ❑

Designing Fire Prevention into Electronic Equipment
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system is consumed.

Prevention Techniques

Based on how fire starts and sustains itself, limiting or interrupting the current in the event of a short circuit failure is the best fire prevention method.

One of the best ways to eliminate the possibility of sustaining the burning process is to protect the load from short circuit or overcurrent conditions. A simple fuse on all of the power entries to all circuit modules will be very efficient. The burning process on any component or PCB may start with a relatively small amount of current. However, any further development and spreading of the process will require a significant amount of current. That is why a fuse would be good protection. However, there are number of precautions and issues that should be considered:

- A fuse has resistance and will cause a certain voltage drop which should be considered in the overall voltage budget.

- A fuse may interrupt power to a single module while the others are on line. The backplane bus drivers/receivers should not cause a bus hang up.

- Value selection of the fuse and its placement on the module should be done with consideration to the local temperature conditions.

- Module fuses do not provide protection for failure on the backplane or wiring.

The last statement has always been of great concern to me as I have observed a number of fires originating on the backplane. In order to eliminate this source or at least to alleviate the possibility, the area covered by the power distribution should be minimized. That will reduce the possibility of a short circuit between the two power rails in case of the overheating and melting of the backplane material.

Another important aspect of the backplane design is the proximity between the signal traces and the power distribution areas. A majority of fires start because of some kind of component failure. Components may cause short circuits or otherwise overload the signal traces connected to them. Therefore, close proximity of signal traces to the power distribution on the backplane is undesirable. It is preferable to deliver power along the periphery of the board without any traces above or below the distribution areas in the multilayer structure of the PCB. The reference layers, required for the control impedance lines, may be all of the same potential, such as Ground layers. Thus, the risk of a massive short circuit between the different voltage layers in the backplane will be greatly reduced.

I would not recommend a fuse or a circuit breaker on a power supply rail common to the system. It has a much larger effect on system performance and significantly reduces the reliability of the whole system. A better feature would be a shut down of the power supply output in case of overload. The benefit of this power supply characteristic is even more apparent in the case of the redundant power supply. However, this feature should include certain intelligence:

- The power supply should shut its output or outputs down only after a significant voltage drop on the common rail, indicating a massive short circuit.

- The power supply should allow overload to persist for a few seconds before activating the shut down in order to permit a destruction of a shorting device or material, if they are small and localized, or filter out the glitches.

Incorporating Smoke Detection Equipment into Electronic Design

I once have investigated a peculiar application of smoke detectors used in common fire alarms. The conclusion was that it is much easier, more cost effective and efficient to use fuses in combination with power supply shut down feature. However, I would like to share some findings, should anyone contemplate "improving" a system or device in this manner.

There are two types of smoke detection devices which may be incorporated into the electronic equipment in order to prevent or alleviate a fire hazard: smoke detectors with photo-electric components or with an ionization chamber. Those with photoelectric action require a certain amount of smoke in order to react. The ionization type devices perform better in cases exhibiting low smoke levels or flame presence since they react to the presence of ionized particles. The smoke detector with an ionization chamber also is better suited to the application in electronic equipment. Among the AC and low voltage DC powered devices, the low voltage DC type is probably more convenient for electronic equipment applications. These devices may be powered from the secondary power supply voltages (+12 V). Such a device should have independent contacts that may be used to trigger a circuit breaker type device with remote trip coil or a relay.

To minimize equipment damage, fuses are recommended over smoke detectors. Fuses typically produce much better protection since they may prevent fire at a very early stage, and therefore, significantly lessen damage. For smoke detectors to react, they require some fire to be present. That means that at least one of the circuit modules, including the PCB, or some times even more, will be destroyed. In addition, smoke detectors have the potential for false alarms and require periodic maintenance.

During my investigations, I have entertained some thoughts about applying current and voltage detectors for accurate indication of a potentially dangerous malfunction. Although I never used this approach, in combination with very accurate gauging of the current consumptions by the modules and overall system, it may result in a more accurate and more efficient damage prevention technique. In conjunction with appropriate software support, it may also provide an accurate failure detection tool for remote or local applications.

Summary

The requirements of fire prevention in electronic equipment are often overlooked or neglected by design engineers. However, the liabilities may be significant, both the legal aspects and in terms of the impact the reputation of the product and the company. The design of fire prevention measures may be difficult — there is a large number of "what if" cases that are not easy to cover and it is impossible to eliminate any damage completely. However, with due caution and thought to the design and proper use of fuses or other overcurrent protection devices, it is relatively easy and inexpensive to create a healthy and safe system.

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Mr. Grabois is a staff engineer at Ascom Timplex. Mike has a BSEE from Moscow Institute of Railway Engineering and a MSEE from New York University. He has worked in digital and analog design at Ascom Timeplex since 1985 and has been involved in design of equipment power distribution, power supplies and high-speed backplanes. ❑

Chairman's Message
Continued From page 1

2. I attended a presentation given by a longtime veteran of the IEC standards scene on the latest from the world of international information technology safety standards. It was an excellent update that was occasionally punctuated with apologies for the standard's inadequacies, this after many years of gestation. Eventually, the discussion migrated to comparing alternatives for the very nature of standards, from very prescriptive (as we have today) to very generic ("products must be safe") to hazard-based standards.

During the session, prescriptive standards were criticized, on one hand, as stifling innovation by being very specific about applying the past to product design and/or product evaluation requirements. On the other hand, they were defended out of concern that exclusively high-level requirements would result in a plague of widely varying interpretations. Additional concerns were expressed for effects of varying interpretations made by test houses. Is continued use of prescriptive standards that draw an ***arbitrary line*** separating what is "good" and acceptable from what isn't the best practice?

3. I regret I was unable to attend Rich Nute's presentation on "The Myth of Accessibility". However, his slides in the colloquium record appear to take a very interesting tack: rather than deal with accessibility using a collection of prescriptive, arbitrary (though widely accepted) requirements, he based his approach in terms of a ***principle*** or ***collection of principles***.

While it may seem like a stretch relating all the above together, to me it came down to the fundamental issue of what we safety professionals do. How much time do we spend enforcing arbitrary lines that someone else developed, lines that we can't well defend as optimum from either an engineering or technological standpoint? Why do we presume interpretations as to what is ***safe enough*** would differ so widely? And, assuming we can know why, what can we do about it?

Product Safety Practice—Brokering?

Let's shift gears, applying considerable imagination in comparing product safety practice to the legal profession. In both cases, the practitioners, equipped with their familiarity with codes and standards, serve as experts arguing claims or resolving differences, frequently before independent third parties or judges.

Is our role to bridge the gap between safety-related science and technology and the classic engineering and management disciplines? Does product safety practice have a technology basis or core? Or are we arbitrating someone else's arbitrary technical requirements? With all the negative press about how the legal profession is perceived today, are we as highly valued by our organizations or customers as lawyers are? In what ways do we uniquely add fundamental value to the product or service?

Product Safety Practice—
Principles of Safety

Let's take a step back and look at a bigger picture. From a societal standpoint, laws in a democracy represent a contract between the individual, various groups and the society as a whole in order to fairly maintain order and balance. When there is general widespread agreement as to what is right and wrong and what is acceptable and unacceptable, history has shown the collection of laws can be at a fairly high and generic level and be both simple and brief. However, as societal cohesiveness breaks down, as a primary set of consistent principles are no longer widely followed and standards of conduct splinter, laws become more complex as various interests fight for their "rights" and privileges. These laws change over time according to who's in power, what's fashionable, etc. The point is this: ***rules proliferate and become more prescriptive as principles become less understood and agreed to.***

Does proliferation of prescriptive requirements merely attest to the fact that there is little agreement as to what is safe enough? If this is the case, will a large body of specific rules really help in attaining the goal of suitably safe products?

Summarizing some of the questions posed above:

1. Why do prescriptive requirements, even if arbitrary and technologically indefensible as optimum, seem to be preferred over high-level or generic requirements?
2. Can we promote a principle-based agreement reflecting what is ***safe enough***?
3. To what extent is safety widely taught as a core discipline in our engineering schools, thoroughly integrated in the same way as other key engineering principles?
4. What core technologies are substantially unique to product safety practice?
5. Is our primary role to migrate safety-related technology or science-based enhancements from other disciplines into mainstream engineering practice?

Maybe we should consider a change in our job descriptions. Maybe we should be promoting safety in terms of engineering and management principles, implicit and explicit contracts to be maintained between producer and customer, rather than focusing on fine-tuning rules having long-forgotten origins that arbitrarily divide the acceptable from the unacceptable. As a reflection of this, perhaps our Symposium papers should address how we can promote the return of safety practice to the core of engineering and management practice, particularly if it becomes clear that we do not have a technology-based core around which our engineering is practiced.

I hope to address some suggestions in the next issue. In the meantime, I'd like to hear your comments on the subject, particularly if you have a different perspective or have ideas on what improvements should be made and how to make them. ❏

Institutional Listings

We are grateful for the assistance given by these firms and invite application for Institutional Listings from other firms interested in the product safety field. An Institutional Listing recognizes contributions to support publication of the Product Safety Newsletter of the IEEE EMC Society Product Safety Technical Committee. Please direct inquiries to:

Ervin Gomez at (408) 553-7684 (phone) or (408) 553-7694 (fax)

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c/o Tandem Computers Incorporated
10300 North Tantau Avenue, Loc 55-53
Cupertino, CA 95014
Attn: Roger Volgstadt

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Employment Wanted

As a free service to our readers, the Product Safety Newsletter will periodically list Regulatory Compliance professionals who are available for employment. Those with employment opportunities are encouraged to contact the following individuals directly.

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Brampton, Ontario
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Hollister, CA
(408) 636 8182

Donald E. Shaffer
Ithaca, New York
(607) 277-0629