IEEE EMC SOCIETY

The Product Safety Newsletter

Vol. 6, No. 3 May-June 1993

What's Inside

Chairman's Message

PSTC and the Future of Product Safety

In the last few days I've had some very interesting conversations with various knowledgeable indi viduals on the topic of product safety practice.

All the people I spoke with are familiar with our Product Safety Technical Committee, some only through this newsletter, and have been involved in product safety for many years. They have radically different working backgrounds, so one would expect their perspectives to be quite different from each other. However, their observations on product safety practice were remarkably similar and are worth sharing:

- Product safety practice is more specialized within industries than is the case with some other safety disciplines, such as workplace safety;
- Little common ground is acknowledged unless industries are related;
- There is a tendency to keep the blinders on with respect to practices and tools employed in other safety disciplines.

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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.

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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UL's Mark for Canada

by Ken Haas,
Corporate Manager — International Projects
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[As we mentioned last issue, UL acceptance in Canada is news, just as CSA as a NRTL is news. We asked both UL and CSA to describe what their new status will mean to regulatory engineers - advantages and possible disadvantages, how submittal and certification processes could change, recognition by local authorities (e.g. - Province of Quebec, City of Los Angeles), plans for resolving problems, and so on. UL has its say this issue, as CSA did last issue. Please write with your questions or comments about these articles. - Editor]

On February 16, 1993, UL announced that it would begin offering a certification mark for use in Canada to indicate compliance with Canadian standards. Never before has UL offered a certification mark for use outside the United States. In that February announcement, we also reminded our clients of existing pathways into Canada. Dubbed the "parallel path," the UL Canadian certification program offers manufacturers flexibility to select the certification option best suited for their needs.

The Parallel Path for Canada

UL's parallel path is really three different ways to achieve certifications for Canada and the U.S. You can —

* Submit products to UL for testing to both U.S. and Canadian standards. UL will then authorize you to apply the UL Mark for the United States and the UL Mark for Canada.
* Use UL's cooperative agreements and reciprocal data exchange programs with other Canadian certification organizations to gain the UL Mark for the U.S. and other Canadian certification marks through one coordinated product submittal to UL.
* Work with UL to gain certifications for the U.S. and work independently with other Canadian certification organizations to gain certifications for Canada.

Not all of these approaches are new. Traditionally, many of you have worked independently with UL and certification organizations in Canada to get your product certified. Ultimately, each client must determine — on an individual basis — which of the parallel path options is the most useful and appropriate. You can choose based on the individual market requirements for each product and your own overall business needs.

Using the Parallel Path

The parallel path options are intended to be transparent for our clients. If you elect to have UL certify your products to U.S. and Canadian standards, simply provide your UL project engineer a copy of any existing Canadian certification report for the products along with the model numbers you wish covered and the production dates for those models. Your UL project engineer will conduct a review of the report and will determine if any tests are necessary. Authorization can come quickly — often, within a day — and at a minimal cost.

If you don't currently have a certification from another Canadian certification organization, simply submit

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In My Opinion....

[This column is the first of what we hope will become a regular feature of the PSN.

We are all familiar with the situation, "Yes, I know what the Standard says, but what does it mean?" Most of us have found that what Standards mean can depend upon who is doing the interpretation.

The IEC has established a procedure to review questions and provide authoritative (but non-binding) interpretations of their Standards. We have reprinted a few of their answers to questions about IEC 950 in previous issues of the PSN. Other Standards writing bodies have similar procedures.

Unfortunately, questions to the IEC must be submitted through the National Committees, a process that takes quite a while, and the answers, although authoritative, may have a vested-interest point-of-view.

This column will provide interpretations by knowledgeable product safety professionals to answer your Standards questions. Their answers are their opinions, and cannot be considered official or binding in any way, even if the responder is or has been a member of a Standards Committee or a safety agency.

However, the answers may clarify points that have puzzled you and may provide good starting points for discussions with various agencies. We would be happy also to hear from our readers if they would like to further clarify or dissent from the interpretations printed here.

The first responder is Rich Nute, who writes "Technically Speaking" for the PSN. — Editor]

My questions concern the maximum current rating of a Laboratory Equipment product with respect to the product's power cord attachment plug.

UL 1262 (the Standard for Laboratory Equipment), 3rd edition, states in paragraph 15.2.2B: "The attachment plug shall be rated for use with a current not less than 100 percent of the rated current, and at a voltage appropriate for the rated voltage of the equipment."

CSA C22.2 No. 151-M1986 (Laboratory Equipment), paragraph 4.5.2.5 states: "Power supply cords shall have ampacities at least equal to the total input in amperes marked".

IEC 1010-1, as well as CSA 1010.1, and the soon to be released UL1262, 4th edition, paragraph 6.10.1 state: "mains supply cords shall be rated for the maximum current for the equipment"

However the U.S. National Electric Code (NEC) seems to contradict this. Section 210, para. 19-24, seems to indicate that a product that is considered to have a continuous load shall not be rated more than 80% of the branch circuit. ("Continuous load" is a product that could operate at full load for 3 hours or longer.)

Paragraph 210-23 seems to indicate that if the branch circuit only provides one outlet, then the rated load current may equal the branch circuit current, but if the branch circuit provides more than one outlet, then the rated load current shall not exceed 80% of the branch circuit current. If this interpretation is correct, then it seems logical that instructions requiring a dedicated branch circuit would be required for continuous load

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News and Notes

by Dave Edmunds
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CSA Makes Technical Registry
CSA has created a directory called the "CSA Technical Registry" which lists by region the products covered, their class number, a contact with extension number, an alternate contact and the relevant standard number. The directory is available from your local CSA office.

Change in Some European Mains Voltages
The following quote was extracted from the June issue of the British Standards Institution Newsletter:

"Tim Eggar, Minister for Energy, has announced that from 1995 the UK will reduce its public electricity supply system to a nominal 230 Volts to harmonize with the other European Community countries. This will mean a reduction from a nominal 240 volts for England, Scotland, and Wales, no change for Northern Ireland, and an increase from 220 volts for the rest of the community".

UL Subject 1950 Bulletin
UL has published their Subject 1950 Bulletin, dated May 14, 1993 which cover UL's position regarding (1) K-Factor Ratings (which indicate the suitability of a distribution unit to supply non-linear loads), (2) Rack-mounted Equipment, (3) 48 Vdc Supply Sources, and (4) Optical Isolators. A copy of the bulletin should be available through your local UL office.

New IEC Working Group on EMC and Functional Safety
A new working group (WG14) is being set up under the IEC Technical Committee No. 77 to prepare a technical report giving guidance on the influence of EM phenomena on electrical and electronic equipment and installations. The guidance will include methods to assess the functional safety of electrical and electronic equipment and installations. Further information can be obtained through the following:

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Technically Speaking

TESTING SAFETY INTO PRODUCTS

In a recent discussion with a third-party certifier, there was an implication that a product cannot be deemed safe until it has been tested.

It was further implied that the outcome of the testing could not be predicted.

The general attitude of this discussion and other similar discussions that I have had is that we must test the safety into the products. In other words, the safety of the product is not known until it is tested.

*****

For the product designer, this attitude is almost like "buying a pig in a poke." This (safety) without advance knowledge as to the requirements being applied to his work. I tell him to design his product and after I get a unit and test it, I tell him whether or not his work is acceptable, i.e., passed the tests.

Indeed, this is the safety certification process. The certification professional only works with a fully functional product. He compares the actual construction to the various applicable requirements in the standard.

The designer wants to know what requirements apply to his product so that he can account for them in the initial design. However, many safety professionals refuse to review the design until they have a sample in their hand. They say they don't know what requirements will apply until after they see the product.

Fortunately, most designers have been through the process at least once, so they know the ropes and can usually design the unit so that it passes most or all the tests the first time through the test protocol. The new designers get help and advice from the experienced designers so as to minimize the changes that might result from the safety testing and "eyeball" examination of the hardware.

Unfortunately, some safety professionals and some certification professionals don't believe they're doing a good job unless they can find something wrong with the product. So, no matter how thorough a job by the designer, something will be found that will require a change.

Is it possible to design safety into the product such that we can predict successful outcome to both testing and "eyeball" examination BEFORE the first prototype is

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Area Activities

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[John Reynolds has been involved with the Product Safety Committee since it was known as the "CSA User's Group". He has served as Chairman, Vice-Chairman and Secretary for the local PSTC group associated with the Santa Clara Valley Chapter of the EMC Society.

We are happy to welcome John to the Product Safety Newsletter as the Area Activities Editor. This is a key position to improve communications among the local product safety groups and to let PSN readers know "what's happening" in the PSTC. But first, YOU have to tell John! - Ed.]

Hello, and welcome to the rebirth of the Area Activities column.

In this column I will highlight the activities of the local product safety groups associated with the IEEE Product Safety Technical Committee.

Constructing a building requires a firm foundation. Similarly, building a society requires strong local chapters.

I believe that supporting and encouraging the development of vigorous local product safety groups is one of the best ways to work towards the PSTC goal of creating an IEEE Product Safety Society. That's what this column will do.

You will see meeting details here: speaker and topic, a synopsis of the presentation, where to find more information, what is happening next month. Please send me as many details as possible because other groups and individuals are interested! Other activities, such as participation in a local colloquium, presenting awards at a science fair, even organizing a picnic, are great to hear about, too.

In addition let us know how we can be of help to your local group.

Although I expect to be in direct contact soon with local product safety groups, please start sending your meeting notices and bulletins me.

Thanks,
John C. Reynolds
■

Prevention of Electric Shock

by Paul W. Hill & Associates, Inc.
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[We are grateful to the author for providing this second installment from his book, "Product Safeness As A Design Parameter", 2nd Edition, 1990 by Paul W. Hill. 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 - Editor]

If a list of safety incidents for widely marketed electronic and electro-mechanical devices were made the list might appear as follows:

1. Electric Shock
2. Fire
3. Mechanical Hazards
4. Toxic materials and Chemicals
5. Thermal Hazards
6. Ergonomics

Ergonomics would appear on the list because operator discomfort awkward placement of controls and awkward operator or servicing positions are viewed as contributors to the overall safe operation of the device and therefore safety related. However, it is electric shock that is given the most attention and number of requirements in industry product safety standards.

Since most safeness flaws are associated with electric shock this is a logical first consideration. Prevention of electric shock is a series of design actions which insulates, shields, interlocks or otherwise restricts access to hazardous potentials.

The general design approaches to the prevention of electric shock are:

1. Design to avoid exposure to electrical hazards.

2. Restrict access to electrical hazards which can not be reasonably avoided by design using guards, barriers, interlocks and lockout devices.

3. Provide two levels of protection from electric shock such that after a single fault in the electrical insulation system, and any consequential faults, one level of protection remains.

4. Alert or warn users and service personnel of hazards which can not be avoided by design or access to the hazard fully controlled.

Electrical safety standards are in general agreement that hazardous levels can be defined as follows:

1. Hazardous voltage is 42.5 volts peak or 60 volts

DC. Some standards increase the AC voltage limit above 100 Hz. Some use 42.5 volts peak or DC.

2. Hazardous current is a continuous current flow greater than 0.75 mA. Newer standards use 0.5 mA. Class II equipment limit is 0.25 mA.

3. Hazardous energy is an energy level exceeding 20 joules reactive, or continuous power of 240 VA at 2 volts.

Recent investigation into electric shock by technical groups in the IEC confirm these levels as reasonable. The work of these groups suggests additional considerations, not yet incorporated into safety standards, relative to electric shock:

1. Square waves produce more serious burns than a sinusoidal wave shape of similar frequency and amplitude.

2. Children can tolerate only about one half the current level of adults, and women only seventy percent that of adult males.

This work suggests to product developers that equipment accessed or operated by women, young adults or children should consider acceptable electrical hazard levels to be significantly less than those permitted by standards.

The Insulation System.

The major purposes of an electrical insulation system are:

a) electrically separate conductors of different polarity or voltage levels for proper functioning of circuits, and

b) prevent electric shock.

The proper functioning of electrical circuits is not as demanding of the insulation system as the prevention of electric shock. It is important to understand the difference between these two functions. Certain insulation requirements, which appear to be well beyond what is required to obtain satisfactory electrical performance in a circuit, are necessary for the prevention of electric shock.

To illustrate these two functions of insulation, consider the insulation requirements for the coil of a transformer. The varnish coating on the wires of the transformer coils need only prevent shorting between the turns of the coil windings to insure proper functioning of the coil. The function of the coil, generating a magnetic field, would be seriously impaired if the turns of the coil were not electrically insulated. The varnish material insulating the coil wire is capable of providing functional insulation, preventing coil turns from shorting each other, but is not sufficient for providing protection from electric shock. On the other hand, the insulation of the power cord providing power to the same coil windings has much more robust insulation because it must also provide protection from electric shock.

Therefore, when considering electrical insulation it will be in its more demanding role of preventing electric shock.

The insulation system is made up of dielectric materials surrounding a conductor or by spatial separation of conductors as shown on the next page.

Classification of Insulating Systems.

Electrical safety authorities recognize three major types or classes of insulation systems for protection from electric shock. One class concerns circuits which are low power and are not hazardous under operating or fault conditions. An example would be a hand held battery powered calculator. By design these are inherently safe relative to electric shock. An insulation fault or direct contact with circuit conductors in the battery powered calculator does not present a hazard to operators or service personnel. Standards refer to this insulation system as Class III.

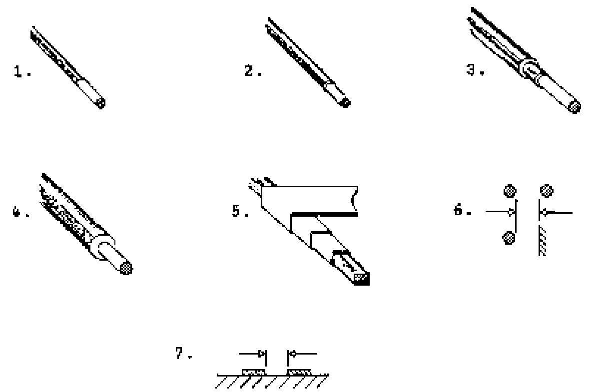
For those devices containing hazardous electrical potentials, two insulation systems for protection from electric shock are accepted. The first is the provision of a conductive earth ground circuit such that an electrical fault in the insulation system is conducted through a low impedance circuit to earth ground. In this system all conductive metal parts which are accessible, and likely to become live with hazardous voltages under fault conditions, are conductively connected to the low impedance earth ground circuit. This is referred to as a Class I insulation system.

The second system is one in which the basic insulation is provided with a second independent level of insulation called supplemental insulation. This electrical insulation system is called Double Insulation or Class II. Devices designed as Class II carry a unique symbol on the equipment rating plate of a square within a square.

Both insulation systems have some very critical dependencies. For Class I a very low impedance path to earth ground must in fact exist, otherwise the fault current will not be safely conducted to earth but seek another path, possibly making the operator or service person the fault conducting path. A second critical requirement is the ability of the earth ground circuit to carry the fault current reliably until the fault is removed or power to the equipment is interrupted. This is commonly referred to as the safety earth ground circuit "fault current carrying capacity".

Class II devices must not permit access to conductive parts protected by basic insulation only. Not being provided with an equipment safety earth ground circuit, a fault in the basic insulation would seek any

Electrical Insulation Types



1. **Operational or Functional Insulation.** Conductors coated with varnish or enamel for the purpose of proper circuit function only and does not provide protection from electric shock.

2. **Basic Insulation.** Insulation which satisfies the basic requirements for protection from electric shock.

3. **Supplemental Insulation.** Insulation consisting of two independent insulation systems, each capable of meeting the requirements for basic insulation.

4. **Reinforced Insulation.** One robust insulation system electrically equivalent to supplemental insulation.

5. **Insulating Tape.** Electrical insulation material in tape form. Two or more layers are generally required to qualify as basic insulation.

6. **Separation in Air.** Separation distance determines if the separation in air qualifies as basic, supplemental or reinforced insulation.

7. **Insulating Substrate.** Printed circuit boards are the most common example. Separation distance between conductors on the substrate determines if the insulation qualities as basic or supplemental.

conductive path to earth, possibly the operator or service individual as the conduction mechanism. For this reason protection from electric shock in Class II devices depends on a second electrical insulation completely independent of the first or basic insulation.

Class I and Class II insulation systems can be characterized by three electrical parameters:

a) Dielectric Strength,

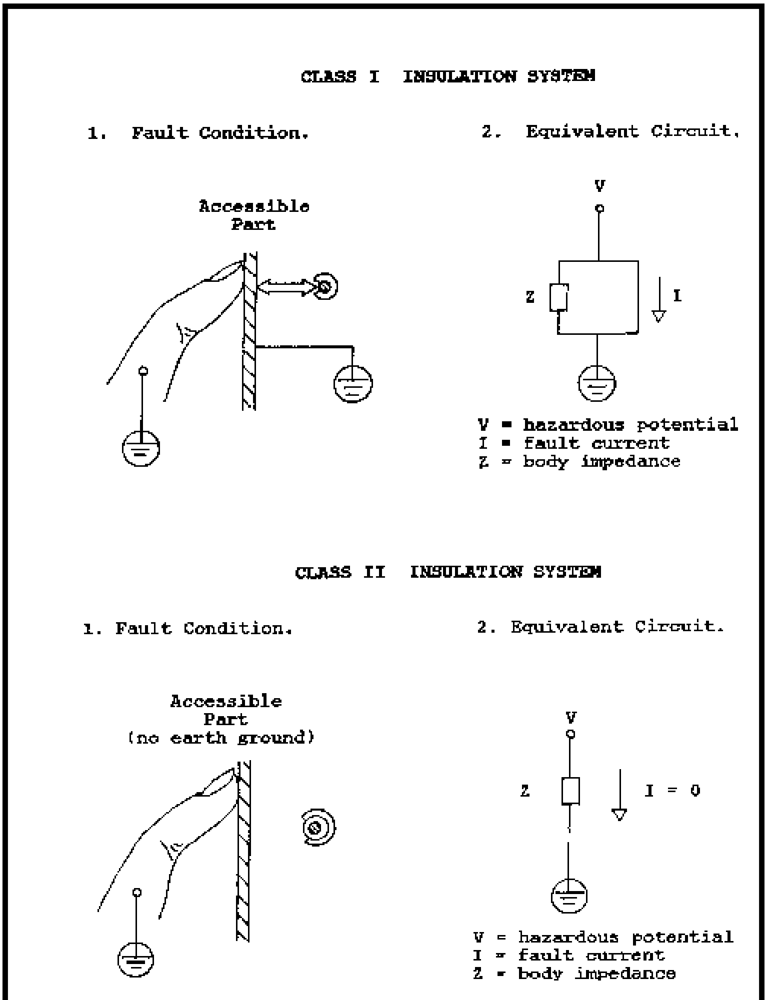
b) Insulation Resistance, and

c) Leakage Current.

All three parameters directly influence the level of protection provided against electric shock.

Dielectric Strength.

The insulation selected for a given conductor must be adequate for the normal working voltage of the circuit plus some additional margin to account for likely voltage excursions. It must also account for decay in its insulation properties over time. It must also be resistant to damage likely to be encountered in its application such as flexing, abrasion, sharp bending and vibration.



Dielectric strength, "withstand voltage" in some standards, is the principal characteristic of an insulation system. It is required by most electrical safety standards to be ten or more times the normal rated working voltage of the equipment. The test is usually made on Class I devices by applying the required voltage between the earth ground circuit and all other circuits which might assume hazardous potentials. For Class II devices the earth ground is simulated by a metal foil or metal plate, or by reaching an internal conductive part with an earth ground probe.

Dielectric strength tests are short duration tests because there is reason to believe prolonged high voltage stressing degrades the insulation. Tests are typically one minute in duration and voltages may be either AC or DC. If components bridge the insulation system, such as filter capacitors from phase or neutral to ground, the DC test is recommended. DC generates less current flow in insulation bridging components, such as capacitors, which can not easily be disconnected for the test.

All test agencies require, as a condition of certification, that each unit produced be dielectric strength tested as part of the manufacturing process. The manufacturer has an option for either AC or DC testing and either a full one minute test or a short term one-second test at a higher test voltage level.

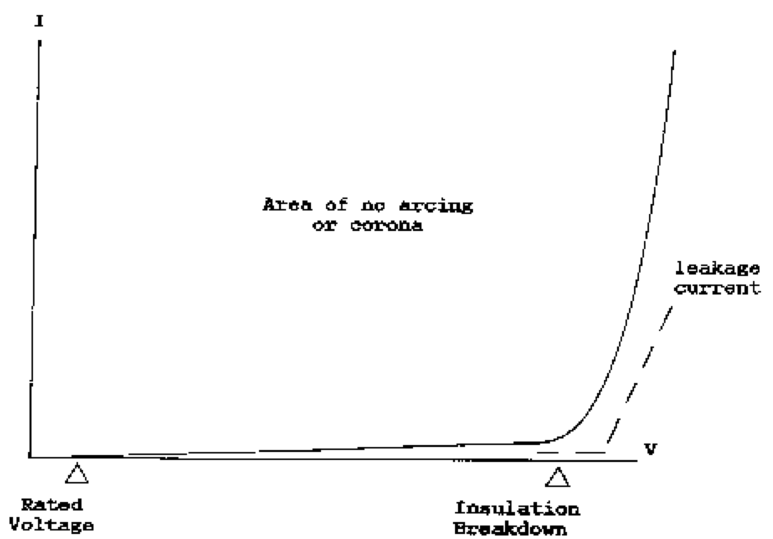
Heating insulation above its thermal rating causes rapid deterioration of its dielectric strength, and consequently its level of protection from electric shock. A common design fault is failure to provide adequate thermal protection to insulation subject to fault conditions. Safety certification tests always include simulation of a cooling fan failure or cooling vent openings blocked while monitoring the temperature rise of insulation.

The dielectric strength of certain primary power components are singled out for special attention by safety certification agencies. Power cords, switches, line filter capacitors and other parts that play key roles in maintaining the integrity of the insulation system are monitored closely by certification agencies.

The designer must select these components with adequate voltage ratings, appropriate dielectric ratings and provide them with thermal protection.

In many cases safety-sensitive components are acceptable to certification test agencies only if obtained from approved manufacturers. Examples are primary power switches, fuses and capacitors between line and ground conductors. More on the subject of component approvals and recognition by test and certification

Ideal V/I Characteristics



Note that the insulation breakdown is much higher than the rated working voltage. This is necessary to satisfy the dielectric strength test requirements which are ten to fifteen times the rated working voltage of the insulation system. This appears to be a rather large safety factor, approaching or surpassing those of highway bridges or aircraft components. However, it takes into account, collectively, the separation of uninsulated conductors, exposure to moisture or condensation and the gradual decay of insulation properties with time.

Safety standards will require these properties to be evaluated both at room ambient and after exposure to humidity and temperature.

agencies is covered in Section 19, Components.

Insulation Resistance.

Insulation resistance is a measure of the ability of the insulation to maintain minimum electrical insulating properties when exposed to elevated temperature and humidity conditions. The test is made with a DC voltage on the order of five hundred volts following some period of exposure to high humidity conditions. In this test a properly designed insulation system should give insulation resistance values in the tens of megohms.

Insulation resistance is considered a "type test" and is not normally required on each unit as part of the manufacturing process. However, it is considered good design practice to periodically conduct this test to verify continued product certification compliance as the product matures or experiences supplier changes or manufacturing process modifications.

Leakage Current.

If an insulation system were perfect, no electrons would physically pass between insulated conductors at difference potentials or of different polarities. However, some electrons do make the passage due to imperfections in the insulation or because a component, with leakage of its own, bridges the insulation system for some functional reason. In well designed insulation systems leakage currents at normal working voltages would barely be measurable. However, when components bridge insulation , such as a capacitor in an RFI filter circuit, leakage currents can occur at hazardous levels.

The standard leakage current test is made by inserting a current measuring device directly in the earth ground circuit, or by inserting a 1500 ohm resistor in the earth ground circuit and calculating current from the voltage drop across the resistor. For Class II equipment the ground is simulated with a foil wrapping or metal plate. The test limits and recommended test circuits are given in safety standards appropriate to the equipment and insulation system. Leakage current is considered to be a type test and is not required to be conducted as part of the manufacturing process. However, periodic verification that leakage currents continue to comply with the equipment certification requirements is recommended.

Recently issued standards may require a different measurement approach to leakage current called "touch current".

Arcing and Corona.

Arcing and corona are either not addressed or not viewed as insulation failure criteria in some safety standards. However, the absence of arcing and corona are important criteria for a well designed insulation system. Arcing and corona may occur during dielectric strength tests and during some fault simulation and abnormal operating tests. It indicates that the insulation system is not capable of supporting the voltage being impressed.

Good design practice is to consider arcing and corona occurring at the test conditions encountered in product safety standards as indication of a borderline insulation system. The current and voltage characteristics of the ideal insulation system is shown in the graph on the previous page.

Mechanical Aspects of the Insulation System.

Up to this point, the discussion of insulation systems has centered on the electrical aspects. Once the electrical insulation properties in the system have been provided they must be maintained over the operational life of the product. The insulation system must be protected against physical damage which reduces the dielectric strength, reduces minimum separation of conductors and general abuse of wires, cables, cords and conductor terminations.

Wires, cables and cords must have fixed terminations and not be subject to becoming loose or changing positions such that spacings between uninsulated portions of conductors are reduced. Conductor terminations must be able to tolerate operational vibration and mechanical shock likely to be experienced in use. Conductors, wires and cords must be provided with strain relief devices such that stresses placed on conductors are not transmitted to electrical connections or terminations.

Wiring channels and wiring support devices must have smooth surfaces and be free of sharp edges and acute bends. If any conductors are intended to repeatedly bend or flex they must have guides and supports to maintain proper positions.

The enclosure must prevent mechanical damage to fixed insulation and prevent dust and liquids from coming into contact with conductors and terminations. Openings in enclosures must be arranged such that the entry of foreign objects do not damage or bridge the insulation.

Thermal Protection of the Insulation System.
Heating of insulation materials is a major cause of the decay of insulation properties. Most insulation materials have maximum temperature ratings assigned. In electrical safety standards temperature limits are associated with the insulation class.

Most electrical safety standards carry tables illustrating the minimum cross sectional area for conductors and related current carrying limits. Wires not large enough to safely carry operational currents will show excessive temperature rise during abnormal tests and fault simulation tests.

Temperature rise of insulation and components is monitored under fault conditions such as failure of a motor to turn when powered on (locked rotor test), failure of a cooling fan, and blocked ventilation openings. Blocked ventilation openings simulate a unit positioned for use in a corner or otherwise positioned such that the flow of cooling air is severely restricted or cut off. Additional protective measures to prevent thermal stress on the insulation system and reduce the risk of fire will be discussed in the section on Prevention Of Fire In Equipment.

Atmospheric Influences on the Insulation System.
Insulation exposed to harsh operating ambients, both internal and external to the equipment, can degrade insulation properties. The principal elements are dust, particles precipitated from the air and polluting or corrosive conditions within the equipment. Dust and accumulated particles often become conductive when exposed to moisture and condensation. The surfaces of printed circuit boards are of particular concern because spacings between conductors are small and easily bridged by accumulated dust or particles precipitated from unfiltered cooling air streams.

Safety standards permit smaller spacings between conductors if the circuitry is protected from the accumulation of dust and other deposits. Protection provided by the enclosure, a coating over printed circuit boards or restricting usage of the equipment to non-polluting ambients are the conditions imposed for the use of small conductor spacings. The reduced spacing values are listed in the tables for spacings, creepage and clearances with the qualifying conditions given in notes to the tables.

Spatial separation of conductors is an important consideration in electrical insulation systems must also be considered. ■

Technically Speaking
Continued From page 6

built? Can a prototype be deliberately and overtly designed and constructed such that it passes all tests and the "eyeball" examination the first time?

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Henry Petroski, in his book "To Engineer Is Human," says, "The process of engineering design may be considered a succession of hypotheses that such and such an arrangement of parts will perform a desired function without fail."

This is an intriguing statement, "...perform a desired function without fail." Does or can this statement apply to the safety function of the product?

Petroski is a civil engineer. In his book, Petroski uses bridges and similar structures for examples to support his thesis that an engineer can indeed predict the successful outcome of design, including the successful outcome of the safety functions of a particular design.

Bridges, upon completion, are not subject to tests equivalent to the hi-pot test, the leakage current test, the mold-stress relief test, the enclosure impact test, etc.

How, then, can we accept the safety of a bridge with no safety testing (on the finished product), when we cannot accept the safety of an electronic product without successful safety testing of the finished product?

The answer, of course, is Petroski's assertion that design is hypotheses that the arrangement of parts will perform the desired function without fail. By understanding the various parameters of the materials used in the bridge, and by hypothesizing the static and dynamic loads applied to the bridge, the designer can reasonably predict that the arrangement of parts will safely withstand the static and dynamic loads.

Petroski points out that when a bridge fails, the designer's hypotheses are proven wrong. Fortunately, very few bridges fail, but when they do, the failure is spectacular. And, the failure is subject to rigorous analysis such that other bridge designers don't use a flawed hypothesis.

The same process, hypothesizing the arrangement of parts for successful outcome of testing, can be used in the design of electronic products.

The issue for the electronic product designer is, what are the desired safety functions?

If the designer knows the desired safety function, then he could apply the process of engineering such that his selection and arrangement of the parts will obtain the safety function without incurring a failure.

There are only a handful of safety tests for products. If we know what facets of the design are critical to the successful outcome of the tests, then we can predict successful results from testing.

Let's examine the more common safety tests.

1. Hi-pot or electric strength test.

This test is applied between mains and ground, and between mains and secondary circuits. It tests the insulation between the mains on the one hand, and the ground and secondary circuits on the other hand. The insulation is comprised of solid material and air in parallel.

If we have sufficient distance through these two insulating media, then the product will pass the test.

For all practical purposes, electric strength is proportional to distance through the insulating media.

To predict success in the hi-pot test, the distances through the insulating media must be greater than the product of the hi-pot test voltage and the volts-per-unit-distance rating for each particular insulating medium.

We can largely ignore distance through solid insulation as almost any solid insulation at almost any thickness greater than zero will easily pass the common 1500-volt hi-pot test. One wag reported that one layer of Charmin is good for 3000 volts!

If the distance in air between any part of the mains circuit and any part of either the ground circuit or the secondary circuit is nowhere less than 1.8 mm, then the product will pass the 1500-volt hi-pot test. As a rule-of-thumb, the volts-per-unit-distance rating of air is about 1.2 kV/mm for 1500 volts.

So, if we know all the distances are adequate, we can predict success for the hi-pot test. The only trick to predicting success is to find all the paths in air around edges of transformer insulation and similar constructions.

(For the purposes of my point, I have ignored the requirements contained in the various standards for distances through insulation and through air.)

2. Leakage current test.

Leakage current in the grounding wire of a product is a function of the insulation resistance and the discrete and distributed capacitance between mains and ground, and between mains and grounded secondary circuits.

Insulation resistance in modern insulations is sufficiently high that it can be ignored as significant to the measured value of leakage current.

Capacitance, both discrete and distributed, are the significant contributors to leakage current.

Discrete capacitors contributing to leakage current are those used for line filters and those sometimes used in switching mode power supplies between the dc and ground. Using Ohm's Law and the capacitive reactance of this total capacitance we can calculate a minimum value of the leakage current.

One distributed capacitance contributing to leakage current is that of the transformer primary to core, to shield, and to secondary. The value of these capacitances will depend on the particular transformer construction, with layer-wound transformers being somewhat higher than triple-flange transformers.

Another distributed capacitance is the power cord itself. An 18 AWG SVT cord will contribute about 5 microamps per meter.

And, of course, the primary circuits themselves have distributed capacitance to ground. Usually, this is the least value of the various distributed capacitances.

So, we can predict leakage current from the parameters of the various components of the primary circuit. We may not be able to predict an exact number, but we can at least predict pass or fail.

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I could continue with other safety tests such as the enclosure impact test, the component fault tests, etc. Some years ago, the Product Safety Newsletter published an article on how to predict the outcome of the stability (inclined plane) test.

So, it is possible to design safety into the product such that we can predict successful outcome to both testing and "eyeball" examination BEFORE the first prototype is built!

In fact, I measure myself on the number of test failures of the products I am involved with. My goal is zero failures per product at any time during the product development program. That is, each and every prototype should meet the complete set of safety requirements. I achieve that goal.

Let me make a distinction between product safety professionals and certification house safety professionals. The product safety professional who advises designers can achieve a goal of no test failures. The certification house safety professional must necessarily take a "show-me" attitude as he is not involved in advising the designers. Having said that, the certification house safety professional should nevertheless be able to "eyeball" a product and predict success or failure for a large number of the tests.

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Product safety is a matter of prediction. As professionals, our job is to predict the future, to predict success of the safety function of the products we work with such that injuries will not occur just as civil engineers predict that bridges do not fall.

If we are to predict a safe future for the users of the product, then we should be able to predict successful outcome of safety testing. We should not rely on the testing to prove the safety of the product, but rather use the testing to prove our ability to predict the future.

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Your comments on this article are welcome. Please address your comments to :

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10300 N. Tantau Avenue,
Location 55-53,
Cupertino, California 95014-0708.

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UL's Mark for Canada
Continued From page 3

your product as you normally would. Under this option, you will save significant costs, since you will be covered by a single, UL-administered follow-up services program.

For those clients wanting to take advantage of UL's cooperative agreements, let your project engineers at both UL and the other Canadian certification organization know that you are interested in using data package exchange. That way, your UL project engineer will be able to develop an evaluation program that covers the requirements of both U.S. and Canadian standards. Once you select which of the organizations will actually conduct the evaluation, submit your product to that organization for testing to both sets of requirements. However, since each organization will handle its own factory visits, your product will be covered by two follow-up services programs.

Assessing Product Acceptance in Canada

UL's accreditations as a Testing Organization (TO) and Certification Organization (CO) by the Standards Council of Canada (SCC), a crown corporation that can legally grant complete federal accreditation, provide the basic acceptances needed for any certification mark in Canada. These accreditations mean that UL can evaluate products to Canadian standards and authorize labeling of those products with the UL Mark for Canada.

The scope of UL's SCC accreditations covers all the product areas we currently evaluate, all UL facilities, and all UL certification programs, including those using client developed test data. This means that you won't have to have products re-tested at another location because they weren't originally tested by an accredited facility. And, you can continue to work with the UL office of your choice — you aren't limited to working with a single facility.

The final result is the UL Mark for Canada. ■

News and Notes
Continued From page 5

Another Airline Bans Consumer Electronics
The following material was extracted from "Newsbytes"
Japan Airlines announced recently that effective June 1, 1993, it is banning the use of personal electronic devices such as CD players, portable electronic games, and laptop computers during critical take-off and landing portions of all flights. The airline joins Northwest, Continental, US Air, and American Airlines in attempting to prevent electronic interference. Also restricted are video cameras, electric shavers, cellular telephones, wireless electronic devices and other equipment designed to transmit electric waves. The restrictions are spreading among the airline industry even before the Federal Government concludes its tests on the possible dangers posed by personal electronic devices. That testing is expected to be completed in October, 1993. The bans are being imposed based on an advisory from the Technical Committee of the International Air Transportation Association concerning the possibility interference to aircraft electronic systems. Proof of interference has not yet been made.

Testing Company obtains NRTL status from OSHA
The United States Testing Company's (USTC) California Division in Los Angeles was recently recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL). The accreditation allows USTC to list, label, and certify products for electrical safety. Further information is available from NSTC directly (Western Region: David Heywood, 800-285-8378; Eastern Region: Stephen Grimes, 800-777-8378).

TÜV Office Opens in Switzerland
Apparently the TÜV Product Service GmbH has been approached by ETSI (Swiss Government) to open an office in Switzerland and achieve national recognition. When this agreement is finalized, Product Service will be able to offer direct competition to SEV in Switzerland for product approvals.

This is good news for those who must deal with SEV, since Switzerland has opted out of the EEA (EC+EFTA), and Swiss national recognition will be required for some products for the forseeable future. (No contact is available for questions on this item).

NEMKO Now Established in the US
NEMKO, a European certification agency for electrical products has now opened a wholly owned subsid-

iary office under the name of "NEMKO Product Safety, Inc." in San Diego, California. The office will provide services to North American manufacturers seeking acceptance on the European NEMKO safety certificates. The services include processing client applications and performing product conformity assessments and testing at the manufacturer's premises. Updated technical information covering the European requirements and standards is also offered.

NEMKO is a full member and active participant in the International IECEE CB Scheme, the CENELEC Certification Agreement, and the Nordic Agreement to simplify multi-national certifications. Also, NEMKO is qualified to perform ISO 9000 quality management assessments.

NEMKO Product Safety, Inc. is first of all staffed to support computer and audio equipment manufacturers, but assistance can be arranged for applicants of all types of electrical equipment. Further information can be obtained from contacting NEMKO Product Safety, Inc., 2131 Palomar Airport Road, Suite 300, Carlsbad, CA 92009. Their phone number is 619-431-5131; fax number is 619-431-2449.

Delay to UL's Battery Disconnect Requirement:
The UL 1950 requirement for providing a means for the battery disconnect at the EPO switch has had the effective date changed from 6/94 to 12/95. Such was the announcement made at the IAC meeting held in June. Not only was the date pushed out 18 months but the parameters of time and VA rating are have also been reopened to industry comments. The requirement as it is now written calls for a battery which has >750VA after 5 minutes to comply with the disconnect requirements. Further information should be available from your local UL office.

Fried Brains
The following was extracted from the San Jose Mercury News, dated May 13, 1993:

"The New York Times quoted a co-worker of Joey Buttafuoco in January on why Amy Fisher shot Mrs. Buttafuoco: "It's the (electric) wires. The wires aren't buried underground like in other parts of the country, so with all this electricity in the air, it fries some people's brains." ■

Chariman's Message
Continued From page 1

Barriers are Falling
The signs are all around that this is changing. Disciplines once easily distinguishable are being united, sometimes forcibly by regulation or market practice. For example, EC product directives are specifying ISO 9000/EN29000 quality assurance systems to assure safety requirements are being met. By-products of product usage, including consumables, packaging and other "disposables", are coming under environmental safety regulation. These developments and numerous others can represent either an opportunity to the prepared or a threat to the unprepared.

PSTC Roles
Will the PSTC play a role in facilitating adjustments to these changes? As probably the largest organization of its type specifically devoted to the advancement of product safety practice, I believe it must. This role will require us to expand our field of view to include more than complying with product-specific public domain standards and obtaining the usual collection of product certifications stickers. What is ironic is that, in spite of our size, PSTC goals and objectives have been influenced by a relatively small number of participants, namely those who have volunteered their time to serve.

There are many ways for you to be pro-active in this time of change. Here are two immediate possibilities within the context of the PSTC: attending our annual meeting on August 12 in Dallas as part of the '93 International EMC Symposium, and participating in the election of new PSTC officers. The annual meeting is the prime venue not only for reviewing and amending formal plans, but also for individuals to directly influence and bring about changes and improvements. It is open to all and I encourage as many of you as possible to attend.

Taking on additional responsibilities in a volunteer organization may seem like a burden, especially in difficult economic times. But it seems to me that it is in difficult times when leaders with vision can be most effective! This summer, the terms of our current central committee officers end, and new leaders are needed to carry on the work. I am asking you to consider serving the PSTC in some capacity. If you are interested in taking part, or simply want additional information about the committee, please contact me by phone or fax.

Brian Claes, Central Chairman
Phone: (408) 578-1963
Fax: (408) 578-5035

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In My Opinion
Continued From page 3

products that exceed the 80% rule.

To further complicate matters, many other UL standards require the 80% rule, such as UL 1950, paragraph 3.2.1, which states: "The attachment plug shall be no less than 125% of the rated current of the equipment." (125% of the rating is the same as 80% of the branch circuit, so if a product is rated 16A, 125% of 16A = 20A, and 80% of 20A = 16A) This is a D1 deviation, which means it came from the NEC or NFPA.

So my questions are:

1) Is UL 1262 in contradiction with the NEC?

2) Why do other standards, such as UL 1950, include the NEC requirement, while UL1262 doesn't? I remember hearing that there is an exception for the 80% rule for equipment used in a professional environment; however, I can not find any such exception in the NEC.

3) If my interpretation of para. 210-23 is correct — that the 80% rule isn't required if instructions are provided requiring a dedicate branch circuit — then why isn't this exception in UL 1950?

Thank you for any assistance or insight you can provide.

Brian Donnelly

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Hi Brian:

1) Is UL 1262 in contradiction with the NEC?

No, I don't believe so. UL 1262 is a product standard. The paragraphs you quote are product-dependent requirements, and are independent of, but consistent with the installation (NEC) requirements.

The plug MUST be rated at least equal to the product rating. Otherwise, the plug may overheat and may result in a fire. This is a product dependent requirement, and is independent of the installation.

UL 1262 does not address installation requirements, namely the 80% rule for multiple outlets on a branch circuit, or 100% rule for a single outlet on a branch circuit. It does not need to do so, as installation rules are a compatibility issue, and are relatively arbitrary. If you use a 15-amp rated product on a 15-amp rated circuit, regardless whether the branch circuit has one outlet or multiple outlets, the system remains safe. However, if used on a multiple-outlet branch circuit, the system may be subject to nuisance tripping of the overcurrent device.

In the old days, before circuit breakers, it was possible (and was often done) to replace the "specified" branch circuit fuse with a larger one. This obviously set up a safety problem as it was likely the wiring ampacity of the branch circuit would be exceeded by the total load applied to the branch circuit. Perhaps this is the origin of the 80% rule.

2) Why do other standards, such as UL 1950, include the NEC requirement, and UL1262 doesn't? I remember hearing that there is an exception for the 80% rule for equipment used in a professional environment; however, I can not find any such exception in the NEC.

Inclusion of the 80% rule in UL1950 and other standards is UL's attempt to include product-related NEC requirements in the product standard. In essence, this is a "nice" service to offer to product manufacturers so that they can become aware of a relatively obscure product-related NEC requirement. Not all product manufacturers are aware of the NEC requirements for products. Indeed, in my early days in this business, I learned of the 80% rule from the UL standard, not from the NEC.

Any manufacturer can get around the 80% rule by specifying the equipment is to be used on a dedicated branch circuit. So, the 80% rule is not an absolute product rule (i.e, not all products must comply).

I am not aware of an exception for the 80% rule for professional equipment. The only exception I am aware of is that when the product exceeds 80% of the branch circuit rating, the product must be installed on a single-outlet dedicated branch circuit.

I can guess that UL would not want to certify a 100%-rule product intended for the home because the home is not built with single-outlet dedicated branch circuits, and such a branch circuit cannot be easily installed. Therefore, for all practical purposes, the 100%-rule applies to non-home (read: professional) equipment.

3) If my interpretation of para. 210-23 is correct — that the 80% rule isn't required if instructions are provided requiring a dedicated branch circuit, then why isn't this exception in UL 1950?

Your interpretation is correct. UL 1950, Sub-clause 3.2.1 cites the 80% rule with no exception for a single-outlet dedicated branch circuit. However, Sub-clause 1.7.11 implies the exception by allowing the single-outlet branch circuit overcurrent device to also provide overcurrent protection for the load (product).

So, the "exception" to the 80% rule in UL 1950 is really one of the infamous UL "secret" exceptions. Obviously, the NEC remains applicable. Both 3.2.1 and 1.7.11 "D1 deviations" to UL 1950 are NEC-based deviations. So, the NEC rules can and do apply to products certified to UL 1950, and UL will certify products with current up to 100% of the plug rating if the equipment is identified as requiring a single-outlet dedicated branch circuit.

— Rich Nute

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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) 447-4070 (phone) or (408) 257-5034 (fax)

The Product Safety Newsletter

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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. Those interested in listing their names should contact the Editor.

Seeking employment as Electromagnetic Compatibility and Regulatory Engineer:
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