The Product Safety Newsletter

IEEE EMC SOCIETY

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What's Inside

Chairman's Message

Standards: Beauty or the Beast

Brian Claes

The semiconductor equipment industry is performing a major revision of its basic product safety standard, SEMI S2-93, Safety Guidelines for Semiconductor Manufacturing Equipment. The first order of business has been to decide on the basic nature of the revised standard. Should it remain largely principle- and performance-based or expanded to include a range of prescriptive requirements? The considerable majority of those participating in its revision adamantly affirm that it should remain a compact, high-level performance document. Curiously, however, as work proceeds the actual text that is being generated is growing like a cancer with more and more prescriptive requirements being added.

The frustration of watching an exemplary standard deteriorate into a collection of prescriptive requirements drove me to ponder the whole matter of how product safety standards are generated and revised. Remember UL 478, Safety of Electronic Data Processing Equipment? In 1980, the fourth edition of UL 478 was barely 50 pages of not very compact prescriptive requirements. Its current successor, UL 1950 (third edition) is now 260+ pages long, with a bright future of future expansion. What's been the benefit of this requirements explosion?

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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 opinion 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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Central Committee

Chairman:	Brian Claes	(510) 659-6574 (510) 659-6852 (fax)	brian.claes@lamrc.com
Vice Chair:	Richard Pescatore	(408) 447-6607	Pescatore@cup.hp.com
Sec./Tres.:	John McBain	(415) 919-8426 (415) 919-8504 (fax)	john_mcbain@hp.com
Symposium:	Mark Montrose	(408) 247-5715	

Local Groups

		Chicago	
Chairman:	John Allen	(708) 238-0188	
		Colorado	
	Richard Georgerian	(303) 417-7537	richardg@exabyte.com
		So Cal/Orange County	
Chairman/Sec.:	Charlie Bayhi	(714) 367-0919	
		Pacific Northwest (Portland)	
Chairman/Sec-Tres.:	Scott Varner	(503) 656-8841	4772949@mcimail.com
		Northeast Product Safety Society (Non-IEEE)	
	Arthur Michael	(860) 344-1651	amichael@safetylink.com
		Santa Clara Valley	
Chairman:	Edward Karl	(408) 986-7184	
		Seattle	
Chairman:	Walt Hart	(206) 356-5177	walthart@tc.fluke.com
		Texas (Central)	
Chair	Vic Baldwin	(512) 990-6145	

Newsletter Committee

Editor	Roger Volgstadt	(408) 285-2553 (fax)	volgstadt_roger@tandem.com
Subscriptions	Dave McChesney	(408) 296-3256 (fax)	
Institutional Listings	Ron Baugh	(503) 691-7568 (fax)	ron.baugh@sentrol.com
News & Notes	John Rolleston	(614) 438-4355 (fax)	jhrolles@freenet.columbus.oh.us
Activities Editor	Kevin Ravo	(408) 296-3256 (fax)	ravok@ul.com
Page Layout	Eileen H. Mae	(408) 556-6044 (fax)	maee@ul.com

Area Activities

y Kevin Ravo
voice: 408-985-2400 ext. 32311
fax: 408-296-3256
email: ravok@ul.com

I hope everyone was able to enjoy the summer vacation time! Things tend to slow down a little during the summer as can be seen by the minimal amount of activities during this period.

The following is an overview of recent and planned activities for the various Local Groups around the USA. If you are aware of any 'activities' Information that may be of interest to readers, please forward it to the above address and I will try to ıclude it in the next issue.

Santa Clara Valley Chapter

May: UL 1950 Third Edition - Clause 6 changes. Dan Barsotti, Underwriters Laboratories.
June: Roles and Functions of the US CPSC. Lee Baxter, US CPSC.
y/Aug.: Summer Break
Sept.: Planning for 1996 - 1997 season.
Fourth Tuesday of the month. Location and time to be announced.
For more information contact:
Edward Karl
Voice: (408) 986-7184

Central Texas Chapter

For information, contact:
Vic Baldwin
voice: (512) 990-6145, fax: (512) 990-6342

Orange County - Southern California Chapter

June: BAPCO Electro-Compliance Video on Universal Safety Tester. Martin Drefs and David Highely.
July: The Bi-National Standard - A Primer for Safety. Charlie Bayhi of CPSM Corp.
Aug. 6: Power Supply Requirements — IEC 950. Philip Ling of HC Power, Inc.
Sept. 3: UL 1950 Practical Application Guideline Review. Charlie Bayhi of CPSM Corp.
Oct. 1: Electrical System Topology — The Problems with Grounding. Henry S. Lurch, P.E. Power Eng. Assoc.
For more information contact:
Charlie Bayhi
voice: (714) 367-0919

Chicago Area Chapter

For information contact:
John Allen
voice: (708) 238-0188

Colorado Area Chapter

May: The international Tesla Society. J. W. McGuinnis, President of the Tesla Society.
June: Herb Gibson form OSHA.
July: Group picnic meeting.
Sept. 11: Safety seminar by Ron Duffy.
Jan. '97: Last meeting for 1996 and first for 1997 at the Jackson Hole Restaurant.

Area Activities
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For more information contact:
Richard Georgerian
voice: (303) 417-7537
fax: (303) 417-7829
e-mail: richardg@exabyte.com

Pacific Northwest Area Chapter

For information contact:
Scott Varner
voice: (360) 817-5500 ext. 55613
fax: (360) 817-7829
e-mail: 4777294@mcimail.com

Northeast Product Safety Society

June: Technical presentation on PTCs and risk assessment by Weinstein Associates.
Aug.: Annual NPSS family barbecue.
Sept. 25: Joint NPSS/IEEE-EMC Society meeting. Technical presentation on line filters and designing for immunity by Curtis-Straus.
Oct. 23: Proposed topics include 1996 NEC, NFPA 70 and Lasers.
Nov. 20: NPSS CE Marking Workshop and Vendor's Night.

For more information contact:
John Freudenberg
e-mail: johnf@ces.teradyne.com

That is it for now. Hope to have more information and details next time.

Best Regards,
Kevin Ravo ■

Standards: Beauty or the Beast
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Some standards growth is inevitable if new objectives are added (such as control of flammable materials) or scope expanded (such as including telephone equipment with computers). Other justifications for growth are not as convincing. How can we avoid making standards revision an end in itself or expansion a seemingly inevitable outcome? I propose that each of us sanity check each and every improvement being considered against a mental checklist. This same checklist should be applied to existing requirements to determine how many of them can be streamlined or eliminated. Items on this checklist include:

1. What really are the problems to be solved by the proposed changes? Are changes to standards the best way to solve these problems?

2. How are the final customers voices being heard? Is there direct communication? Is it filtered through one or more levels of vested interests? Do we even know who the customer actually is or what the customer expects?

3. Do the proposed change directly benefit the customer, for example, by lowering the customer's total cost of ownership? Are the proposed changes the most cost effective from the customer's perspective over the lifetime of the product?

4. Does the proposal benefit other parties beside the final customers? Are Guaranteed Employment Acts being created for ourselves and other parties? Since the costs associated with these other benefits will ultimately be borne by the customer, how much of these costs will result in a corresponding savings for the customer over the products lifetime?

5. What are the scientific, technical and societal needs motivating the proposed changes?

6. When prescriptive or quantitative limits are specified, are they based on sound technical and scientific foundations that clearly support the specified values or levels?

7. Do the proposed changes merely reflect precedence and accepted practice? Have these traditional practices been checked against loss experience? Have you reviewed the field data and reports yourself?

8. What are we relying on to verify the effectiveness of our requirements, both current and proposed?

9. Does the proposed change have to be made at all? Have they already been elsewhere in an easily referred to standard?

10. Are the principles behind the proposed requirements understood and clearly applicable? Are foreseeable variations in interpretation acceptable and justifiable, based on clearly stated underlying principles?

11. Do the proposed changes force particular or prescriptive courses of action? Are viable alternative approaches discouraged or eliminated by the proposed changes?

ɪe above is a lot to think about. But it does force us to think beyond our immediate concerns. Similar broad operating principles will be applied to the SEMI S2 revisions as their development continues. These include:

1. Actively assess and test the true needs and requirements of the customer and marketplace. Make sure there is mutual awareness of what is being presumed as being customer requirements.

2. Test each requirement for strict relevancy, sufficiency and effectiveness. Identify and test the metrics used to determine effectiveness.

3. Distill and summarize prescriptive requirements into clear statements of principle and performance objectives.

4. Transform proven prescriptive requirements into non-binding application notes to be included as examples of acceptable practice; jettison remaining prescriptive requirements.

5. Whenever possible, avoid including requirements found in pre-existing standards, whether they be voluntary market-driven or used by regulatory enforcement authorities; these requirements may be addressed by merely referring to the standard(s) in question. Any conflicts with other applicable standards should be flagged in application notes.

I'm interested in your reactions and observations to the above. Please feel free to share your thoughts by writing to the PSN or sending e-mail directly to me.

Brian Claes
brian.claes@lamrc.com ■

Application of IEC and U.S. Overcurrent Protection Devices in Electrical and Electronic Equipment

by Lal Bahra, P. Eng.
Underwriters Laboratories Inc.

This article provides technical guidance on the acceptance of IEC type overcurrent protection devices (OPDs) used as components of electrical and electronic equipment for U.S. applications. The article also provides guidance for acceptance of U.S. OPDs under the CB Scheme and for CE Marking applications as European test houses have procedures for accepting OPDs other than IEC type. Only equipment OPDs are discussed in this article and not branch circuit types. Even though the following discussion is centered around IT equipment, it may also apply to other types of products.

APPLICATION CRITERIA

When accepting OPDs in the equipment, the following two characteristics are of prime importance in addition to other criteria given in the OPD and the end product standards:

- ▼ time-current characteristics (curves); and
- ▼ interrupting (breaking) capacity.

The time-current curves give the criteria for the operation of an OPD within a defined time when a higher than rated current flows through the device. Usually for supplementary (equipment) protective devices, these curves do not follow the standard curve for branch circuit protective devices. For supplementary protective devices, this information is available to the designer of the end product in the data sheets for such devices. The designer can then select an OPD having characteristics according to the needs of the equipment. In such cases, an investigation of the equipment is conducted based on the operating characteristics of the OPD and the result must be no fire or shock hazard.

The interrupting capacity is related to the ability of the OPD to successfully break the circuit under short circuit conditions. The IEC terminology for "interrupting capacity" is "breaking capacity." For supplementary protective devices, this interrupting capacity need not be the same as for branch circuit applications if the short circuit current, at the location of the OPD in the equipment, is less than the branch circuit short circuit current.

To determine the suitability of a supplementary tective device to clear a short circuit fault if the interrupting capacity of the device is not known, a abnormal test may be conducted by simulating a short circuit on the load side of the OPD. The source of the supply circuit, for this test, should be capable of supplying the short circuit current which is the maximum recommended by the end product manufacturer. Fuses must remain intact during this short circuit test since removal of the damaged fuse may result in a shock hazard and the damage to the fuse may not repeat itself in the same fashion each time when a short circuit occurs.

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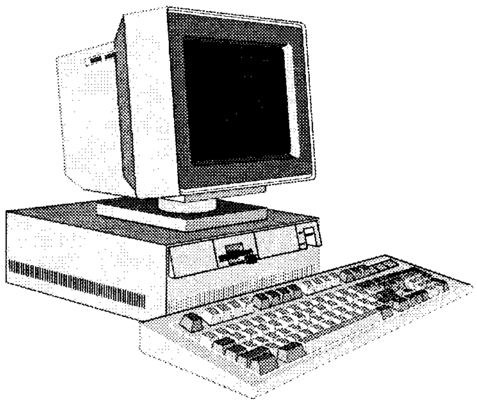
Safety Net — News from the Internet



by John Quinlan

In the previous (and first) installment of this column, I listed a few Internet resources for safety, EMC and compliance issues. Unfortunately, I neglected to take into account the delay between column submission and newsletter publication, and much of the information was already ated before it was printed — my apologies. Given the unavoidable delays of publication and the permanence of the Internet, I will avoid dated issues in the future, and instead stick to highlighting some of the interesting threads that have recently appeared on the emc-pstc list and relevant news groups.

The highlighted topic of this issue pertains to transformer insulation requirements. The dialog was initiated by Jim Eichner (JEichner@statpower.com) on 07/05/96. Edited versions of the original post and replies from Horst Dierich (dierich@ibm.net), Richard Nute (richn@sdd.hp.com), Michael Rains (mrains@foxboro.com), Egon H. Varju (73132.2222@compuserve.com) and Peter Tarver (peter_tarver@nt.com) appear below.

Jim Eichner poses the questions:

We have a high-frequency switching transformer with a mains-connected primary winding and a SELV secondary winding. The core, which is not accessible, is made of a partially conductive ferrite material and is floating (not conductively connected to anything). We need to meet Reinforced insulation requirements between the primary and secondary windings.

(1) Does it matter what insulation level we have from the primary to the core and from secondary to the core? In other words, can the core be simply treated as an interspersed conductive part which counts for zero in creepage and clearance measurements from the primary to the secondary?

(2) If so, does it matter how the total is divided — can most of it be on one side or the other, or do we have to meet at least Basic insulation requirements from each winding to the core?

(3) Would varnish impregnation help in any way? The varnish would cover the complete core and windings, but obviously not the coil terminations.

(4) Is hipot testing required from either winding to the core, or just between the windings?

Horst Dierich replies:

IEC 950, 2nd edition with Amendment 3, Clause 2.9.1 states:

"It is permitted for clearances and creepage distances to be divided by intervening, unconnected (floating) conductive parts, such as unused contacts of a connector, provided that the sum of the individual distances meets the specified minimum requirements."

Thus it does not matter what insulation level is between the primary and the core or between the secondary and the core as long as the sum meets the requirements of reinforced insulation. The core can be treated as an intervening conductive and floating part. Most of the spacing can be on one side. Alternately, one side could be treated as basic insulation, and then the other side would have to be supplementary insulation (both sides as basic is not sufficient), resulting in double insulation. See the insulation definitions in Clauses 1.2.9.2 - 1.2.9.5.

Richard Nute replies:

For the purposes of safety, varnish should not be considered an insulation. This is because (a) its thickness is not controlled, (b) its coverage is not necessarily 100%, and (c) it is considered fragile and subject to damage from handling. Consequently, hipot testing is required between the windings. Because you are designing two independent insulations, however, it would be a good idea to hipot each winding to the core independently.

The core will float at a potential established by the stray capacitances of the total insulation system. The most reliable practice then is to assume the core is floating at the midpoint, and establish Basic insulation from each winding to the core. Alternately, assign the core to either the primary or secondary and establish Double or Reinforced insulation to the other winding.

Michael Rains adds:

It would seem reasonable to consider that varnish vacuum impregnation reduces the micro environment surrounding the transformer windings from a Pollution Degree 2 to a Pollution Degree 1 when the transformer is located in a Pollution Degree 2 environment. This can help a little with primary-secondary end turn creepage distance issues.

Egon H. Varju warns:

Although valid in concept, you may have great difficulty convincing the various safety certification agencies that any form of varnish impregnation reliably complies with Clause 2.9.7. On the other hand, I agree that if you have a reliable and consistent varnish coating, you might stand a better chance of convincing the agencies to accept Pollution Degree 1 spacings.

Peter Tarver concludes:

There may be some validity to the claim that vacuum impregnation can create a Pollution Degree 1 micro environment for internal parts of a transformer out of an overall Pollution Degree 2 environment, but I suspect that a formal quality control program would be needed to ensure continued compliance and to get safety certification agencies to buy into the idea. I have seen vacuum impregnation work well in some instances and poorly in others, even with identical transformers and processes. Dipping would be even more unreliable in this application. ■

What If The Power Went Out?

[Editor's Note: This story was reported as follows. No attempt was made to verify its accuracy. - ed.]

What happens to life support patients during loss of power? The question was raised during the recent power outages in the Western U.S. There should be no cause for alarm, since hospitals have backup power systems. However, the spirit of human error lives on! We can overcome even the most carefully planned safety systems in our finer moments.

Evidence the following...

South African Health - Pelonomi Hospital
Date: 26 July 1996 10:08

"For several months, our nurses have been baffled to find a dead patient in the same bed every Friday morning," a spokeswoman for the Pelonomi Hospi- (Free State, South Africa) told reporters.

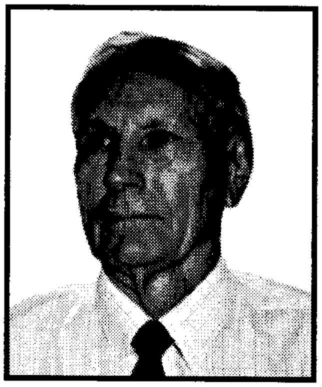
"There was no apparent cause for any of the deaths, extensive checks on the air conditioning system, and a search for possible bacterial infection, failed to reveal any clues. However, further inquiries have now revealed the cause of these deaths.

"It seems that every Friday morning, a cleaner would enter the ward, remove the plug that powered the patient's life support system, plug her floor polisher into the vacant socket, then go about her business. When she had finished her chores, she would plug the life support machine back in and leave, unaware that the patient was now dead. She could not, after all, hear the screams and eventual death rattle over the whirring of her polisher.

"We are sorry, and have sent a strong letter to the cleaner in question. Further, the Free State Health and Welfare Department is arranging for an electrician to fit an extra socket, so there should be no repitition of this incident. The inquiry is now closed."

from ("Cape Times," 6/13/96)
The headline of the newspaper story was, "Cleaner Polished Off Patients." ■

Organizing the Product Safety Function



Paul W. Hill

[We are grateful to the author for providing a series of condensed installments from his book "Managing Product Safety activities." This text is a registered copyright of Paul W. Hill & Associates, and is reproduced with permission. Details about the book may be obtained by calling (704) 892-6982. -ed.]

A survey of established product safety functions would indicate the use, in one form or another, of three different organization approaches. Small enterprises would tend to display a product safety function as a single individual operation attached to product development activities. Larger companies would tend to have more centralized functions with a well defined position in the organization as a separate department. Large corporations with several divisions or a diverse product mix have a greater need to coordinate safety practices and policies across several product types or production facilities. Most often this is accomplished by a corporate level product safety function which acts as the guide, coordinator and general overseer of corporate-wide product safety operations.

As an enterprise grows it tends to pass through each stage with large companies having elements of all three structures in place. Each organization format is discussed in the following sections.

Single Individual product safety operation.
When a company, division or plant location is limited in size or product mix the product safety activities can often be handled by one individual. On a small number of product types this individual can accomplish most of the basic functions of product safety such as:

❑ Provide product developers with safety requirements appropriate for the products and maintain a library of necessary equipment ar component safety standards.

❑ Conduct basic electrical, mechanical, thermal and similar safety tests on products.

❑ Make certification applications and interface with test agencies associated with safetycertifications.

❑ Maintain the validity of product certifications and assist in follow-up service activities.

❑ Participate in risk assessment and investigate field safety problems.

Single individual product safety operations often pand, with the aid of one or more assistants to over additional tasks such as:

- ❑ Participation in setting design objectives for product safety matters.

- ❑ Participation in design reviews.

- ❑ Maintain a library of equipment and component safety standards appropriate to the products produced.

- ❑ Conduct tutorials for product developers, quality assurance, manufacturing, marketing and other groups which should be aware of product safety issues and related requirements imposed by regulatory agencies such as OSHA, FDA, CPSC and ISO 9000.

- ❑ Participate in safety standards writing activities through industry associations and advisory groups.

The efficiency of such a one or two person effort be very high and is often maintained, usually one for each product group, even after the organiza- has grown in number and complexity of products. The effectiveness of this small group can be enhanced considerably by the use of a consultant with specialized product safety knowledge and experience to assist in unique or complex situations.

The major advantages of a one or two person operation in product safety are:

- ❑ The product safety effort can reside within the product development group and be an integral part of the product conception, development and change activities.

- ❑ A savings in space and equipment can be realized if product development testing can be integrated with safety test and evaluation. Most product development groups are equipped with test facilities which can perform many safety related evaluations.

- ❑ Safety, electromagnetic compatibility, ergonomics and other product performance considerations are closely interwoven in product development. When these areas of specialization are in close organizational proximity, there is valuable cross fertilization and the risk of oversight of one or more of these items is reduced.

For all its advantages there are several possible difficulties with this type of product safety organization. Potential trouble spots are:

- ❑ Uniformity of interpretation and application of requirements. When two or more "one person operations" are operating within an organization or division of a company it is essential that there be but a single level of safety established and maintained for products in the same or related markets. Some form of coordination for consistency of approach and safety levels presented is required.

- ❑ There is generally little room in one person operations for unplanned surges in workload. Slipping test and product certification schedules is costly, delays product releases and disrupts manufacturing schedules. If such assistance is not obtainable from within it is appropriate to engage a product safety consultant offering services in the area of need.

- ❑ The individual assigned to handle product safety responsibilities must be respected by the product development organization. Knowledge of the product, development processes, and ability to communicate the required safety attributes of the product is essential. Much communicating will be required, much of it tutorial. The ability to communicate product safety requirements is essential, not in terms of elegance and authority, but in terms engineers understand and easily assimilate. Key in communicating these matters is an understanding of the rationale, technical soundness and reasonableness of the safety requirements being imposed.

In spite of these potential problem areas the "one person operation" can be made to work well and effectively in relatively small or specialized product groups within a larger organization.

In spite of these potential problem areas the "one person operation" can be made to work well and effectively in relatively small or specialized product groups within a larger organization. A case can be made for maintaining such units even when the business entity becomes large and has established a centralized product safety function.

Centralized product safety function.
As an enterprise grows it tends to think in terms of collecting dispersed specialized tasks into one stand alone operation. All activities of a given type or kind are collected into one department or single service function. Centralization of this kind has certain economic and administrative advantages such as:

- ❑ Greater utilization of specialized test and evaluation equipment.

- ❑ Safety related procedures can become standardized and establish a uniform level of safety across product lines.

- ❑ Administrative and overall management of safety activities can be more firmly established than when two or more safety efforts operate independently.

The centralized form of product safety activities has several short comings, among them are:

- ❑ The closely coupled working arrangement between the product developers and the safety organization in the "one person operation" is almost always weakened as the lines of communication lengthen.

- ❑ The funding arrangement for services rendered between operating departments almost always leads to increased costs to the product development group. Rates for services tend to become based on the funding needs of the service department and independent of the actual value of the services.

- ❑ A centralized safety operation generally can not give the extra attention to product developers in unplanned or emergency workload situations. The centralized safety operation will have priorities, scheduled commitments, quest and other impedances to prompt reaction.

Some hybrid forms which combine the two approaches work well when the centralized group serves to fill a special need in equipment, expertise, or when a duplication for each product development operation is not justified. Examples of the latter are materials flame testing facilities, certain specialized failure analysis capabilities and a single interface to safety certification and regulatory agencies.

Corporate level product safety function.

Companies with a broad product mix, several manufacturing or product development locations, or serve several different markets have a real need to establish a product safety coordinating capability. It is essential that the various product lines reflect a common minimum level of safety for similar products or markets served.

It is also important that changes in industry safety standards, trends in litigation, field safety problems and other safety related matters are tracked and communicated to those with a need to know.

Collection and distribution of information on important safety matters within the company is best done by a dedicated group representing the entire enterprise. It is also necessary at times to have one voice which speaks for the entire company on safety matters. Positions on safety issues before certification and regulatory agencies is an example of such a situation. Product recall procedures, litigation processes and compensating actions for safety standard deficiencies are similar matters with a broad company impact which are best solutioned by a central coordinating effort.

The form of this organization can vary from a one person operation within an existing corporate office to a dedicated corporate staff. Whatever the form of organization the essential mission is one of internal company coordination and guidance for product safety matters and the primary interface to safety related agencies and regulatory bodies.

The corporate level product safety function is not generally involved in the day to day operations of the line organizations but can contribute materially to the efficiency of line safety operations. These contributions are in the form of periodic audits, newsletters and sponsorship of professional training of product safety personnel.

Whatever the form of organization the essential mission is one of internal company coordination and guidance for product safety matters and the primary interface to safety related agencies and regulatory bodies.

1. Periodic audits assist local product safety in maintaining company wide requirements for the safety of products, uniformity in the procedures and timely implementation of new regulatory requirements and revisions of standards. These audits should not be police actions but constructive reviews which aid and support local safety management in the upgrade and enhancement of safety operations.

2. A newsletter to the product safety and product development communities is a valuable item. It is difficult for most local safety functions to remain current on new standards, revisions and regulatory activities. A central collection and distribution function of industry, regulatory and export events related to product safety matters is essential.

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3. Product safety practitioners have a pressing need to grow their capabilities to professional status as safety becomes a larger factor in marketability, general market acceptance and financial success of commercial products. Providing the opportunity for professional development is vital for the maintenance of competence in a product safety function.

In the matter of professional development, few learning opportunities exist for product safety matters in formal industrial educational systems, colleges or universities. It is almost always necessary to employ the services of continuing

Providing the opportunity for professional development is vital for the maintenance of competence in a product safety function.

education programs at local learning centers, colleges and universities. When these approaches are not available or not appropriate to local needs, the use of safety consultants offering seminars and in-plant training sessions in the subject of product safety are useful.

The corporate product safety function should display the primary leadership in locating the talent, providing the resources, organizing and sponsoring this necessary service to the entire product safety organization. ■

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U.S. SUPPLEMENTAL FUSES FOR IEC APPLICATIONS

The U.S. supplemental fuse standard UL 248-14 is bi-national standard (Canada and U.S.).The sizes of the most commonly used supplemental fuses within IT equipment are 6.3 mm by 33 mm (1/4" by 1 1/4") and "5 mm by 20 mm". A micro-fuse is defined as having no dimension > 10 mm.

Supplemental fuses complying with UL 248-14 are required to:

- ▼ carry 100% of their rated current continuously without opening;
- ▼ open in 2 min or less at 200% of the rated load for fuses rated up to 30 A;
- ▼ open in 4 min or less at 200% of the rated load for fuses rated > 30 A and up to 60 A; and
- ▼ open in 1 hr or less at 135% of the rated load.

Micro-fuses are designed to open in less than or equal to 1 min at 200% rated load. The 135% test does not apply to micro-fuses.

Fuses rated 125 V have a min interrupting capacity of 10,000 A. A micro-fuse has a minimum interrupting capacity of 50 A. A fuse rated < 125 V m[illegible] have interrupting capacity < 10,000 A. A fuse rated 250 V may have a dual interrupting capacity rating which is 10,000 A at 125 V a.c. and as follows at 250 V:

- ▼ 35 A for fuses rated up to 1 A;
- ▼ 100 A for fuses rated > 1 A and up to 3.5 A;
- ▼ 200 A for fuses rated > 3.5 A and up to 10 A;
- ▼ 750 A for fuses rated > 10 A and up to 15 A; and
- ▼ 1,500 A for fuses rated > 15 A and up to 30 A.

European test houses are beginning to require the use of fuses that have a high "interrupting capacity" (1500 A at 250 V) because fuses with low breaking capacity may shatter if the short circuit current exceeds the breaking capacity of the fuse. Designers must choose a fuse with an appropriate breaking capacity suitable for the maximum short circuit current available from the circuit under consideration.

In some European countries, fuses, other than the IEC type, are acceptable (See Table 2 on page 20 & 21). If U.S. fuses do not meet the interrupting capacity requirement of 1500 A at 250 V, additional testing at an interrupting capacity rating of 1500 A at 250 V must be conducted.

In European countries, all fuses that have dimensions other than as specified in IEC 127-2 and 127-3 are defined as non-standard (other than 5 mm by 20 mm and 6.3 mm by 33 mm). Non-standard fuses are accepted in European countries as follows [based on the latest CCA (CENELEC Certification Agreement) decisions]:

(a) The manufacturer or vendor must keep the non-standard fuses in stock, as a spare part, in the country where the equipment is sold.
(b) It must not be possible to replace a non-standard fuse from outside of the equipment.
(c) In equipment, the maximum rating of fuses directly connected to the mains supply must not exceed the values given in the following table.

Country	Max Fuse rating
Denmark	8A
Finland	16A
Norway	16A
Sweden	16A
Switzerland	10A
U.K.	16A for pluggable type A 30A For pluggable type B

(d) Fuses must be marked so that they are readily identified without any risk of a mistake being made when replaced. Marking with the manufacturer's part number is acceptable; simply marking the current and voltage is not acceptable.

(e) A suitable marking must be placed adjacent to the fuseholder to warn against incorrect fuse replacement. The marking may be in English.

(f) UL fuses with rated current, voltage and dimensions within the scope of IEC 127-2 or 127-3 are acceptable, but tests shall be repeated with IEC fuses in place of UL fuses. The UL fuse and IEC fuse can be of different ratings as long as both are properly identified.

(g) Non-standard fuses with current and/or voltage ratings outside the scope of IEC 127-2 and 127-3 but which have dimensions in accordance with IEC 127-2 or 127-3 must meet applicable requirements of IEC 127 as far as applicable or perform satisfactorily within the equipment when tested according to EN 60950. European test houses require 10 samples of each fuse for test purposes.

(h) Non-standard fuses with dimensions and ratings not in accordance with those of IEC 127-2 or 127-3 must perform satisfactorily when equipment is tested under fault conditions in accordance with EN 60950. Compliance is checked by repeating 10 times the worst case fault condition, each time with a new sample of the fuse.

(i) Also, for testing the breaking capacity, the maximum short circuit current is assumed to be as follows by European test houses when UL type fuses are accepted in the equipment.

Fuse Rating (A)	Max S/C Current (A)
1 or less	35
>1 to 3.5	100
>3.5 to 10	200
>10 to 15	750
>15 to 20	1500

MARKINGS FOR FUSE RATINGS AND BREAKING CAPACITY FOR CENELEC APPLICATIONS

For Europe, according to Publication HD 109.2 S1, a symbol of the rated breaking (interrupting) capacity is required to be placed between the marking for the rated current and the marking for the rated voltage. The following form of markings are accepted by European test houses.

T315mA L		F4AH
250 V	OR	250 V

Where,

L Indicates low breaking capacity
H Indicates high breaking capacity
T Time delay fuse
F Fast blow fuse

U.S. ELECTRO-MECHANICAL SUPPLEMENTARY PROTECTORS FOR IEC APPLICATIONS

The U.S. standard for such devices is UL 1077, Supplementary Protectors for Use in Electrical Equipment. The opening characteristics and the interrupting capacity of electro-mechanical supplementary protectors are as defined by the manufacturer. Their use inside the equipment, other than the large main frame computers and similar equipment, is not common. The acceptance criteria would be similar to that for supplemental fuses given above.

IEC FUSES FOR U.S. APPLICATIONS

The IEC standard for equipment fuses is the IEC 127 series, Miniature Fuses (for use in equipment) and has six parts, 127-1, -2, -3, -4, -5 and -6. IEC 127 also has supplements Nos. 1, 2 and 3 which were issued as IEC Publications 127A, 127B and 127C. IEC Publications 127B and 127C contain pages which are referred to as IEC standard sheets I, II, III, IV and V. Except for the standard sheet IV fuse construction, all other IEC fuses are of size 5 mm by 20 mm. The IEC standard sheet IV fuses are of size 6.3 mm by 33 mm. The IEC standard sheets also specify time-current characteristics. The time-current characteristics (calibration curves) of IEC 127 fuses are completely different from those of the UL 248-14.

- ▼ IEC 127-1 covers definitions and general requirements;
- ▼ 127-2 covers cartridge fuse-links;
- ▼ 127-3 covers sub-miniature fuse-links;
- ▼ 127-4 covers universal modular fuses;
- ▼ 127-5 cover miniature fuse-links and IEC publication;
- ▼ 127-6 covers fuseholders for miniature cartridge fuse-links.

Fuses tested according to IEC Standard Sheets I and V are high interrupting capacity fuses; other IEC 127 fuses are of the low interrupting capacity type. Fuses tested to the requirements of the IEC standard sheets II and III are accepted as indicated in Table 2 (on page 20 and 21).

IEC 127 fuses usually have the following time-current characteristics (See the actual IEC 127 series for other minor differences).

- At 150% of the rated current of the fuse, the fuse shall not open in 60 min. This could also mean that the IEC 127 fuse may carry 150% of the rated current continuously and simply not open; and

- At 210% of the rated current of the fuse, the fuse shall not open in 30 min (2 min for the IEC standard sheet III fuse). The IEC standard sheet IV type fuse has a 200% calibration point instead of 210%; and

- For opening times at 275%, 400% and 1000%, see Table 1 on page 19.

The breaking capacity for IEC standard sheets I and fuses is 1,500 A and for IEC standard sheets II, III and IV fuses, it is 35 A or 10 times the rated current of the fuse, whichever is greater.

In switch mode power supplies, opening of semiconductor type devices such as transistors, diodes, integrated circuits, etc and other electronic components such as resistors, capacitors, etc. is usually acceptable for protection against abnormal operating conditions. Criteria for acceptance is given in the end product standard. Therefore, opening of an IEC fuse (listed by European test houses as components) under abnormal operating conditions, which opens in compliance with the criteria given in the end product standard, should also be considered acceptable.

In general the following rules apply as a guide when accepting IEC fuses in U.S. applications:

a) If IEC fuses are accepted for compliance with requirement of subclause 2.11 (limited power source) or 3.1 (internal wiring protection) or 5.4 (single fault [open or short] abnormal operating conditions) of UL 1950, there are no further requirements other than the fuses must be Certified by an NCB (who is also a UL MOU partner) of the CB Certification Scheme and criteria given in the applicable subclause of the UL 1950 must be met.

b) IEC fuses must not be accepted for protection of external primary or secondary wiring, for applications where a fuse is required to provide protection equivalent to branch circuit protection, or where a fuse is used to provide a NEC Class "2" output.

c) Some European test houses conduct tests on fuses which do not fall within the scope of IEC Publication 127, i.e., the current rating of the fuse may be beyond the limits of IEC 127. In such cases, the test house logo does not appear on the fuse and test data may be unobtainable. When test data cannot be obtained, then in addition to all other tests, short circuit testing to verify interrupting capacity must be conducted in the actual application at 125 V, 10,000 A and/or 250 V, 1500 A, as applicable.

d) IEC fuses with low interrupting (breaking) capacity must not be accepted in primary or secondary circuits unless it can be verified that the short circuit current of the circuit under consideration does not exceed the interrupting capacity of the IEC fuse.

IEC CIRCUIT BREAKERS (FOR EQUIPMENT) FOR U.S. APPLICATIONS

The most common IEC standard for equipment circuit breakers is IEC 934, Circuit Breakers for Equipment (These are considered electro-mechanical supplementary protectors for U.S. applications). The tripping times are as specified by the manufacturer at 200% and at 600% of the rated current of the circuit breaker. The interrupt capacity can be from 300 to 3000 A.

Criteria for acceptance would be similar to the IEC fuses given above.

U.S. AND IEC FUSEHOLDERS

IEC fuseholders are constructed according to IEC 127-6 (replaces previous IEC 257). These fuseholders are of the shock-proof type construction and are generally acceptable in the U.S. They must comply with the requirements of the end product standard as applicable. The IEC fuseholder construction requires that the fuse in the fuseholder shall be accessible with the use of a tool only. Contacts inside the fuseholder are recessed and protected. The fuse carrier is insulated and contact of the fuse with the live circuit is made only after the fuse carrier is pushed in and turned. In other words these fuseholders are "shock proof" type.

Fuseholders having internal fuse clips, that are not normally accessible with the IEC test finger, are not acceptable if insertion of the fuse will provide conductive access to the fuse end caps or fuse clips through the fuse itself.

Not all U.S. fuseholders of the post extractor type are of the touch proof or shock proof type construction, as the inner metal shell of the fuseholder assembly may be accessible to the test finger probe of IEC 950. In the U.S., if the inner shell contact (the rear terminal) of such fuseholders is connected to the "line," for 125 V applications, no shock hazard will result unless the polarity gets changed. Where the neutral conductor is connected to the accessible metal shell contact (side terminal) of the fuseholder, a caution marking (disconnect power before replacing fuse) is usually required for 250 V applications.

For the CB Scheme, application of the CE marking and for evaluation to UL 1950 (without D3 deviations) applications, fuseholders mentioned above are not acceptable. Only shock proof fuseholders are permitted for these applications.

CONCLUSION

From the above it is apparent that with proper investigation, IEC 127 fuses may be acceptable if they are suitable for the application. Likewise, U.S. fuses are acceptable to many European test houses if the fuse meets the applicable criteria.

REFERENCES

UL 248-1: Low-Voltage Fuses, Part 1 - General Requirements
UL 248-14: Low-Voltage Fuses, Part 14 - Supplemental Fuses
IEC 127-1: Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links.
IEC 127-2: Part 2: Cartridge fuse-links + Amendment No. 1
IEC 127-3: Part 3: Sub-miniature fuse-links + Amendment No. 1
IEC 127-4: TTD Universal modular fuses (UMF)
IEC 127-5: Part 5: Guidelines for quality assessment of miniature fuse-links
IEC 127-6: Part 6: Fuse-holders for miniature cartridge fuse-links
CCA Decisions June, 1996

TABLE 1

TIME-CURRENT CHARACTERISTICS - A COMPARISON OF UL AND IEC TYPE FUSES

% of Fuse	Amp Rating	U.S. UL 248-14				International IEC 127									
		Fast Acting		Time Delay		Sheet I		Sheet II		Sheet III		Sheet IV		Sheet V	
						Quick	High	Quick	High	Time Lag	Low	Quick	Low	Time Lag	High
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	0-30 A	Cont.	-	Cont.	-										
	0-30 A	-	1 h	-	1 hr										
[illegible]	32 mA - 5.3 A	-	-	-	-	1 hr	-	1 hr	-	1 hr	-	1 hr	-	1 hr	-
200	0-3 A	-	2 min#	5 sec	2 min#										
200	>3-30 A	2 min#	12 sec	2 min#											
200	>30-60 A	4 min#	12 sec	4 min#											
200	50- 100 mA											-	20 sec		
200	> 100 mA - 10 A											-	20 sec		
210	32 mA - 6.3 A					-	30 min	-	30 min	-	2 min			-	30 min
275	32 mA - 3.9 A					.01 sec	2 sec	-	-	-	-				
275	4 A - 6.3 A					.01 sec	3 sec	-	-	-	-				
275	32 - 100 mA					-	-	.01 sec	.5 sec	.2 sec	10 sec				
275	125 mA -6.3					-	-	0.5 sec	2 sec	.6 sec	10 sec				
275	1 A - 3.15 A													1 sec	80 sec
275	3.15 A - 6.3 A													1 sec	80 sec
275	50 - 100 mA											.002 sec	.2 sec		
275	> 100 mA - 10 A											.02 sec	1.5 sec		
	32 - 100 mA					.003 sec	.3 sec	.003 sec	.1 sec	.04 sec	3 sec				
400	125 mA - 6.3 A					.003 sec	.3 sec	.01 sec	.3 sec	.15 sec	3 sec				
400	1 A - 3.15 A													95 ms	5 sec
400	3.15 A 6.3 A													150 sec	5 sec
40	50 - 100 mA											.001 sec	.03 sec		
400	> 100 mA - 10 A											.008 sec	.4 sec		
1[illegible]	32 - 100 mA					-	0.2 sec	-	0.2 sec	.01 sec	3 sec				
100[illegible]	125 mA - 6.3 A					-	0.2 sec	-	.02 sec	.02 sec	.3 sec				
1000	1 A - 3.15 A													10 ms	100 ms
1000	3.15 A - 6.3 A													29 ms	100 ms
1000	50 mA - 100 mA											-	.005 sec		
1000	> 100 mA - 10 A											-	.06 sec		

* Not applicable to micro-fuses.
# For micro-fuses, the time is 1 min.

TABLE 2
FUSE TYPES ACCEPTED BY EUROPEAN COUNTRIES (BASED ON CCA DECISIONS)

NON-STANDARDIZED FUSE-LINKS ARE GIVEN IN THE BELOW-MENTIONED TABLE.

+ = indicates acceptance
- = indicates non-acceptance

Type of interrupting devices and conditions	AT	BE	DK	FI	FR	DE	IT	NL	NO	SE	CH	GB	IE
1. IEC 127-2 and IEC-3													
1.1 Intermediate values according to ISO rec. 3/R20-series are accepted. Markings on replaceable fuse-links according to IEC 127 and adjacent to the fuse-holders are always required.	+	+	+	+		+	+		+	+	+	*)	+
2.1 UL fuses with rated current, voltage and dimensions inside IEC 127-2 and IEC 127-3.	+	+	+	+		+	+		+	+	+	-	+
2.2 They shall comply with IEC 127 as far as possible.	+	+	+	+		+	+		+	+	+	-	+
2.3 It shall be possible to use also an IEC 127 fuse instead of an UL fuse. Tests are performed with both UL and IEC 127 fuses.	+	+	+	+		+	+		+	+	+	-	+
2.4 If the two fuses do not have exactly the same rated current, this must be indicated adjacent to the fuse-holder, e.g., UL fuse: 3 A, IEC 127 fuse: 3.15 A. However, it must not be possible to put two fuses in parallel at the same time.	+	+	+	+		+	+		+	+	+	+	+
3.1 Fuses with dimensions according to IEC 127-2 and IEC 127-3 but with rated current and/or rated voltage outside IEC 127-2 and IEC 127-3.	+	+	+	+		+	+		+	+	+	+	+
3.2 a) They shall comply with IEC 127 as far as applicable. or	+	+	+	+		+	+		+	+	+	-	+
3.2 b) They shall operate satisfactorily when the appliance is tested according to EN 60950. Compliance is checked by repeating at least 10 times, each case with a new fuse during worst case fault conditions.	+	+	-	+		+	+		+	+	+	+	+
3.3 They shall be available as spare parts in the country where the appliance is sold.	+	+	+	+		+	+		+	+	+	+	+
3.4 Identification markings are required on the fuse and adjacent to the fuse-holder to ensure correct replacement.	+	+	+	+		+	+		+	+	+	+	+

Type of interrupting devices and conditions	AT	BE	DK	FI	FR	DE	IT	NL	NO	SE	CH	GB	IE
.5 They shall not be replaceable from the outside.	+	+	+	+		+	+		+	+	+	+	+
.6 Maximum acceptable rated current when used as a mains fuse: 8 A 16 A 10 A	- + -	- + -	+ - -	- + -		- + -	- + -		- + -	- + -	- - -	- + -	- + -
4.1 Fuses with dimensions and ratings outside IEC 127-2 and IEC 127-3	+	+		+			+		+	+	+	+	+
4.2 They shall operate satisfactorily when the appliance is tested according to EN 60950. Compliance is checked by repeating at least 10 times, each case with a new fuse during the worst case fault condition test.	+	+		+			+		+	+	+	+	+
4.3 Moreover the requirements according to 3.3-6 apply	+	+		+			+		+	+	+	+	+
5.1 Replaceable fuses according to 1.1-4.3 above but provided with pig-tails	+	+		+			+		+	+	+	+	+
5.2 Non-replaceable fuses according to 1.1-4.3 above but provided with pig-tails i.e. the appliance is not intended to be repaired. Markings are not required in that case.	+	+	**)	+			+		+	+	+	+	+
6.1 Other types of interrupting devices not pretending to be and not marked as a fuse Item 3.3 above applies.	+	+	+	+			+		+	+	+	+	+

*) - UK tests fuses in the application as in 3.2 b).
**) - Denmark accepts standardized fuses with separate metal end caps.

...terrupting devices shall be capable of breaking the maximum fault current which they can be subjected to.

...-tail fuse is a miniature fuse-link which has at both ends of its body a metal cap provided with an axial terminating lead ...solid copper, attached approximately to the centre face of both end caps by means of welding or hard-soldering. Separate end caps may be pressed on an ordinary fuse-link.

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BE Belgium
CH Switzerland
DE Germany
DK Denmark
FI Finland
FR France
GB United Kingdom
IE Ireland
IT Italy
NL The Netherlands
NO Norway
SE Sweden ■

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