# Introduction to Burn Hazards

PSES
Product Safety Engineering Society

Taiwan Chapter Promotion Party - 2005, June

IEEE

# Foreword

- Laptops A Male Fertility Risk?
- December 09, 2004, A provocative piece of news bore the similar headline widely reiterated on mass media, warning the businessmen and teenage boys could be taking risks of their fertility by using the laptop computers.

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# Basis

- The latest research, *"Increase in scrotal temperature in laptop computer users,"* published Thursday, December 09, 2004, in the Europe's leading reproductive medicine journal, U.K. journal Human Reproduction.
- The lead researcher, Dr. Yefim Sheynkin, Associate Professor of Urology and Director, Male Infertility and Microsurgery at the University, and his staff have linked laptops and male infertility.

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# The Experiment

- The scientists worked with 29 healthy volunteers aged 21 to 35, measuring two one-hour sessions of scrotal temperatures on different days with and without laptops.
- They found that scrotal temperatures rose by 2.1°C when the men sat with their thighs together, which is necessary to keep LC on the lap. But, the rise was significantly higher when the LC were used - 2.8°C on the right side and 2.6°C on the left.

# Discovery

- The study shows that scrotal hyperthermia is produced by both
  - special body posture, and
  - local heating effect of the LC.
- This deductive hypothesis is founded upon previous studies that
  - 1°C above the baseline is the possible minimal thermal gradient capable of inhibiting spermatogenesis and sperm concentration may be dropped by 40 % per 1°C increment of median daytime scrotal temperature.

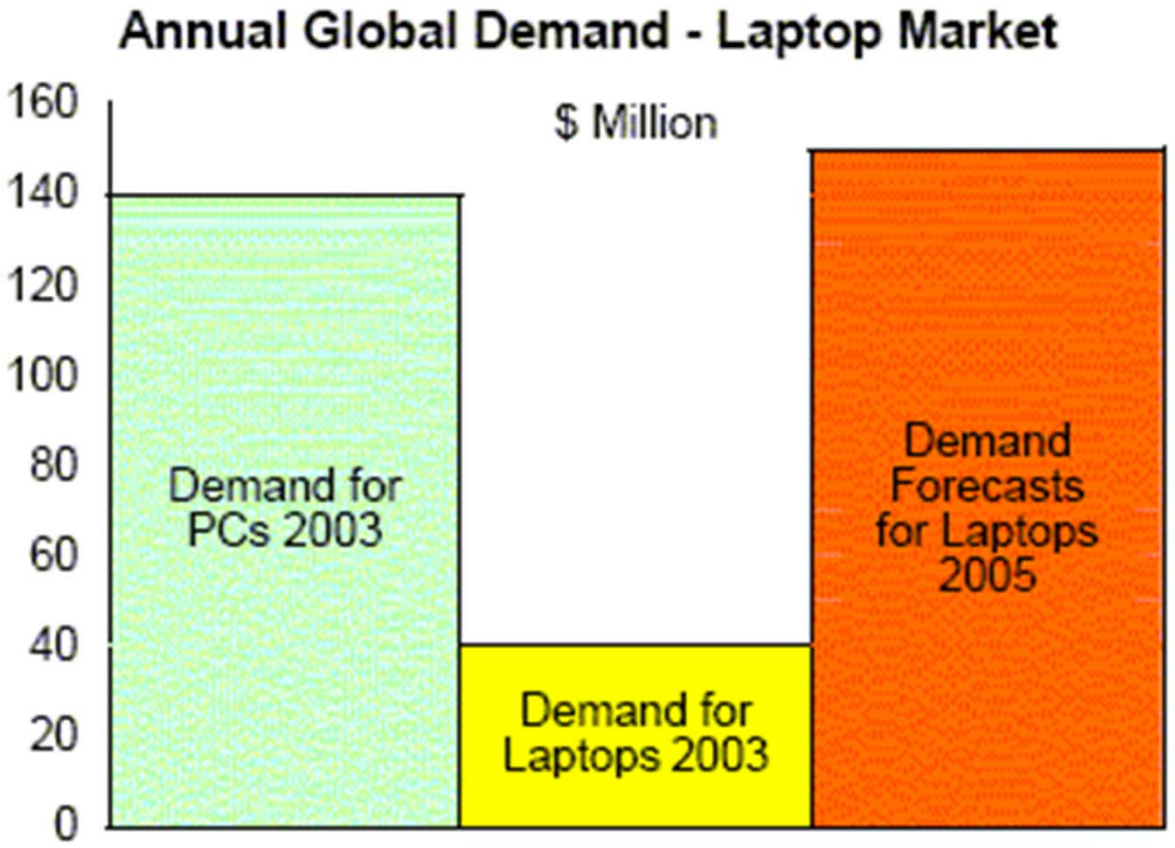
# Severity

- Sperm may take three to six months to recover from heat damage, since it takes the testes roughly 72 days to produce it.
  - Reversible biological effect
- But the long-term vicious spirals due to chronic exposure shall not be disregarded.
  - Irreversible biological effect
- As to the participants, they put a computer on their lap without a second thought about it.

# Widespread Potential

- "*I really believe the next cycle of (corporate PC) upgrades is going to be notebooks*" says Anand Chandrasekher, vice president and general manager of Intel's Mobile Platforms Group.
  - Unceasing improvements in powerful processors, dazzling large LCD screens, longer battery life, wireless networking growth, improved upgradability and features as potent as those attractive prices.
- Laptops outsell desktops for first time
  - Notebook sales accounted for 53% of the total personal computer market last month (May, 2005).

# Gartner Forecast 2004




*Source: MIC, IDC, NPD Group, 2004*

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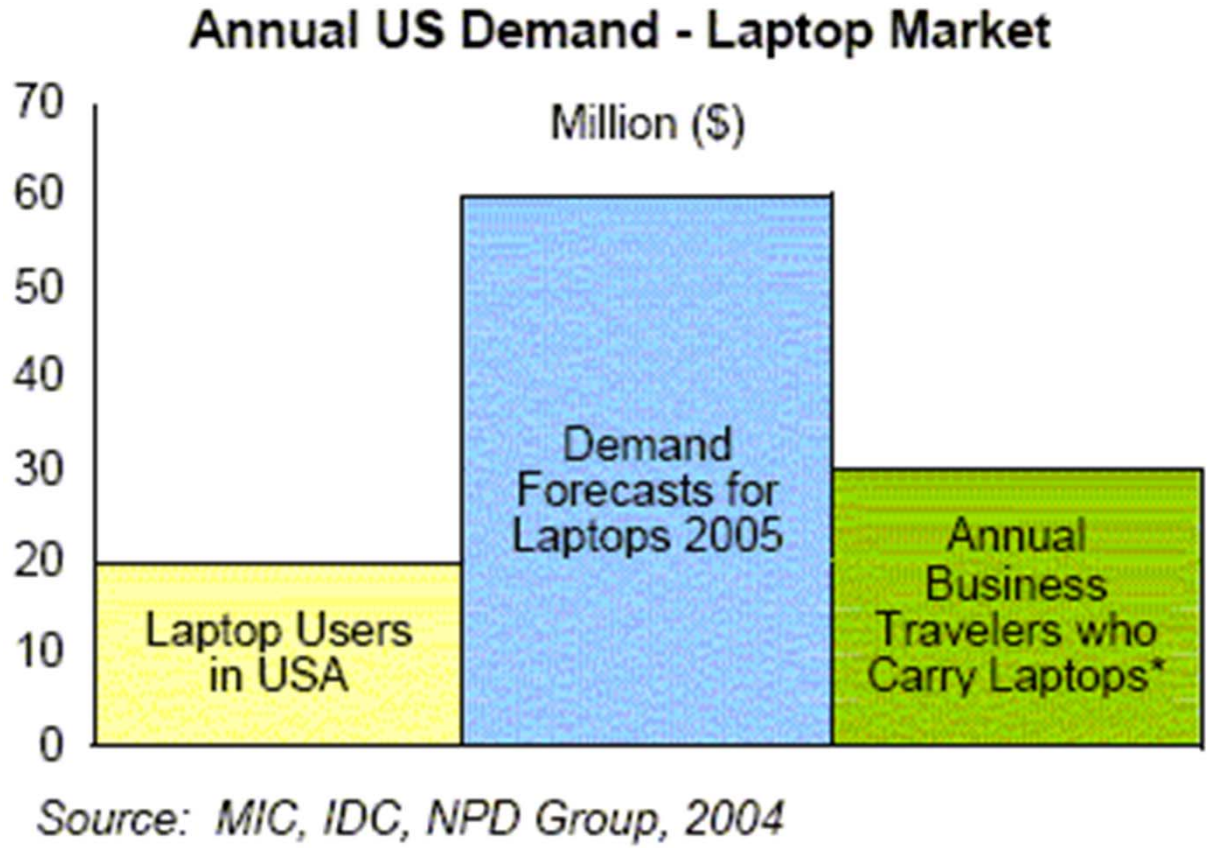
# Gartner Forecast 2004 (cont')




*Source: MIC, IDC, NPD Group, 2004*

** Usage by business travelers (1 hour or less): 6 million*
*Usage by business travelers (3 hours or more): 9 million*

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# Did it Faithfully Happened?

- May 26, 2005, market researcher Gartner revised its earlier projections.
- It said PC shipments world-wide in 2005 would exceed 202 million units, up 10.2% from the previous year.
- The rethinking of a previous Gartner forecast was mainly due to a spurt expected in mobile PC shipments. Gartner expects that
  - 26.5% more mobile PCs will be sold in the current year,
  - whereas desktop units will straggle at 4.6% growth.

# Safety Standards Speaking

- What is the so-called thermal hazard?
  - One of the definitions addressed in EN 292-1 (*Safety of machinery - Basic concepts, general Principles for design - Part 1: Basic terminology, methodology)* is that a hazard result in expected burns and scalds injury, and furthermore the environmental effects on health adversely.
- The general principles in the phase of design for protection against burn hazards may be found in
  - EN 292-2 (*Part 2: Technical principles and specifications)* - the machinery parts or materials at extreme temperatures shall be isolated from contact, proximity, ejection and where the risk exists, the extreme temperatures is not only hot (e.g. scald or burn) but also very cold inclusively (e.g. frostbite).

# Safety Standards Speaking (cont')

- In general, most LCs are categorized into the scope of IEC 60950x, the standard for information technology equipment (ITE).
- The excessive temperatures on accessible surfaces, emission of molten objects and the exposure of heated metal (resulted from electrical bridging) will serve as a failure of the conformity.
  - The similar criteria are broadly adopted in safety standards.

# Safety Standards Speaking (cont')

- A novel standard prepared by ECMA *(European Computer Manufacturers Association )* - ECMA-287, standard of electronic equipment
  - It was established in the philosophy of hazard-based safety engineering (HBSE) technology, using engineering principles and taking into account relevant IEC product standards and pilot safety documents.
- ECMA-287 was laid out by the categories of hazards (electrical shock, fire, burn, mechanical, radiation & chemical) and it's free to download.

# Basic Thinking of HBSE

- Dissimilar to customary appearance
  - Readily comprehensible
  - Macro vs. micro


**An injury occurs ONLY when energy of sufficient magnitude and duration is imparted to a body part.**

# Introduction to EN 563 *(Ergonomics Data to Establish Temperature Limit Values for Hot Surfaces)*

- The precious data specified are based on scientific research and represent as far as is known, and does not provide protection against pain.
  - It's only applicable to the healthy skin of adults, and not applicable to a large area of the skin (approximately 10% or more of the skin of the whole body) and skin contact of more than 10% of the head or contact which could result in burns of vital areas of the face (e.g. the airway)
  - The data specified in EN 563 are based on scientific research and represent of mainly:
    - i) H. Siekmann for short contact periods (between 1s & 10 s);
    - ii) A. R. Moritz and F. C. Henriques for long ones (> 10 s).

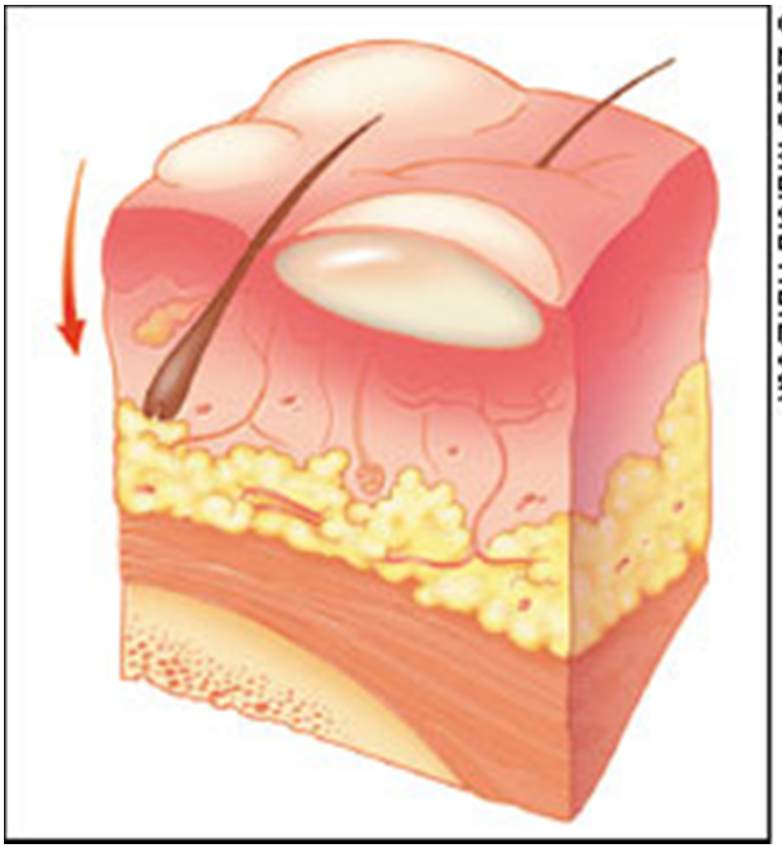
# Determination of the Applicable Burn Thresholds

- Key factors
  - surface temperature,
  - surface texture, and
  - contact period.
- For a particular contact period, a superficial partial thickness burn starts when the skin comes into contact with the surface whose surface temperature exceeds the correspondent burn threshold.

# Estimation of the contact period

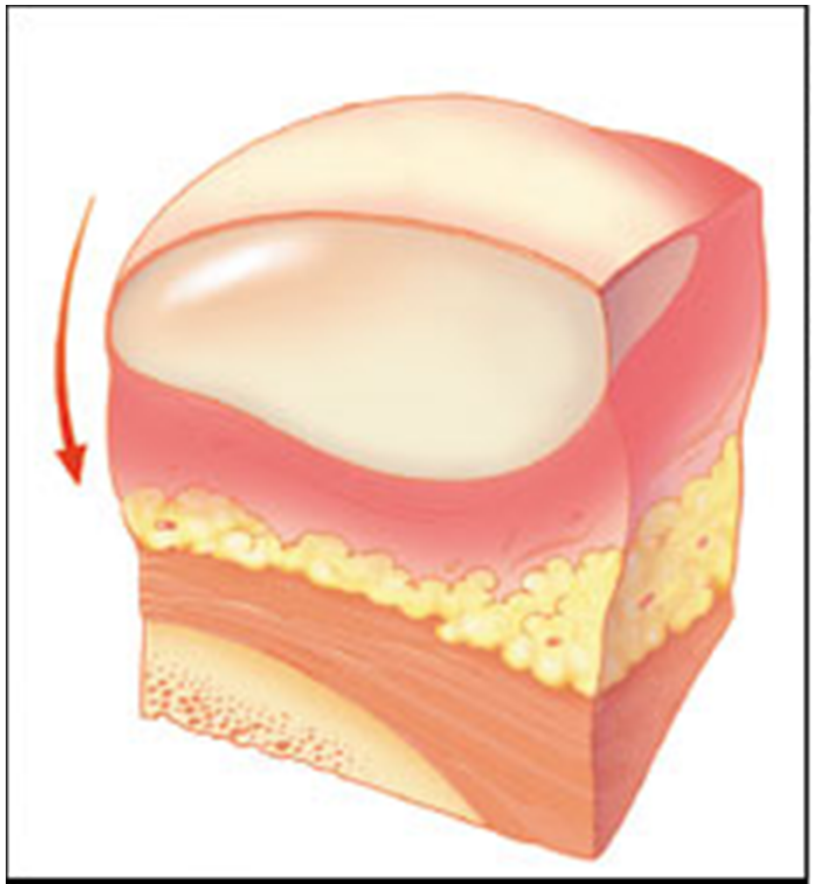
- Referred to EN 563, annex B
  - **0.5 s** may be selected only if in the case of a healthy adult, there is absolutely no restriction of movement and the contact is made unintentionally;
  - **1 s** shall be used in the event of non-intended contact;
  - **4 s** is proposed for the conditions that restrict ease of movement, elderly or disabled persons; and also, shall be used in the event of intended contact;

# Levels upon Severity (1/3)



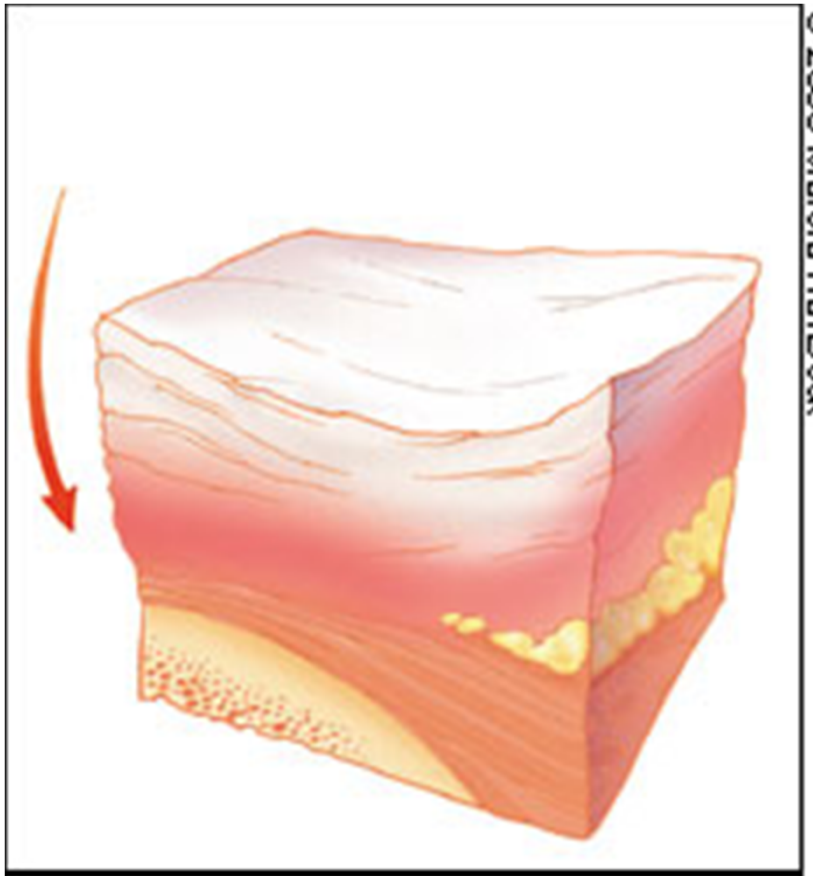

- EN 563
- Superficial partial thickness:
  - Follicles and glands survive.
- ASTM C 1057
- First degree:
  - incomplete necrosis of epidermal layer (redness).

# Levels upon Severity (2/3)




- EN 563
- Deep partial thickness:
  - substantial dermis and glands mostly destroyed.
- ASTM C 1057
- Second degree:
  - complete necrosis of epidermis (blistering).

# Levels upon Severity (3/3)




- EN 563
  - Whole thickness:
    - No surviving glands.
- ASTM C 1057
  - Third degree:
    - 75% destruction of dermis scarred upon healing.

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# Comparison among Standards

- B1-standard vs. C standard
  - B1 handles on particular safety aspects, and
  - C gives detailed safety requirements for a particular machine.
- Appendix B gives a quick cross-comparison among the criteria of the relevant standards, and appendix A shown their elaborations.

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# Summary

- Modules of heat transfer usually known are:
  - Conduction,
  - Convection, and
  - Radiation.
- Dr. Sheynkin's research is a typical example of free (natural) convection, the hot surface of the LC forms convection currents and incurred the rise the scrotal temperature in extremely confined space.
  - The same outcome will probably happened to a man in the cross-legged posture and supports a hot flat-bottomed object.

# Summary

- So far, the protection against burn hazards in most safety standards is major in conduction heat.
  - Conduction heat transfer occurs only when there is physical contact between solid bodies (systems) at different temperatures.
- In general, the following factors may affect the threshold but they are of minor importance
  - Thickness, moisture of skin in contact, force applied…etc.

# Summary

- Radiation heat imparted to body exposure (referred to as thermal effects) is not a new concern.
  - In contrast with harmful ionizing radiation, non-ionizing radiation (NIR) encompasses the long wavelength (> 100 nm). Besides the visible region, human senses cannot perceive the NIR except for heat (where intensive enough).
- Exclusive of a surfeit of exposure, the body has many effective ways to regulate its temperature in a good manner.
  - Much of current debate was focused on the "non-thermal" biological effects generated by low-level non-ionizing electromagnetic fields (EMFs) (e.g. mobile phones and base stations).
- So far, there is no definitive conclusion and current understanding will not be capable of giving unequivocal answers until the causes of these diseases have been discovered all.

# Summary

- In the thinking of the HBSE, Besides restricting the use of the thermal energy and making the hot objects inaccessible, the safeguards may be achieved by the provision of thermal insulation,
  - e.g. reduce the mass and the temperature, employ the texture with lower specific heat, etc. upon the nature of thermal energy.

$$Q = M\,Cp\,(T - To)$$

# Summary


**An injury occurs ONLY when energy of sufficient magnitude and duration is imparted to a body part.**

- Where above is not applicable , symbol which most frequently seen is the IEC 60417-50417 (a hot surface within an equilateral triangle), it indicates the marked item can be hot and should not be touched without taking care. Unintentional contacts due to the absence of visual interpretation are not being abandoned; a suitable isolation or barrier is needed.

# Summary

- Until now, most of safety standards are not sufficient for covering all possibilities in all respects.
  - The measure for the effectiveness in a clinical study is very rare and complicated.
- Someday another provocative finding will challenge our practice inevitably. The behavior of personal avoidance may helps,
  - actively recognize hazardous energy sources and subsequent injuries,
  - raising public consciousness on the importance of product safety and employing a personal safeguard will free us from getting hurt and prevent misinterpretation against commercial advertising and the siren-song-like statement.

# Thank you !!

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APPENDIX A.1

Requirements in IEC 60950-1, 1st Edition (2001), Information Technology Equipment - Safety - Part 1: General Requirements

| Clause Designation | Locations of Unintentional Contact | Locations of Intentional Contact | Contexture of the Surface | Limits (degrees Celsius) |
|---|---|---|---|---|
| ***4.5.1 Maximum temperatures*** | External surfaces of equipment which may be touched | -- | Metal | 70 |
| | | | Glass, porcelain and vitreous material | 80 |
| | | | Plastic and rubber | 95 |
| | Parts inside the equipment which may be touched | -- | Metal | 70 |
| | | | Glass, porcelain and vitreous material | 80 |
| | | | Plastic and rubber | 95 |
| | -- | Handles, knobs, grips, etc., held or touched for short periods only | Metal | 60 |
| | | | Glass, porcelain and vitreous material | 70 |
| | | | Plastic and rubber | 85 |
| | -- | Handles, knobs, grips, etc., continuously held in normal use | Metal | 55 |
| | | | Glass, porcelain and vitreous material | 65 |
| | | | Plastic and rubber | 75 |

APPENDIX A.2

Requirements in IEC 60065, Seventh Edition (2001), Audio, Video and Similar Electronic Apparatus – Safety Requirements

| Clause Designation | Locations of Unintentional Contact | Locations of Intentional Contact | Contexture of the Surface | Limits (degrees Celsius) |
|---|---|---|---|---|
| ***7.1.1 Accessible parts*** | Enclosures | -- | Metallic | 75 |
| | | | Non-metallic | 95 |
| | | | Wood | 95 |
| | -- | Knobs, handles, etc. | Metallic | 65 |
| | | | Non-metallic | 85 |
| Note 1: For tropical climates, the permissible temperature reduced by 10 degrees Celsius is required.<br>Note 2: For fault conditions, the permissible temperature rises up to 100 degrees Celsius are allowed (125 degrees Celsius only for wood). | | | | |

APPENDIX A.3

Requirements in Standard of electronic equipment, ECMA-287, 2nd edition, Dec. 2002

| Clause Designation | Locations of Unintentional Contact | Locations of Intentional Contact | Contexture of the Surface | Limits (degrees Celsius) |
|---|---|---|---|---|
| ***5.1 Access to hot surfaces*** | External surface of equipment may be touched | -- | Metallic | 65 |
| | | | Non-metallic | 85 |
| | -- | Handles, knobs, grips, etc. held continuously | All | 43 |
| | | Handles, knobs, grips, etc. held or touched for short period only | Metallic | 55 |
| | | | Non-metallic | 65 |

## APPENDIX A.4

Burn thresholds in EN 563:1994 + A1:1999, Safety of machinery - Temperatures of touchable surfaces - Ergonomics data to establish temperature limit values for hot surfaces

| Clause Designation | Events of Unintentional Contact | Events of Intentional Contact | Contexture of the Surface | Limits (degrees Celsius) |
|---|---|---|---|---|
| ***4.2.1 Burn thresholds for a contact period below 1 s*** *(taking1 s for example)* | Touching of a hot surface and quick withdrawal following the pain sensation | -- | Bare/uncoated metal | 63-73 |
| | | | Ceramics, glass and stone | 84-90 |
| | | | Plastics | 91-99 |
| | | | Wood | 128-155 |
| ***4.2.2 Burn thresholds for a contact period between 1 s and 10 s*** *(taking 4 s for example)* | Touching of a hot surface and extended reaction time | Activation of a switch or pressing a button | Bare/uncoated metal | 58-63 |
| | | | Ceramics, glass and stone | 71-76 |
| | | | Plastics | 74-82 |
| | | | Wood | 93-113 |
| ***4.2.3 Burn thresholds for a contact period of 1 min or longer*** *(taking 1 min for example)* | Falling against a hot surface without recovery | Prolonged activation or continuous use of control elements (controls, handles etc.) | Bare/uncoated metal | 51 |
| | | | Ceramics, glass and stone | 56 |
| | | | Plastics | 60 |
| | | | Wood | 60 |
| | | | **ALL** | 48, if 10 min ≤ t < 8 h<br>43, if t ≥ 8 h |

Note 1: Estimation of the contact period (referred to EN 563, annex B)
a) **0.5 s** may be selected only if in the case of a healthy adult, there is absolutely no restriction of movement and the contact is made unintentionally;
b) **1 s** shall be used in the event of non-intended contact;
c) **4 s** is proposed for the conditions that restrict ease of movement, elderly or disabled persons; and also, shall be used in the event of intended contact;
Note 2: Grey area in the figures of burn threshold
a) Upper boundary bounds reversible and irreversible cutaneous injury;
b) Lower boundary bounds non-injury and reversible cutaneous injury.

## APPENDIX B

Quick Cross-comparison among the Safety Standards

| Standard Designation | Unintentional | | | | Short -term Intentional | | | | Long -term Intentional | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | Nonmetal | | | M | Nonmetal | | | M | G | P |
| | | G | P | W | | G | P | W | | | |
| **IEC 60950-1** | 70 | 80 | 95 | N/S | 60 | 70 | 85 | N/S | 55 | 65 | 75 |
| **IEC 60065** | 75 | 95 | | 95 | 65 | 85 | | | N/S | | |
| **EN 563** | 63 | 84 | 91 | 128 | 58 | 71 | 74 | 93 | 48 | | |
| **ECMA-287** | 65 | 85 | | | 55 | 65 | | | 43 | | |

Presumed contact periods: Unintentional = 1 s or accessible surface;
Short-term intentional = 4 s or intentional operation;
Long-term intentional = exceeds 10 min but less than 8 h or continuously held.
Note 1: Abbreviations: M = Metal; P = Plastics or Rubbers; G = Glasses, Porcelain or Ceramics; W = Woods; N/S = Not specified.
Note 2: The values of lower boundary (non-injury) and moderate climate condition were adopted.

The likeness to EN 563 in percentage was tabulated as below:

| Standard Designation | Unintentional | | | | Short -term Intentional | | | | Long -term Intentional | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | Nonmetal | | | M | Nonmetal | | | M | G | P |
| | | G | P | W | | G | P | W | | | |
| **IEC 60950-1** | 111%<br>(+7) | 95%<br>(-4) | 104%<br>(+4) | N/S | 104%<br>(+2) | 99%<br>(-1) | 115%<br>(+11) | N/S | 115%<br>(+7) | 135%<br>(+17) | 156%<br>(+27) |
| **IEC 60065** | 120%<br>(+12) | 113%<br>(+11) | | 74%<br>(-33) | 112%<br>(+7) | 120%<br>(+14) | | | N/S | | |
| **EN 563** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| **ECMA-287** | 103%<br>(+2) | 101%<br>(+1) | | | 95%<br>(-3) | 92%<br>(-6) | | | 90%<br>(-5) | | |

Note 1: The likeness is the quotient of the subject variable divided by correspondent burn thresholds in EN 563.
Note 2: The values in parentheses are the difference from correspondent burn thresholds in EN 563.