The Product Safety Newsletter

IEEE EMC SOCIETY

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What's Inside

Guest Editorial

Choices –

So far, the only thing we can count on in our job is that things are constantly changing. The rate of change is increasing daily. The standards we test to have changed from six (two standards for EDP equipment times CSA, IEC and UL) down to three then to one, with minor differences between the various standards bodies. The certification agencies have changed too. We now have the choice of who will do the tests and what test mark will be obtained.

It is these new choices that will change the way we do our jobs. Not too long ago it was a simple matter (at least for EDP equipment) of writing three reports, and having a visit from each of the three agencies to obtain three test marks. With the arrival of the “NRTL” program in the United States, we now have a choice of many different laboratories that can test and approve products. Likewise, in Canada, Germany and most of Western Europe, we can choose any one of several

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The Product Safety Newsletter

The Product Safety Newsletter is published bimonthly by the Product Safety Technical Committee of the IEEE EMC Society. No part of this newsletter may be reproduced without written permission of the authors.

Opinions expressed in this newsletter are those of the authors and do not necessarily represent the opinions of the Technical Committee or its members. Indeed, there may be and often are substantial disagreements with some of the opinions expressed by the authors.

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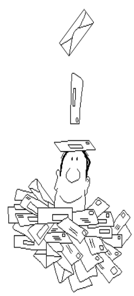

To the Editor:

I'd like to comment on Brian Claes' provocative "Safe Enough" Chairman's Message in the July- August, 1994, issue.

Brian postulates that "product safety" essentially has no technologies of its own.

I disagree.

There are a number of technologies unique to product safety. When I think of technologies unique to product safety, I consider those technologies which are not required for normal functioning of the equipment, and which are installed in the equipment solely for the purpose of providing protection from a hazard. In essence, the safety technologies are those of devices we would categorize as "safeguards," those devices which provide a protective function, but not a normal operating function.

There are five unique technologies just for protection against electric shock hazard:

1. Limited voltage.
2. Limited current.
3. Equipotential bonding (grounding).
4. Additional insulation.
   - double insulation.
   - reinforced insulation.
5. Automatic disconnection of the supply.
   - ground-fault circuit interrupter.
   - immersion detection circuit interrupter.

There are a number of technologies for protection against fire and spread of fire:

1. Overcurrent devices.
   - fuses.
   - circuit-breakers.
2. Overtemperature devices.
3. Flame-retardant materials.

There are a number of technologies for protection against x-radiation from cathode-ray tubes:

1. X-radiation attenuating glass.
2. HV overvoltage control circuits

Unfortunately, most of these technologies were not developed by safety engineers. Perhaps this is why Brian asserts that product safety has no technologies, meaning no technologies which product safety engineers invented. (Of course, the invention of the GFCI must be attributed to safety researcher Charles Dalziel.)

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Area Activities

by John Reynolds
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Central Texas

The History and Highlights of Electrical Safety in Medicine - Facilities and Equipment was presented at the July meeting of the Product Safety Technical Committee of Central Texas by David G. Kilpatric, P.E. His research and publications have formed the bases for safety standards and codes that are in use today. Mr. Kilpatric and his wife, Lorraine, have published a paper "Electrical Safety Standards in The Health Care Delivery System" that was published in critical reviews in Bioengineering. Mr. Kilpatric was also instrumental in helping to revive the EMB (Electronics in Medicine and Biology) chapter in the Central Texas Section of IEEE.

Officer Candidates for 94/95 were presented and election conducted by Bob Hunter. Voting was by secret ballot with the following persons being elected for the 94/95 term:

Chair: Vic Baldwin - ROLM
Vice Chair: Charlie Goertz - Dell Computer
Sec./Tres.: Daniece Carpenter - Dell Computer

Northwest Chapter (Portland)

Summer Vacation!!! **There were no meetings during the months of June, July and August. Meetings will resume in September.**

Santa Clara Valley Chapter

An updated talk on ELF Affects **by Mr. Dan Weinberg, Ph. D. was presented at the June 28th meeting of the SCV PSTC.**

The new meeting location is Hewlett Packard, Building 48, Oak Room, in Cupertino. **Many thanks to Ken Warwick and Apple Computer for hosting the SCV PSTC meetings for these past years.**

Election results were announced. **Murlin Marks is the new Chairman, Edward Karl is coming in as Vice-Chairman, Mark Montrose will continue on as Treasurer and Parviz Boozapour will be Secretary for a second term.**

The next meeting will be in September.

Orange County/Southern California Group

New Methods for Certifying Rack Mount Units **was presented by Dave Faultersack of Unisys at the August 2nd meeting.** o

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Technically Speaking

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Fire Prevention

Last issue, I discussed fire enclosures and how they prevent spread of fire. I discussed fire containment (you need a stove-like construction), flame-retardant materials (fuel-regulated fire), smothering (oxygen-regulated fire), and automatic extinguishing (not practical).

I said that the best solution to fire -- any fire - is to prevent fire in the first place.

Fire results from the conjunction of the four elements of fire: heat, fuel, oxygen, and flame. If any one element is missing, there is no fire

In the last issue, we dealt with fuel and oxygen, and we assumed we had a flame. In this issue, we'll deal with heat sources and with the management of heat.

Two issues ago, I discussed pyrolysis. You will recall that pyrolysis is the chemical decomposition of a material with increasing temperature. This is the first step in the ignition process.

Fire prevention is a simple matter of preventing pyrolysis, i.e., preventing smoke. Or, at least, preventing pyrolysis gasses from reaching ignition temperature.

The old adage is: Where there is smoke, there is fire. If there is no smoke, then fire is unlikely. To prevent fire, we must prevent smoke (pyrolysis).

To prevent pyrolysis, we must prevent heating the fuel material to pyrolysis temperature.

We have two choices: First, assure that the electrically-caused beating will never reach the pyrolysis temperature of the fuel material. Second, select a material having a pyrolysis temperature greater than the circuit temperature.

The second method is used in electric heaters. We know that we will have lots of heat and high temperatures. The materials used in electric heaters are, usually, metal and ceramic. Both have very high pyrolysis tem-

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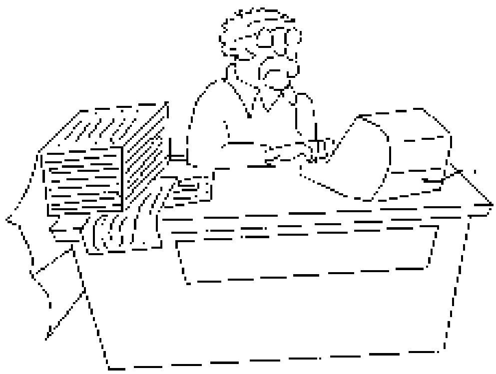
News and Notes



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Software Reliability Engineering Symposium

The fifth International Symposium on Software Reliability Engineering (ISSRE) will be held in Monterey, California November 6 - 9, 1994. ISSRE is a major symposium in the emerging field of software reliability engineering. The symposium offers technical sessions on the following: Formal Methods, Safety, Modeling, Measurement, Testing, Industry Reports, Tools, as well as several panel discussions. Tutorials and tool fairs which exhibit testing/reliability products from leading industry, academia and tools developers will also be included. Registration for IEEE members registering before October 7th is $ 275.00 and $ 325 after Oct. 7th. Tutorials are extra. For further information, please call (202) 371-1013

ISO 9000

The various Quality Management Standards under the BS 5750 umbrella are being revised and will shortly be available under their new numbers. BS EN ISO 9000. The changes are meant to improve their presentation, make them more user friendly, and more applicable to the service sectors. The revised standards also incorporate the best management practice, give clearer management responsibility, and focus more on improvement procedures. Copies of a prepared guidance document which clarifies the changes clause by clause are available from BSI (British Standard Institute).

Electromagnetic Compatibility Symposium

A call for authors and papers for the 1994 International Electromagnetic Compatibility Symposium scheduled for December 5-9 1994 in Sao Paulo Brazil. Contact IEEE EMC Society or send paper to 1994 International Symposium on EMC, Dr. Marcos Andre da Mattos, c/o Instituto de Eletrotecnica e Energia, Univ. de San Paulo, 05508-900 Sao Paulo SP Brazil.

Laseet Fire Protection

NFPA Technical Committee on Laser Fire Protection has a Draft document available for comment. The closing date is 14 October 1994. Copies can be obtained from NFPA, I Batterymarch Park, PO Box 9101, Quincy MA.

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Bridging Basic and Reinforced Insulation with Caps and Resistors

by: Lal Bahra, P. Eng.
Canadian Standards Association

It is becoming very common to connect capacitors and resistors from primary to secondary to reduce RFI noise.

Clause 2.3.11 of Standard C22.2 No 950 allows capacitors to bridge reinforced or double insula- tion under certain conditions. Clause 2.3.9 of the Standard does not allow SELV circuits to be conductively coupled to a primary circuit includ- ing the neutral.

As an extension of the requirement of Clause 2.3.11 of Standard C22.2 No 950, resistors are permitted to bridge reinforced or double insula- tion. CENELEC Certification Agreement (CCA) group allows capacitors and resistors to bridge basic, supplementary and reinforced or double insulation under certain conditions. Also, the Technical Committee on IEC 950 has defined the requirements for line-to-line capacitors more clearly, and revised requirements have been published as Amendment No 2 to IEC Publica- tion 950.

A new (second) edition of IEC Publication 384- 14 has been published which describes line-to- ground and line-to-line capacitors more clearly.

New Requirements For Line-to-Line (X) Capacitors

The recently published Amendment No. 2 to IEC Publication 950 adds the following requirements to Clause 1. 5.6 of that publication.

A capacitor connected between two phase conductors or between one phase conductor and the neutral conductor of the mains sup- ply shall be one of the following.

• An Xi capacitor complying with IEC 384- 14;

• An X2 capacitor which passes the pulse test of IEC 384-14, Clause 12.11.2, as applied to XI capacitors, with the test voltage reduced to 2.5 kV;

• An X2 capacitor which passes the endurance test of IEC 384-14, Clause 12.11.2, with the 220 ohm resistor short circuited (Appendix B of IEC 384-14).

Since most of the X-capacitors are presently Certified as X2, additional tests in accordance with IEC Publication 384-14 must be conducted when accepting X2 capacitors. (Above references to the IEC Publication 384-14 are to the first edition).

The second edition of IEC 384-14 lists X capacitors as follows:
XI - Suitable for installation Category 111. (Peak impulse voltage withstand in service > 2.5 kV < 4.0 kV).

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Letters to the Editor
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Product safety does indeed have technologies of its own.

Brian asks whether “safe” is attainable. He implies that safe is not attainable as eliminating all risk is generally impractical if not impossible.

Risk is a statistical term. The statistic of risk is to predict the future given a set of past experiences. The idea of risk cannot be used for predicting whether or not a new design (i.e., no data of past experiences) could or will result in an injury.

The basic process of safety is first to identify all energy sources within the product (or whatever situation is under consideration). The second step is to classify the various energy sources as hazardous or non-hazardous. The third step is to design safeguards for each hazardous energy source. Then, test the safeguard to confirm that it performs as designed. The last step is to consider the consequences of failure of the safeguard and, if appropriate, to design a mitigating safeguard (a safeguard that is called upon in the event of failure of the first safeguard, e.g., supplementary insulation in a double insulation system).

Risk is associated with the performance of the safeguard. A safeguard cannot be designed that will withstand all possible situations. For example, we design enclosures to withstand a specified value of impact and pressure. If a particular situation exceeds those values, then we can expect the enclosure-safeguard to fail. In the event of a safeguard failure, we presume an injury will occur.

So, risk is the probability of the enclosure (safeguard) being subjected to either an impact or a pressure exceeding the values to which it was designed. (Risk may also represent the probability of a fabrication error such that the safeguard fails under a lesser value than that which it was designed for.)

Safe is attainable. But, it is conditional on Brian’s next questions, what constitutes “safe enough,” and whether “safe enough” is reasonable.

“Safe enough” is simply deciding whether the failure value of a safeguard is acceptable. The common value of enclosure impact strength is 5 foot-pounds. How do we determine if the value of 5 foot-pounds is acceptable?

Answer: Research. We can study impacts that the product might incur given its nature and environment. Then, we can pick a value that exceeds the situations we expect. We can then say that the safeguard will be effective in the environments we expect the product to be operated in. Indeed, we would have no reason to ever expect a failure of the enclosure (safeguard) - provided the product is operated in the situations we studied.

Given a sufficient stimulus, all safeguards are subject to failure. So, we can never create a product that will be safe in all situations. But, we can always create a product that is “safe enough.”

Brian says that the future of safety practice lies in it making sense to those designing,

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manufacturing, using, and servicing products.

Safety in a product is the judicious design of safeguards. Manufacturing must make the product per the print. The user should not need to be aware of any safeguards. The serviceman must necessarily remove or defeat safeguards and therefore must invoke personal avoidance to be safe.

Safety is designed into products in the form of safeguards. Our job is to teach designers the principles of safety such that they can design or invent safeguards appropriate for their products and their designs.

Manufacturers and users need not understand safety principles to manufacture and use the product. This is not to say that they should not be aware of safety principles.

The serviceman needs to know what parts constitute safeguards such that upon removal he can avoid the hazard.

I concur that every design engineer should also be a safety engineer. Engineering curricula should include a required one-term course in safety principles. If our engineers had this background, we wouldn't have a need for third- party safety certification.

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Author's Response:

I appreciate Rich's comments. I believe he articulates a view of product safety practice that rises well above the norm. Regarding the issue of product safety having little or no technology of its own, Rich touched upon two key points warranting additional comment.

-Rich brings up an excellent point in his first paragraph when he defines safety by contrasting normal functionality with installing safeguards to provide hazard protection. A properly engineered and designed product not only does what it should do **but also does <u>not</u> do what it should <u>not</u> do.** Historically, the long view is that failure, particularly that resulting in loss of property and/or life, has advanced basic engineering practice much more than multitudes of successes. This also ties in closely with Rich's concluding notion that every design engineer should be a safety engineer.

Unfortunately, the general practice of engineering has deteriorated to the point that this "positive performance" (product does what it should do) is emphasized over preventing undesired outcomes (product doesn't do what it shouldn't do). This imbalance has been a relatively recent development in our industrial age, having its origins I believe in the pressured mentality of accepting greater technological risk during World War It and the resulting Cold War in order to satisfy a higher priority of national survival:
-we were being challenged technologically by dangerous adversaries
-mission success was the highest priority - safety was an issue only when it threatened mission success

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I believe the quality and safety movements of the last decade or so are moderating reactions to this history.

This emphasis on basic capability positive performance is reinforced both in the way engineers are educated and the way products are marketed and sold. Over time, assuring that products don't do what they're not supposed to do has been relegated to others, including those in the product safety business. While this creates job opportunities in product safety, product assurance and quality disciplines, the result is simply a more convoluted process. It's been my experience that most of what product safety people contribute is history and a checklist (safety standards are essentially a reflection of lessons learned the hard way) and that very few are technologically equipped or positioned to interpose themselves directly and efficiently into the development process. In a nutshell, safety types aren't designing products, but rather their primary participation is in design reviews and certain types of follow-on testing. This must change.

There was a time when there essentially were no safety engineers. All engineers regardless of specialty discipline were expected to fully incorporate safety in their practices and designs. In fact, the first directive in the code of practice for Registered Engineers in California (and I'm sure nearly everywhere else for that matter) places safety above all other interests. As I mentioned previously, we began to get away from this over the last two generations. Rather than reintegrate safety into mainstream engineering practice, safety engineering as a separate discipline emerged and a whole industry and practice grew up around it. In general, I believe this practice is inefficient and would eventually be done away with if we weren't always developing more requirements and discretely cheering on greater regulatory burdens that serve to provide additional credibility and work opportunities.

In the interests of design process efficiency and faster time to market, both the "negative" (safety, accident prevention) and positive aspects of product performance must be equally and concurrently addressed. This can only be accomplished when design personnel simultaneously design in and assure product safety. And this can only happen when they have been properly educated in better design principles and tools in addition to product safety history (standards and other lessons learned). It's up to the individual safety practitioners to decide how they can best serve this improved process and then properly prepare themselves in order to prevent their own evolutionary extinction.

I would propose that most of the items in Rich's lists are not technologies per se, but rather are concepts with associated limit values. Under the present system, these approaches and limits are then given to (or imposed on) engineers and designers who then employ them either in designing the product properly the first time or in correcting their errors and omissions at some later point in the product's- life cycle.

The last point I want to comment on concerns Rich's treatment of risk. Rich led off by indicating "risk cannot be used for predicting whether or not a new design ... could or will result in injury." I know I'm in the minority on this point, but I disagree with this conclusion.

In fact, I believe Rich, in practice, does also, for in the next seven paragraphs he describes a risk- based approach to safety design which I believe he endorses. The only major concern I have with this treatment is that it associates risk alternately with **EITHER probability (likelihood) or consequence** (severity). It cannot be overemphasized that the concept of risk becomes meaningless without **simultaneously taking BOTH likelihood and severity into account.**

As I have shared in previous articles, I believe safety standards in general have become unnecessarily burdensome, in large part because they are chock full of prescriptive, often arbitrary, limits addressing only consequence (severity). I believe we are doing a critical disservice by not confronting and dealing with probability; we need a transfusion from the reliability and systems disciplines in treatment of probability and risk. The consequence of this deficiency is a collection of arbitrary black and white boundaries separating what is alleged to be safe from that which is not, without regard to the overall risk of hazard or accident.

Brian Claeso

Please send the latest Product Safety news and events/conferences/ committee meetings, etc. to:

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e-mail: edmunds.wbst843 @xerox.com

Don't assume that someone else will!!!

Help Wanted

We are looking for someone to layout the Newsletter every other month.

You need to have enthusiasm and access to a computer with page layout software. it would be nice (though not essential) also to have access to an image scanner, OCR Software, e- mail and a fax machine.

This is an excellent opportunity to have some fun, learn more about computers and newsletter layout (not to mention, Product Safety) and make a worthwhile contribution to our profession.

Previous experience is not required. we can teach you on the job.

Please contact Roger Volgstadt or John McBain (page 2) for details.

News and Notes
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02269-9101.

ICALEO
The 13 International Congress on Application of Laser and Electro-Optics is scheduled for Orlando FL 17-20 October 1994. For additional information contact LIA, 1242 Research Parkway, Orlando FL. 32826, Phone (407) 380-1553, Fax (407) 380-5588.

The following material is extracted with permissionfrom the "TMO Update", a monthly Newsletterpublished by the Marley Organization of Ridgefield, CT. Contact Mr. C.W. Hyer at 203-438-3801 for subscription information.

MORE MRA's SIGNED

John Locke of A2LA and Michael McSweeney of Standard Council of Canada signed a mutual recognition agreement (MRA) at a recent International Conference on Accreditation co-sponsored by Mexico's SECOFI in Monterey, Mexico. This MRA according to an A2LA release, "gives A2LA- accredited laboratories SCC accredited status and gives SCC accredited laboratories A2LA accredited status."

In addition to SCC and A2LA, other Canadian and U.S. organizations invited to make presentations at the Mexico conference were: Canadian General Standards Board (CGSB), Canadian Standards Association, CSA, Hewlett Packard, Inchcape Testing Services (ITS), Quality Management Institute (QMI), and Southwest Research Institute (SwRI). We were told a clear message at the conference that the Mexican government will be at least as active in all phases of accreditation as the Canadian and US Governments. Supporting this conclusion,

ITS announced it was setting up a laboratory facility and conformity assessment services center in Mexico." Note: A2LA (American Association for Laboratory Accreditation) is an association of test houses whose goal is to enhance the economic survival of their membership. SCOPE:Accreditation for testing laboratories and/or inspection agencies on the basis of technical competence. Also offers ISO 9000 registrations and can offer certifications of material lots.

CHANGES IN IRELAND
Forbairt is a new agency in Ireland which brings together the former functions of EOLAS (Irish Science and Technology Agency) and the Industrial Development Authority. The operation of NETC (National Electronic Test Center) remain unchanged. For more information contact Jackie FitzGerald or Michael Hughes, NETC, Forharit, Glasnevin, Dublin 9, FAX: 353 1 837 0705.o

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Don't assume that someone lese will!!!

Bridging Insulation ...
Continued Frorn page 7

X2 - Suitable for installation Category 11. (Peak impulse voltage withstand in service < 2.5 kV).

X3 - General purpose (not suitable for use in installation Category III or 11). (Peak impulse voltage withstand in service < 1.2 kV).

This means that Xi and X2 capacitors are both suitable for IEC 950 applications from line to line.

New Designations for Line-to-Ground (Y) Capacitors

The pending second edition of IEC 384-14 describes Y-capacitors as follows:

YI - Suitable for bridging double or reinforced insulation (working voltage < 250 V, 8 kV peak impulse test).

Y2 - Suitable for bridging basic or supplementary insulation (working voltage > 150V < 25OV, 5 kV peak impulse test).
Y3 - Same as Y2 except peak impulse test before endurance test is not conducted.

Y4 - Suitable for bridging basic or supplementary insulation (working voltage < I SOV, 2.5 kV peak impulse test).

From the above, it is clear that YI and Y2 can be used as line to ground capacitors for 250V equip- ment and YI, Y2 or Y4 may be used as line to ground capacitors for 125V equipment.

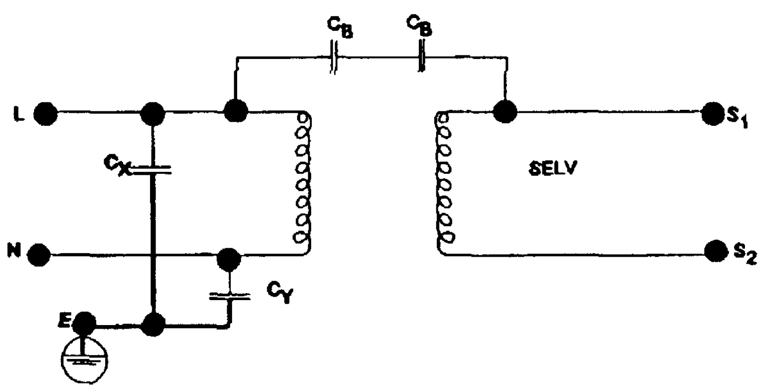

Fig. 1
Earth Conductor Current ≤ 3.5mA
Secondary Leakage Current ≤ 0.5mA with One Capacitor Shorted

Requirements for Resistors in IEC Publication 65

Clause 14.1 of IEC 65 permits a single resistor to bridge reinforced insulation provided the cur- rents flowing through the resistor comply with the requirements for limited current circuits and earth leakage currents.

Also persons must be protected from suffering shocks due to flashovers between the terminals of the resistors. This means that clearance and creepage distances must be in compliance with the requirements between end caps and between metal leads as applicable.

Requirements (Proposed) for Capacitors Bridging Reinforced or Double Insulation

Upon acceptance of proposed requirements, IEC Publication 950 will permit a single Yl-capacitor complying with the requirements of IEC384-14 (secondedition). 100% dielectric voltage withstand test will be required on the capacitor before assembly into the equipment as IEC 384-14 requires only electric strength test and does not require any thickness for insulation.

Also, two capacitors will be accepted in series, each complying with the requirements of IEC 384-14 (second edition) for Y2- or Y4-capacitors provided that each capacitor is rated for the total voltage across the pair. The capacitors must have the same nominal value.

The currents flowing through the capacitors will be required to comply with the limited current circuit and earth leakage current limits of the Standard.

Requirements (Proposed) For Resistors

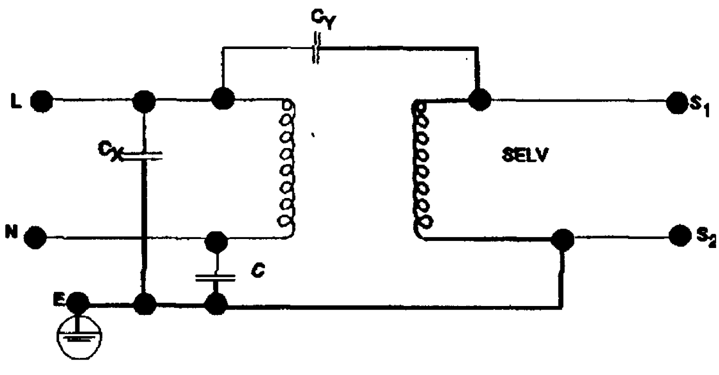

Fig. 2A

Total Earth Conductor Current ≤ 3.5 mA

Bridging Reinforced or Double Insulation Upon acceptance of proposed requirements, IEC Publication 950 will permit two resistors in series to bridge reinforced or double insulation comply- ing with the clearance and creepage distances requirements of IEC 950 between end caps or lead terminations. The resistors must have the same nominal value. The current flowing through the resistors will need to comply with the limited current circuits and earth leakage current limits of the Standard. The resistors must be of a type which fail open circuit under abnormal fault conditions.

IEC Publication 65, Clause 14.1 specifies a damp heat test for resistors for 21 days. Following this test, the resistor is subjected to 50 discharges from a I nF capacitor charged to I OkV. After the test, resistor must not vary by more than 50% from the value measured before the damp heat test. The IEC 950 proposal does not take this into account. As a precaution, the resistance value of each of the two resistors must not be less than 500k ohms for 125V applications (if no doubler circuit is used) and not be less than I megaohm for 250V applications.

If the 500k ohm resistor varies by 50%, then the resultant 250k ohm value will result in 0.5 mA (i.e. 125V/250k) leakage current.

Since the resistance value of a resistor tends to decrease after exposure to high voltage transient, the leakage current must be measured following the electric strength test of Clause 5.3 and it must comply with the limits of Clause 5.2.

ACCEPTANCE CRITERIA
From the proposed changes just described it is clear that the following are of concern when accepting capacitors or resistors that

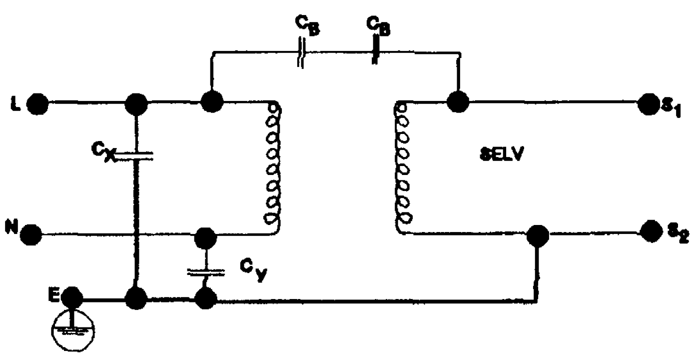

Fig. 2B
Secondary Leakage Current ≤ 0.5mA
With One Capacitor Shorted

Continued From page 6

bridge

operational, basic, supplementary or reinforced (or double) insulation.

Construction
The capacitors must comply with the construction and test requirements of the applicable IEC Publication and/or CSA Standard as applicable.

Resistors should be constructed in such a manner that creepage distances and clearances between end terminations are not less than those required by the Standard. Resistors other than the wire-wound type, generally open circuit under fault conditions; capacitors either open or short circuit under fault conditions.

Voltage Rating
The voltage rating of a capacitor must be

equal to the total voltage across two capacitors when two capacitors bridge reinforced insulation.

Nominal Value
When two capacitors or resistors are provided to bridge reinforced or double insulation, they must have the same nominal value, otherwise the voltages will be divided unproportionately across the two capacitors or resistors.

Limited Current Circuits
The circuits bridging reinforced and supplementary insulations must be evalu- ated as limited current circuits if the output current is within the acceptable limits. The currents under single fault and normal operating conditions must comply with the requirements

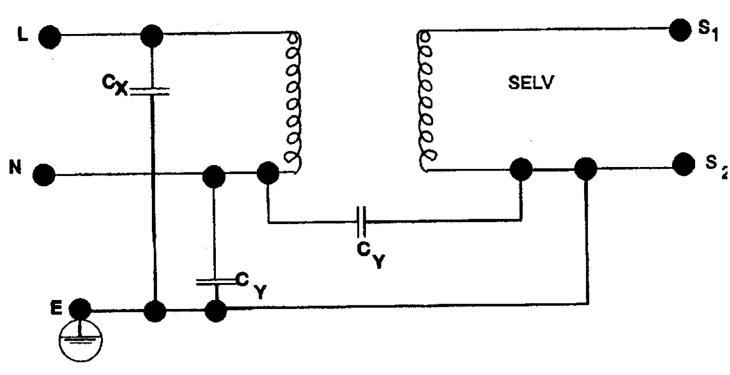

Fig. 2C
Total Earth Conductor Current ≤ 3.5mA

for limited current circuits,

Clause 2.4 of Standard C22.2 No 950. The measurement of current must be conducted after the electric strength test of Cl 5.3.

Leakage Currents (When Basic Insulation is Bridged)
When capacitors and resistors bridge basic insulation provided between live parts and earthed parts and earthed SELV circuits, the current through the earth conductor must not exceed 3.5 mA. In this case equipment should be reliably connected to earth. It is important to remember that the whole of this leakage current passes through the earth conductor. See Figures 2A, 2B and 2C.

- The circuit shown in Fig 2A is accept- able with a single Y-capacitor only if the ground path, including the wind- ing, is an acceptable ground path. The leakage current limit can be up to 3.5 mA.

- The circuit shown in Fig 2B shall apply if the winding does not meet the requirements of an acceptable ground path. The secondary leakage current shall be < 0.5 mA under single fault condition and < 0.25 mA under normal operation.

- The circuit shown in Fig 2C is accept- able if the ground path is acceptable The leakage current limit is 3.5 mA.

Leakage Currents (When Reinforced Insulation is Bridged)
When capacitors and resistors bridge reinforced insulations provided between live parts and unearthed metal parts and floating SELV circuits the leakage current must be limited to 0.25 mA. Under single fault condi- tion the current must not exceed 0.5 mA.

In this case, the whole of the leakage current could pass through the body of the person touching the unearthed part or float- ing SELV circuit. See Fig 1. When the secondary is not connected to earth or the secondary winding does not meet the criteria for an acceptable ground path, the second- ary leakage current limit shall be < 0.25 mA under normal conditions and < 0.5 mA under a normal fault conditions. Total earth leak- age current shall be < 3.5 mA.

Line-to-Ground Capacitors and Resistors These components are connected across basic insulation. In case of failure of basic insulation, the earth path must be able to carry the fault currents which would be generated. The overcurrent protective device characteristics will limit the current flow to a certain time depending upon the value of the fault current. The earth path from the earthed end of the capacitor or resistor must meet the requirements of CSA Standard C22.2 No 0.4. A resistor must have suf- ficient wattage, if provided for capacitor discharge protection (i.e. the resistor acts as a bleeder).

Note: The circuit diagrams are shown with capacitorsfor bridging insulations. Capacitors can be replaced with resistors. The darker path shows the earth path which should be testedfor its integrity.❑

Technically Speaking
Continued From page 5

peratures. The temperatures are so high that we usually say that these materials, metal and ceramic, are non- flammable materials.

The first method is to limit electrical heating such that the temperatures never attain material pyrolysis temperature. The common means for controlling abnormal electric heating is by means of fuses, circuit-breakers, or thermal cut-outs.

Actually, these are not two methods. The principle is that the electrical heating shall not cause the temperature of any fuel material to increase to the pyrolysis temperature. This is a compatibility issue of electrical heating and pyrolysis temperature. Both parameters must be considered at the same time.

Schematically, we have:
1. Electrical heating.
2. Thermal coupling of the heat to a material
3. Fuel material heating.
4. Ignition.

Electrical heating of a material occurs when the material is thermally coupled to the heat source.

The electrical heating involves two heat parameters, temperature and energy.

The first parameter is temperature. The temperature must be greater than the sum of the fuel material ignition temperature, and the temperature drop across the thermal coupling mechanism.

The second parameter is thermal energy. The thermal energy must be sufficient to heat the fuel material to ignition temperature. If the thermal energy is too small, then the fuel material will act as a heat sink and limit the temperature rise.

I want to illustrate the two ideas of temperature and thermal energy.

Consider a match. The match will readily raise the temperature of a wood shaving to ignition temperature.

But, the match will not raise the temperature of a log to ignition temperature.

In both cases, the match produces the same temperature and the same thermal energy. In the case of the log, while the temperature of the match flame is greater than the log ignition temperature, the thermal energy of the match flame is insufficient to raise the temperature of the log to ignition temperature.

This illustrates that material ignition requires both temperature and thermal energy. The principle is that a small thermal energy may be able to heat a small part to ignition temperature, but not a large part. (This is a simplification, but it illustrates the principle.)

In both cases, if the match flame temperature was less than the ignition temperature of the material, then, regardless of energy, or size of the material, the material would not ignite.

We want to prevent ignition. To do so, we need only control the temperature of electrical heating. If the temperature is less than the material ignition temperature, then, regardless of energy, ignition cannot occur.

Normal operation of equipment controls electrical heating. Normal operation rarely results in excessive electrical heating and consequent fire.

Virtually all electrically-caused fires occur under circuit fault conditions which cause excessive heating. So, we are concerned with electrical heating under fault conditions. (One exception is electric heaters which, depending on proximity to flammable materials, can cause fires under "normal" conditions.)

Electrical heating is the conversion of electric energy to thermal energy. Electrical heating is expressed by:

$P = I \times I \times R$

where P is power in watts,
I is current in amperes, and
R is resistance in ohms.

(For this discussion, we will not consider heating due to electric arcs. Rather, we will consider heating in low-voltage circuits, below 300 volts peak.)

Note that there are only two parameters involved in electrical heating, current, 1, and resistance, R. (Further note that electrical heating is independent of voltage.)

For electrical heating to occur, power must be dissipated in a resistance. If R is zero, then there is no electrical heating. For electrical heating, there must be a value of R greater than zero.

In evaluating a product for fire, we must look for candidate resistances in a relatively high current fault path. Often, these resistances are not discrete components, but rather are components whose resistance only comes into play under fault conditions. In other words, we need to include resistances that are negligible under normal conditions, but significant under fault conditions. Some such resistances are wire, PCB traces, connectors, switch contacts, and wire terminations. Each of these is assumed to be zero during normal operation. However, under fault conditions, with maximum current, cross-sectional area of a wire or PCB trace may be too small for the fault current and thereby overheat. Connectors and switches have contact resistance which can also dissipate power under overcurrent conditions.

Furthermore, candidate resistances must also be robust. That is, they must be capable of dissipating high power for enough time to raise the temperature of the fuel material to ignition temperature.

The other factor in power dissipation is fault current. What is the value fault current that can be expected? If the current is limited by a fuse, then the maximum continuous fault current is 110% of the fuse rating. If the current is not limited by a fuse, then the maximum fault current is determined by connecting a variable load to the circuit and adjusting for maximum current.

Maximum fault current is not the maximum rated output of a power supply. Most power supplies will output much more than rated current into fault. And, they will do so for an extended period of time. So, you must always measure the fault current with a variable load.

Then, using that current, you can evaluate the various candidate power-dissipating resistances to determine if the temperature exceeds material ignition temperatures.

One caveat: Sometimes maximum fault current will cause an immediate failure of a candidate power-dissipating resistance. If this occurs, then you need to re-test at a lower value of current to evaluate the long-term dissipation. This is because not all faults are short-circuit or maximum current. A fault current can be any value exceeding rated current up to maximum fault current.

If overheating occurs, then fire prevention is a simple matter of taking steps to reduce the resistance of the power-dissipating device.

Or, fire prevention is a simple matter of installing a fuse to limit the current to a value which will not cause overheating.

Fire prevention in electronic products is not a simple matter of following the construction requirements of standards. Fire prevention requires an understanding of fault currents and their paths, and power-dissipating resistances.

Fire can be prevented.

This discussion just gives a broad overview of general principles of electronic product fire causation and prevention. There is a lot more that can be said and can be researched. Even then, protection against ignition for any particular product will require more engineering and testing than currently required by our various safety standards. The extra effort will pay off in fewer fires than we now incur

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Your comments on this article are welcome. Please address your comments to the Product Safety Newsletter, Attention RogerVolgstadt, c/o Tandem Computers Inc., 10300 N. Tantau Avenue, Mail Stop 55-53, Cupertino, California 95014-0708. Or, send e-mail to VOLGSTADT-ROGEROTandem.COM. ❑

Get Involved!

We are always looking for volunteers to help with the newsletter (as well as the Central Committee and Local Groups).

Also, won't you take some time to write to the Editor with your questions or comments?

Have you come across any thorny problems or come up with good solutions lately? If so, won't you share them with us?

See Page 2 for contacts.

Guest Editorial
Continued From page 1

Recognized testing laboratories.

Another phenomenon is the cooperative agreement, or Memorandum of Understanding (MOU) between testing agencies throughout the world. These agreements allow a manufacturer to work with one laboratory to obtain more than one test mark. Often one agency can perform the testing, issue a report and submit data to the other agency who then issues their test certificate. These agreements take on many forms. Some are still in the planning stages; some do not allow for much reduction in effort. Yet some are well established and require only submittal of the proper test data and fees to obtain the additional test mark(s). One such example that the author has had experience with is the CB Scheme. Provided the appropriate deviations are specified in the original test plan, the receiving agency should only need to review the construction of the product. You should be careful, however, and research the requirements of each testing agency before using any form of cooperative agreement.

Another aspect to the NRTL program is that to become a NRTL, the laboratory does not have to be a US based firm. In the case of Canadian Standards Association, it is now possible to go to one agency and obtain both a Canadian and US test mark. The CSA Monogram with the "NRTL/C" notation is finding widespread acceptance in the US. CSA is also accepted as a test laboratory by the City of Los Angeles. In addition, the Standards Council of Canada has accepted UL as a Certification Body. Instead of the CSA "NRTLIC" mark, a manufacturer may go to UL and request the UL "C" test mark. The UL "C" mark is being accepted as equivalent to the CSA Monogram for many types of equipment. One set of tests, one laboratory, one test mark, and two market countries.

All of these new programs, schemes, or agreements are causing our jobs to change. In some ways, the UL "C" or CSA "NRTL/C" is simplifying our jobs. But choosing the best testing and approval plan for the company is becoming more involved.

The goal is the same as before, but the way to reach that goal has changed. The choices available to us have grown. With these new choices come different and better ways to obtain the mix of certifications that will allow the sale of our product in the most countries. Consequently, planning our test and submittals will be different. On top of the changing array of testing and certification services available to us, the requirements for certification are changing. For example, as I enter the area of telecom approvals for products that have network features, I find the need for different safety approvals since some of the test marks I have relied on before are not accepted by certain PTTS.

I find myself spending more time planning the certification of my product than the actual testing. The range of selections of third party certification is changing rapidly. The correct choice of which laboratory to use and which certification marks to get is not as simple as it used to be.

I wish all my colleagues successful hunting in looking for the right choices.
John Reynolds❏

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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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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