Introduction to IEC 62368-1

including

Hazard Based Safety Engineering

Presented by
Richard Nute
Life Senior Member, IEEE
Charter Member, PSES
Product Safety Consultant
Vancouver, Washington, U.S.A.

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Some of the material in this presentation is adapted or taken from

- an ITIC presentation, “Preparing for the Global Transition to IEC 62368-1,” by Flore Chiang, Staff Engineer, Product Safety, Underwriters Laboratories Taiwan Co., Ltd., September, 2011.

- an Orange County PSES Chapter presentation on IEC 62368-1 by Charles Bayhi, Principal Consultant, CPSM Corporation, January, 2011.

- a Santa Clara PSES Chapter presentation, “Transition to a New Hazard Based Safety Standard, IEC 62368-1,” by Kevin Ravo, Underwriters Laboratories, Inc., October, 2010.

- IEC 62368-1 Technical Brief, “HBSE’s Three Block Models,” by Jesson Chen, Underwriters Laboratories Taiwan Co., Ltd., April 16, 2010.

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62368-1, 2nd Edition

Implementation Dates

date of Ratification (DOR) (1)	2014-06-20
date of Availability (DAV) (2)	2014-08-01
date of Announcement (DOA) (3)	2014-12-20
date of Publication (DOP) (4)	2015-06-20
date of Withdrawal (DOW) (5)	2020-12-20

62368-1, 2nd Edition

Announced Formal Transition Dates

EU *Date of Withdrawal (DOW)* - Legacy Standards (60065/60950-1): **June 20, 2019**

- Official Journal (OJ) of the EU (latest): July 8, 2016
- DOW = Date superseded standards (60065 & 60950-1) cease to give 'presumption of conformity' with the essential requirements of the relevant Union legislation

Cenelec	EN 62368-1:2014 Audio/video, information and communication technology equipment - Part 1: Safety requirements (IEC 62368-1:2014, modified) IEC 62368-1:2014 (Modified)	08/07/2016	EN 60065:2014# + A1:2015# + A:2014 EN 60950-1:2006# + A11:2009# + A12:2011# + A1:2010# + A2:2013 Note 2.1	20/06/2019
	EN 62368-1:2014/AC:2015	08/07/2016		

IEC 62368-1 innovations

- **Introduces models**
  - model for injury
  - model for safety
- **Classifies energy sources**
  - class 1: may be detectable
  - class 2: may be painful
  - class 3: capable of causing injury
- **Introduces the concept of safeguards**
  - basic safeguard
  - supplementary safeguard
  - reinforced safeguard
- **Applies safeguards based on persons**
  - ordinary person
  - instructed person
  - skilled person

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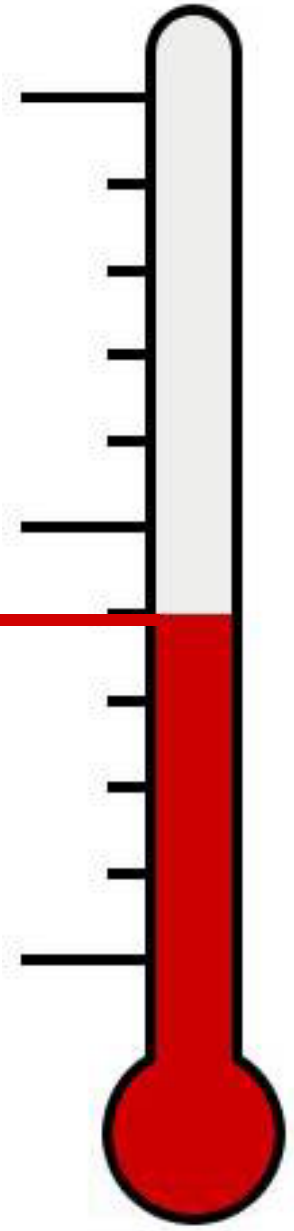
For each form of energy, there is a threshold level for injury to a body part.

An energy source exceeding the body threshold level for that form of energy is a *hazardous energy source*.

For each form of energy above this threshold, injury is possible

An energy source less than the body threshold level is likely a *non-hazardous energy source*.

For each form of energy below this threshold, injury is not likely



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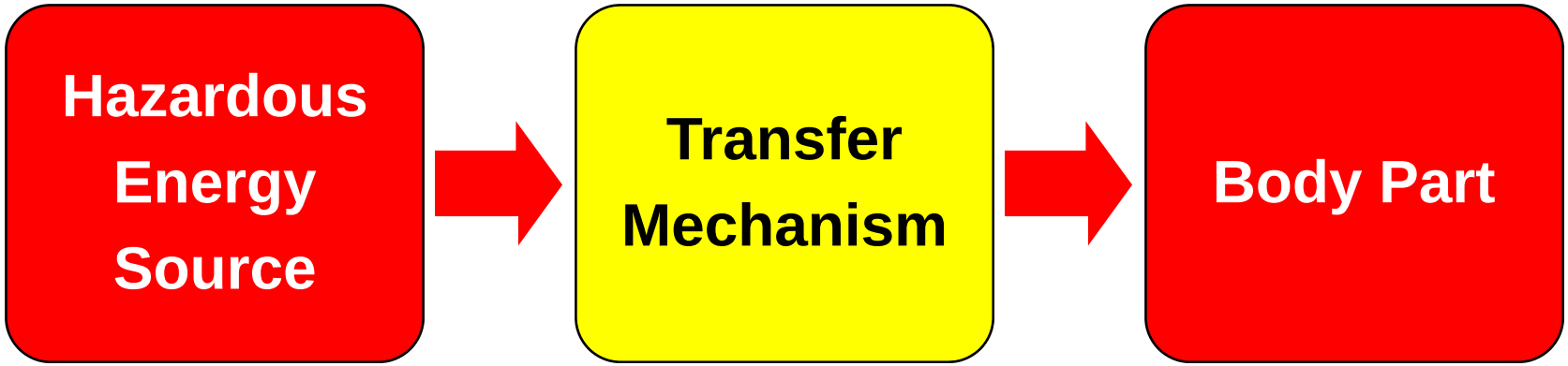
HBSE model for injury

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



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HBSE model for safety

No injury occurs when a safeguard is interposed between a hazardous energy source and a body part.

Energy source classifications

Energy source class	Effect on the body	Effect on combustible materials
Class 1	May be detectable, but is not painful nor is it likely to cause an injury.	Ignition not likely
Class 2	May be painful, but is not likely to cause an injury.	Ignition possible, but limited growth and spread of fire
Class 3	Capable of causing injury.	Ignition likely, rapid growth and spread of fire

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Energy class magnitudes

Energy source class	Electric shock injury	Electrically-caused fire	Mechanical injury	Thermal injury
	ES-1, -2, -3	PS-1, -2, -3	MS-1, -2, -3	TS-1, -2, -3
Class 1	< 30 V rms or < 0.5 mA	< 15 watts	< 7 kg mass	< 48 ° C
Class 2	< 50 V rms or < 5 mA	< 100 watts	< 25 kg mass	< 58 ° C
Class 3	> 50 V rms and > 5 mA	> 100 watts	> 25 kg mass	> 58 ° C

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Safeguard types

Safeguard	physical part or system or instruction specifically provided to reduce the likelihood of pain or injury, or, for fire, to reduce the likelihood of ignition or spread of fire
Equipment	a physical part of the equipment
Installation	a physical part of the installation
Personal	personal protective equipment that is worn on the body
Instructional	a visual or audible indicator or message invoking a specified behaviour on the part of a person and that is intended to reduce the likelihood of transfer of class 2 or 3 energy to a body part (i.e., a warning)

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Equipment safeguards

Safeguard	physical part or system or instruction specifically provided to reduce the likelihood of pain or injury, or, for fire, to reduce the likelihood of ignition or spread of fire
Basic	is operational under **normal operating conditions** and under **abnormal operating conditions** whenever an energy source capable of causing pain or injury is present in the equipment
Supplementary	applied in addition to the **basic safeguard** that is or becomes operational in the event of failure of the **basic safeguard**
Reinforced	single **safeguard** that is operational under: – **normal operating conditions**, – **abnormal operating conditions**, and – **single fault conditions**
Double	comprising both a **basic safeguard** and a **supplementary safeguard**

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Persons

Person	Who	Minimum required safeguards	
		Class 2	Class 3
Ordinary	**All persons**	**basic**	**basic + supplementary, or reinforced**
Instructed	persons who have been instructed and trained by a **skilled person**	**precautionary safeguard**	**basic + supplementary, or reinforced**
Skilled	persons who have training or experience in class 2 and 3 energy sources	**skill safeguard**	

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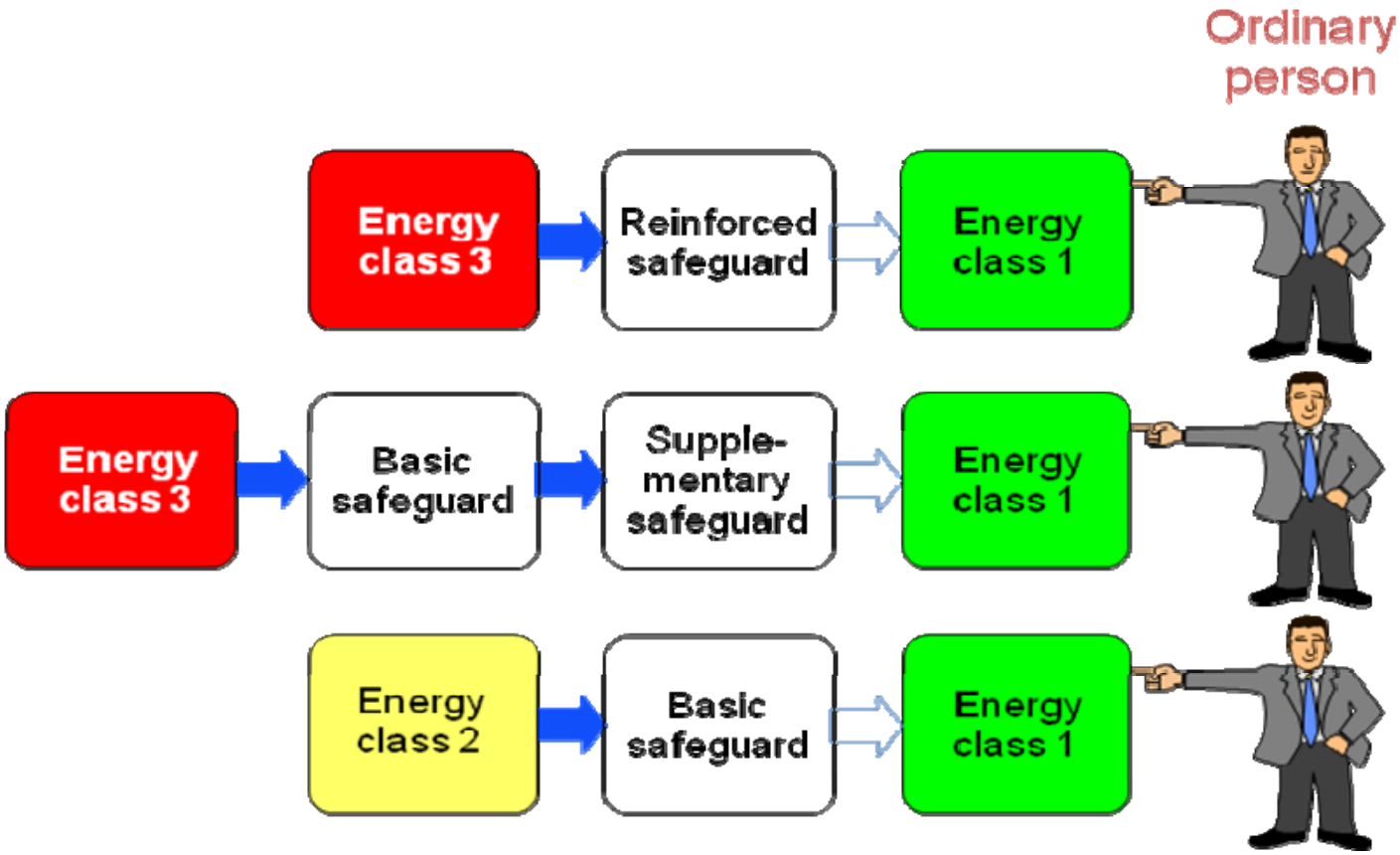
Ordinary person safeguards

All accessible parts shall be a Class 1 source
(ES1, PS1, MS1, TS1)



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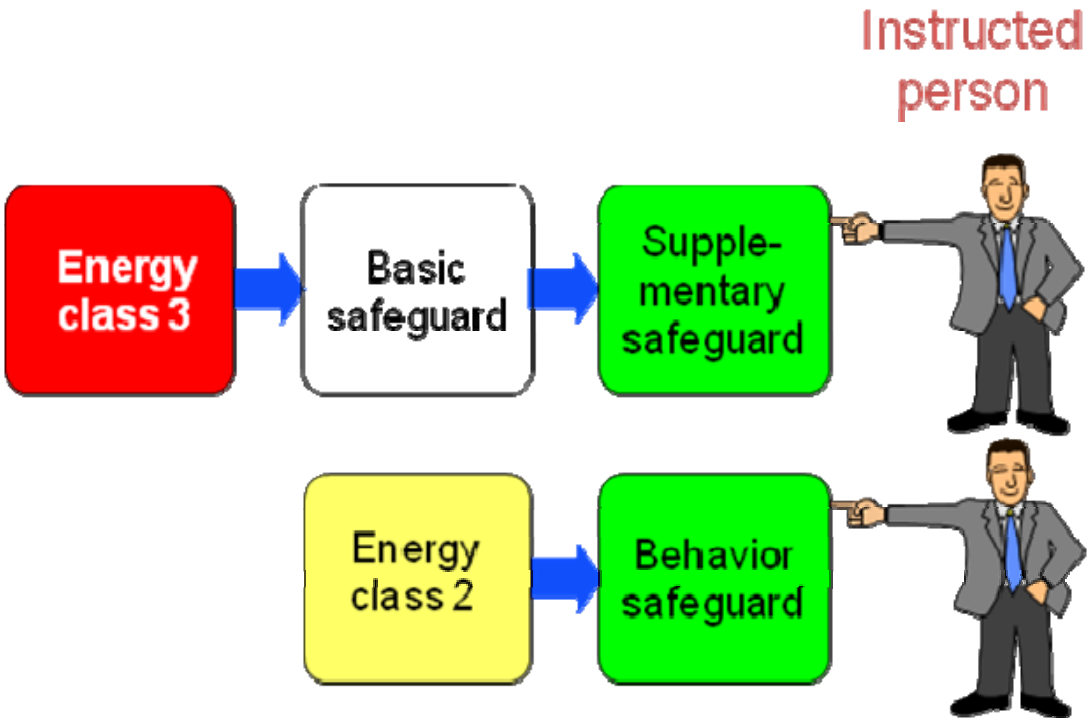
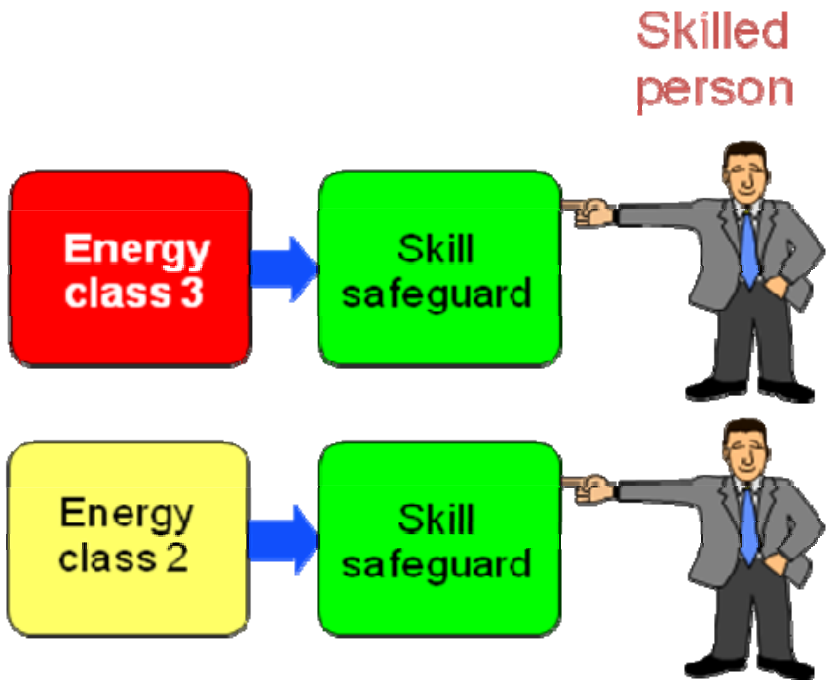
Instructed person safeguards



Skilled person safeguards



IEC 62368-1 – What is it?

- New Safety Standard for
  - **Consumer Electronic** (Audio/Video) Apparatus
  - **Information Technology Equipment**
  - **Communication Technology Equipment**
- **Hazard-Based**
- **Technology Independent**
- Based on
  - Sound **Engineering Principles**,
  - Existing **IEC Horizontal Standard**s
  - **Research**, and
  - **Field Data**

NOT a simple merger of IEC 60065 and IEC 60950-1

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IEC 62368 is three documents

IEC 62368-1

IEC 62368-1

Edition 1.0 2010-01

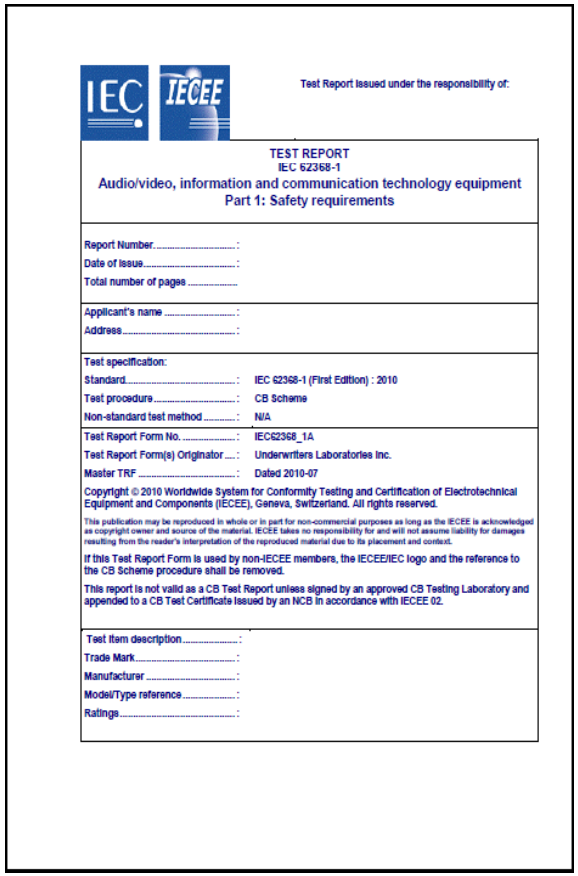
INTERNATIONAL STANDARD

colour inside

Audio/video, information and communication technology equipment – Part 1: Safety requirements

COMMEMORATIVE COPY

TR 62368-1



Test Report issued under the responsibility of:

TEST REPORT
IEC 62368-1
Audio/video, information and communication technology equipment
Part 1: Safety requirements

Report Number.....:
Date of issue.....:
Total number of pages.....

Applicant's name.....:
Address.....:

Test specification:
Standard.....: IEC 62368-1 (First Edition) : 2010
Test procedure.....: CB Scheme
Non-standard test method.....: N/A
Test Report Form No.....: IEC62368_1A
Test Report Form(s) Originator.....: Underwriters Laboratories Inc.
Master TRF.....: Dated 2010-07

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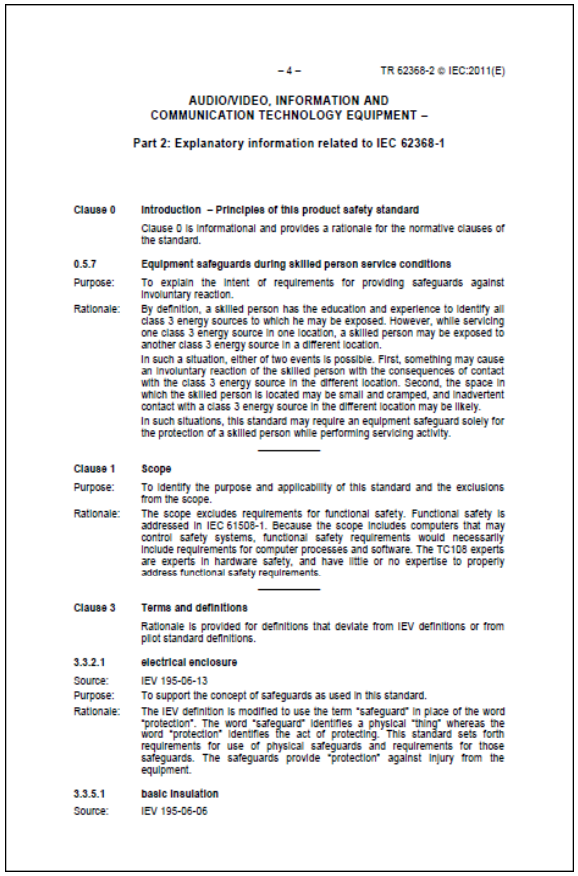
This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

Test item description.....:
Trade Mark.....:
Manufacturer.....:
Model/Type reference.....:
Ratings.....:

IEC 62368-2



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AUDIO/VIDEO, INFORMATION AND COMMUNICATION TECHNOLOGY EQUIPMENT –

Part 2: Explanatory information related to IEC 62368-1

Clause 0 **Introduction – Principles of this product safety standard**

Clause 0 is informational and provides a rationale for the normative clauses of the standard.

0.5.7 **Equipment safeguards during skilled person service conditions**

Purpose: To explain the intent of requirements for providing safeguards against involuntary reaction.

Rationale: By definition, a skilled person has the education and experience to identify all class 3 energy sources to which he may be exposed. However, while servicing one class 3 energy source in one location, a skilled person may be exposed to another class 3 energy source in a different location.

In such a situation, either of two events is possible. First, something may cause an involuntary reaction of the skilled person with the consequences of contact with the class 3 energy source in the different location. Second, the space in which the skilled person is located may be small and cramped, and inadvertent contact with a class 3 energy source in the different location may be likely.

In such situations, this standard may require an equipment safeguard solely for the protection of a skilled person while performing servicing activity.

Clause 1 **Scope**

Purpose: To identify the purpose and applicability of this standard and the exclusions from the scope.

Rationale: The scope excludes requirements for functional safety. Functional safety is addressed in IEC 61508-1. Because the scope includes computers that may control safety systems, functional safety requirements would necessarily include requirements for computer processes and software. The TC108 experts are experts in hardware safety, and have little or no expertise to properly address functional safety requirements.

Clause 3 **Terms and definitions**

Rationale is provided for definitions that deviate from IEV definitions or from pilot standard definitions.

3.3.2.1 **electrical enclosure**

Source: IEV 195-06-13

Purpose: To support the concept of safeguards as used in this standard.

Rationale: The IEV definition is modified to use the term "safeguard" in place of the word "protection". The word "safeguard" identifies a physical "thing" whereas the word "protection" identifies the act of protecting. This standard sets forth requirements for use of physical safeguards and requirements for those safeguards. The safeguards provide "protection" against injury from the equipment.

3.3.5.1 **basic insulation**

Source: IEV 195-06-06

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HBSE vs. IEC 62368-1

HBSE

- is a comprehensive **engineering approach** to design safe products

IEC 62368-1

- **scope** is broad and inclusive of the current IEC 60065 and IEC 60950-1
- follows a different approach to safety using **HBSE** principles
- uses performance tests to demonstrate safety
- Hazard-Based approach is different than the more prescriptive approach taken by the existing standards IEC 60065 and IEC 60950-1

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Benefits of Hazard-Based standard

- Easier introduction of **new technology** to the marketplace
- Provides **single standard** for a broad range of products
- Allows minimization of **national/regional differences**
- **Design freedom**
- **Stable**
- Preserves information on **basis** for requirements
- **Understandable**
- **User friendly**

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Implementation plan for IEC 62368-1

- is intended to ultimately **replace** IEC 60065 and IEC 60950-1
- initially published in 2010 with a minimum five (**5**) year effective date that is being recommended by IEC TC108
- its Test Report Form (**TRF**) has been published
- publication of national standards based on IEC 62368-1 expected to follow after the publication of IEC 62368-1
  - it is hoped that National/Regional Committees will adopt effective dates that will coincide with the effective date timing recommended by IEC TC108, but this cannot be guaranteed.
  - since the five-year transition period is the **best case scenario**, there's no guarantee that one or more **regulators** will adopt the standard sooner.
  - **retailers** and other major **customers** may demand a product to be certified to IEC 62368 sooner than the transition period.

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Relative advantage

- **Economies of scale**
- Hazard-based → **Technology independent**
- Use of **horizontal** standards
- **Rationale** document (IEC 62368-**2**)
- **Design freedom** (less prescriptive)

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IEC 60950-1 vs. IEC 62368-1

IEC 60950-1

- incident-based
- product-specific
- construction-based
- reactive

IEC 62368-1

- hazard-based
- tech. independent
- performance-based
- proactive

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Incident-based safety standards

- based on inversion of **bad experiences**
- comprised of **historical safety** measures
- prescribes **limited** acceptable constructions

Hazard-based safety standards

- based on known **body susceptibility** (i.e., thresholds of various physiological effects with respect to energy sources)
- any technology can be reduced to **forms of energy**
- energy sources are **definable** and **quantifiable**
- **safeguards** can be designed with respect to parameters defined by the hazardous energy source

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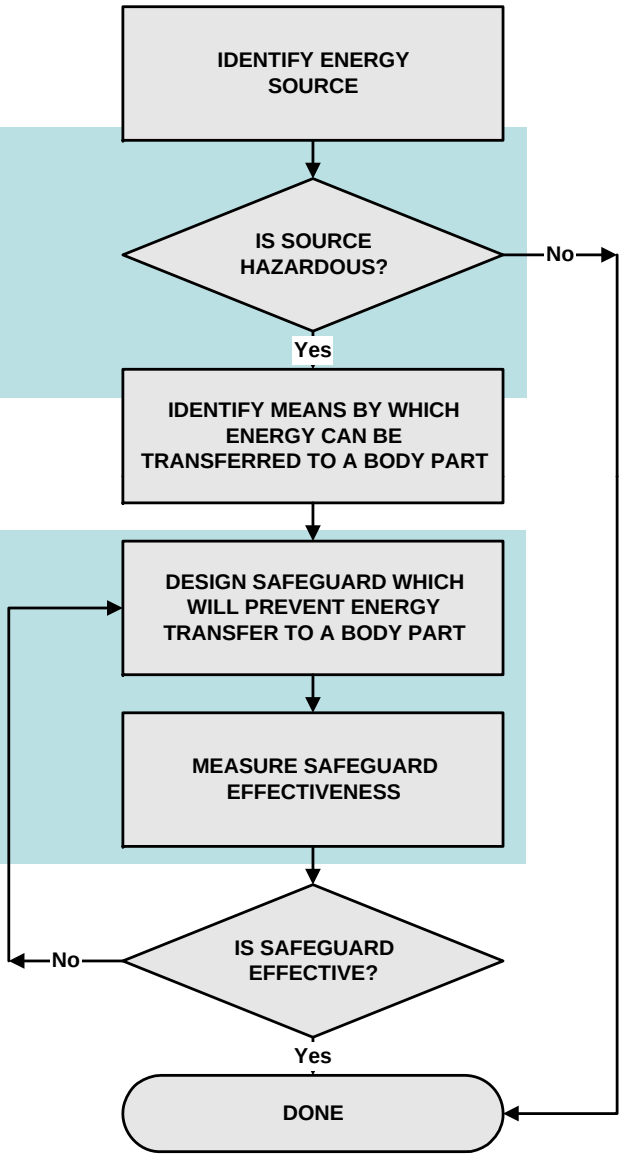
HBSE2 Process

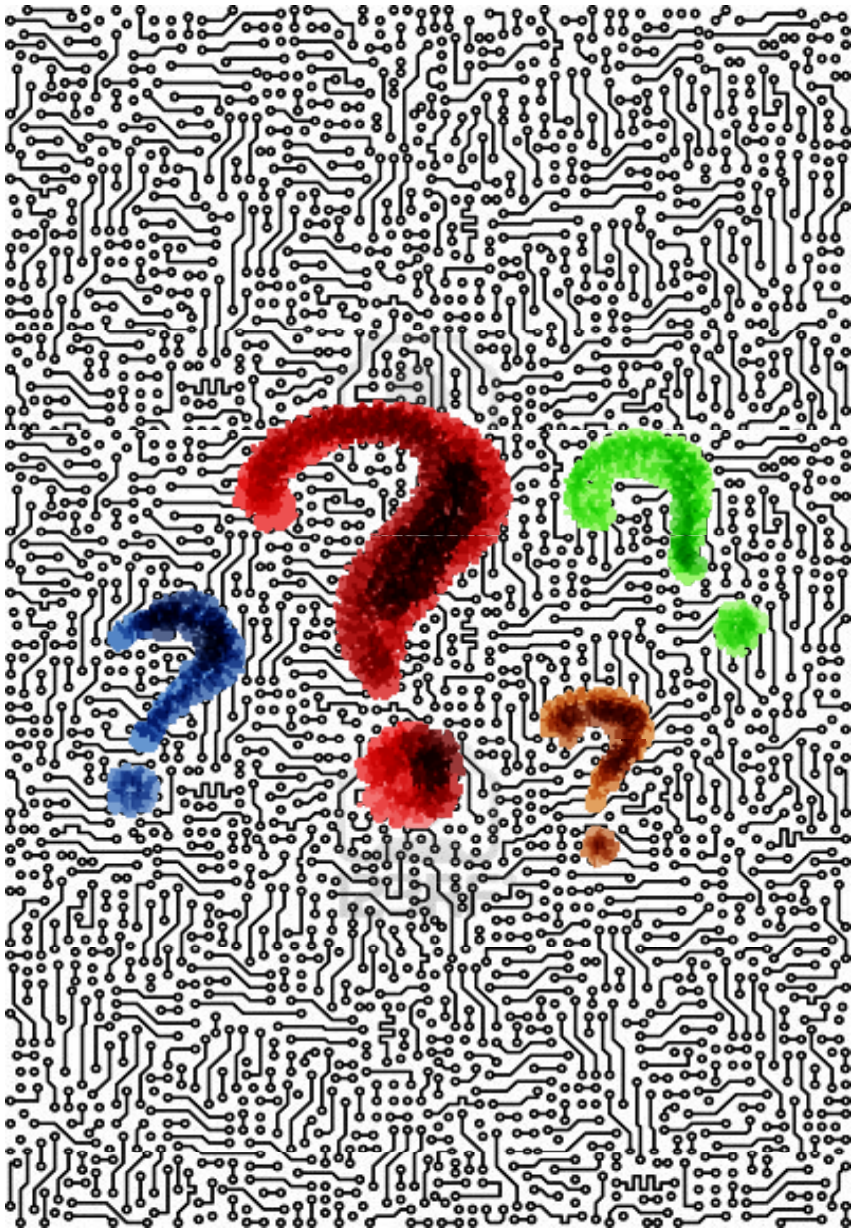
The limit values for determining whether or not an energy source is hazardous are based on IEC Basic and Group safety publications.

The safeguard tests and parameters are based on IEC Basic and Group safety publications.



Product investigation

1. Identify the **ES1**, **ES2** and **ES3** parts and circuits and their respective safeguards.
2. Identify the **PS1**, **PS2**, and **PS3** circuits and the fire safeguard methods.
3. Identify the **MS1**, **MS2**, and **MS3** parts and circuits and their respective safeguards.
4. Identify the **TS1**, **TS2**, and **TS3** parts and circuits and their respective safeguards.



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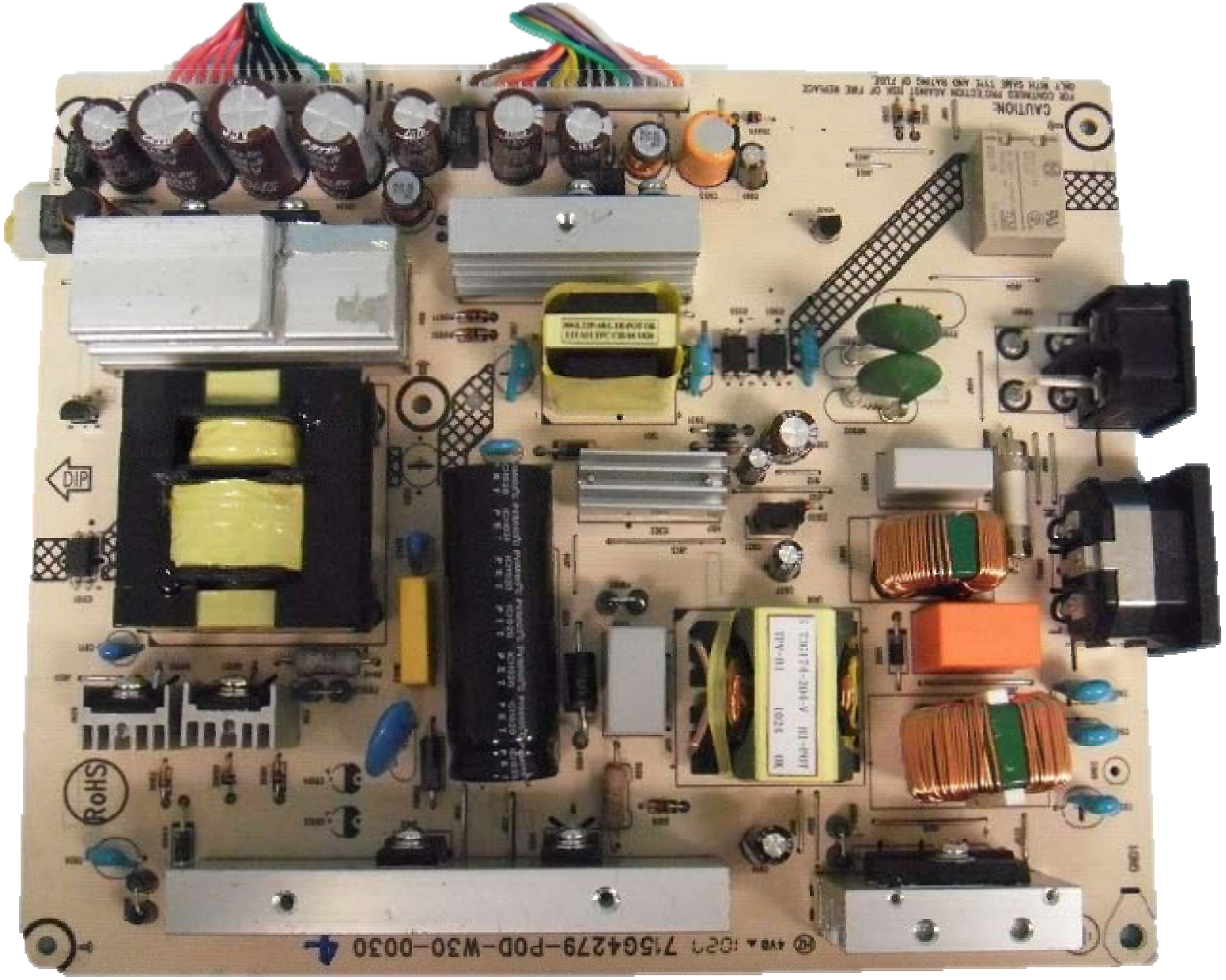

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PRODUCT INVESTIGATION – ELECTRIC SHOCK

- **What are the ES1, ES2, and ES3 parts and circuits?**
- **What are the product safeguards against electric shock?**

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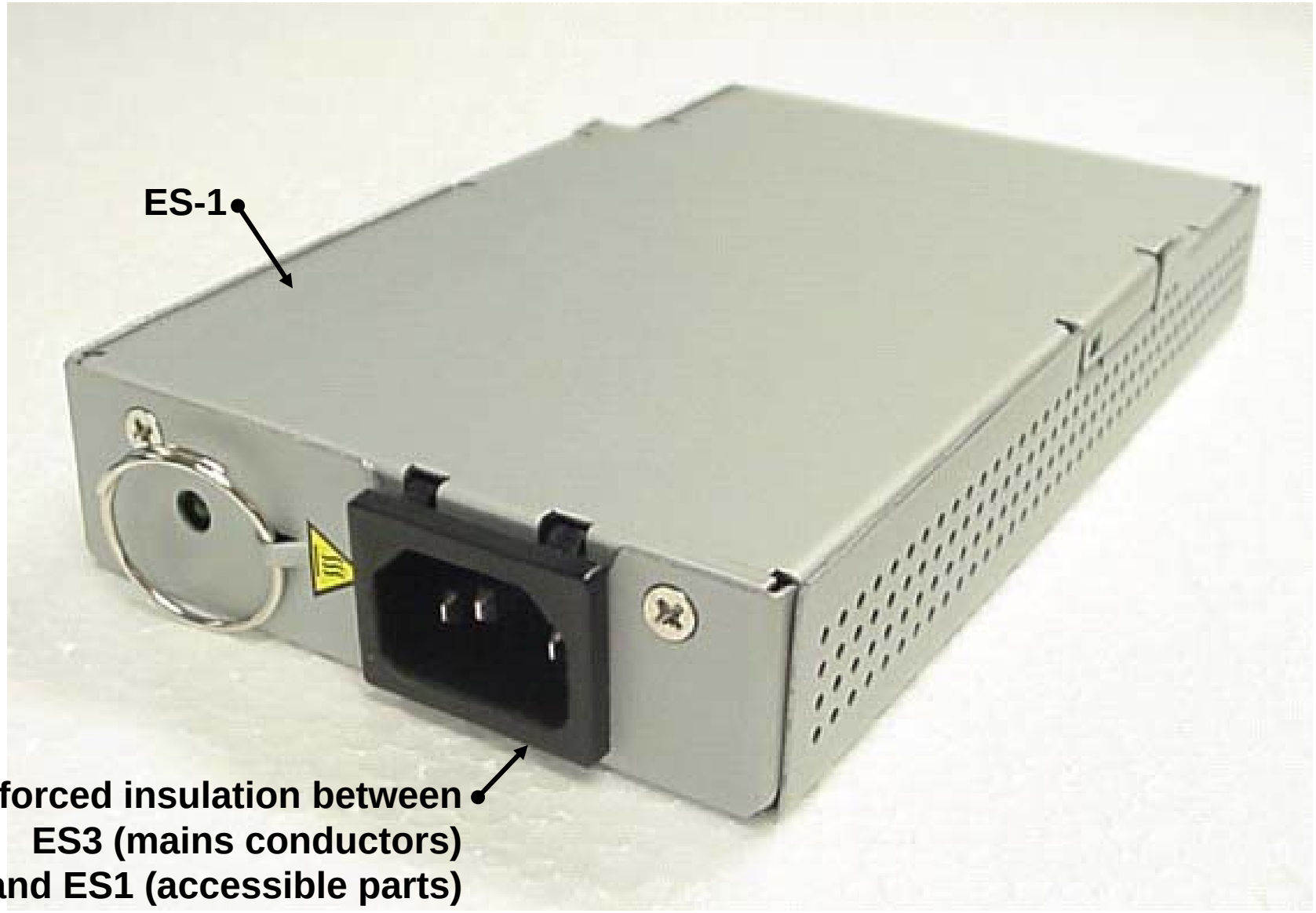
ES1 PARTS EXAMPLE – POWER SUPPLY



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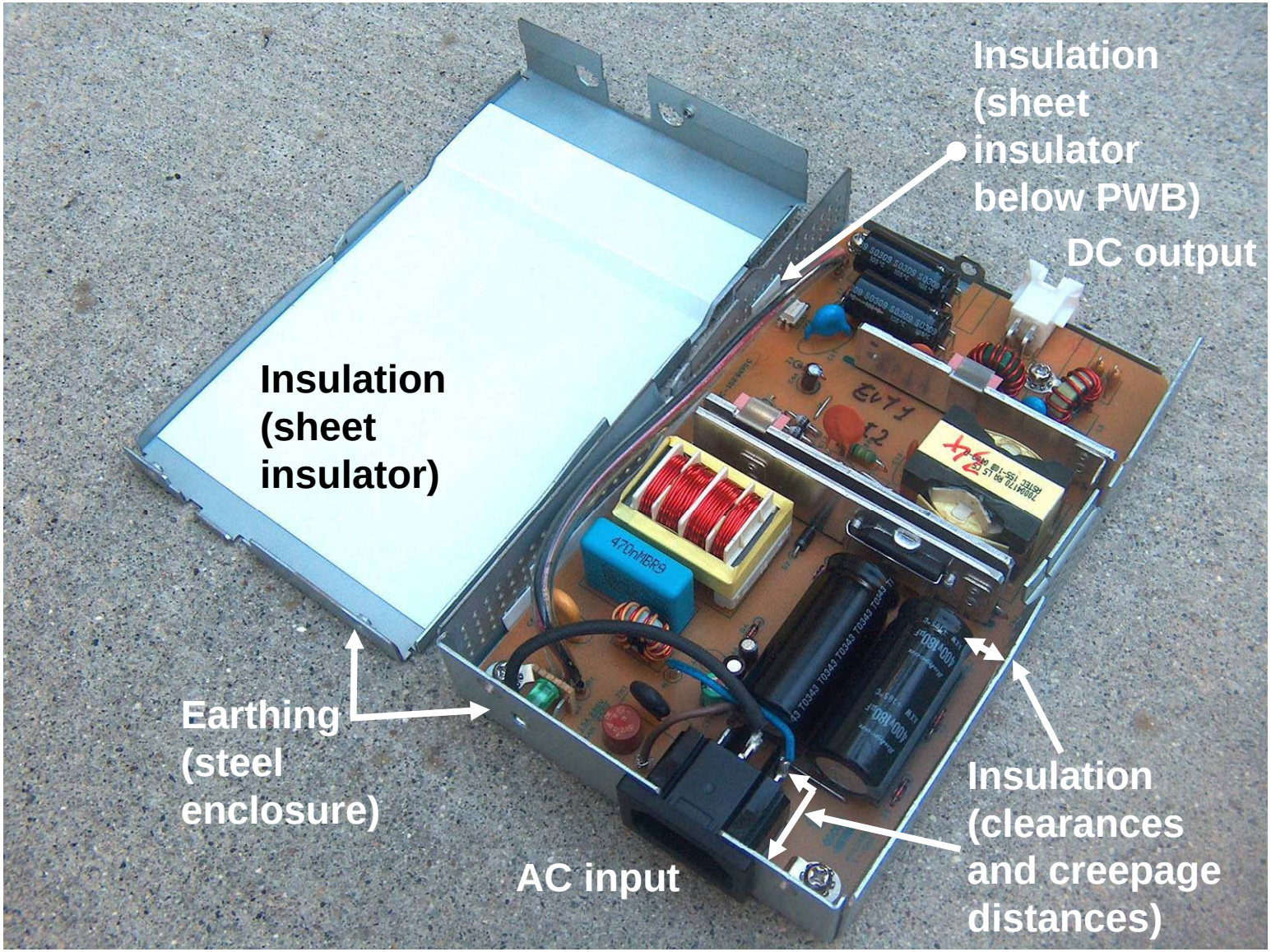
VARIOUS INSULATIONS



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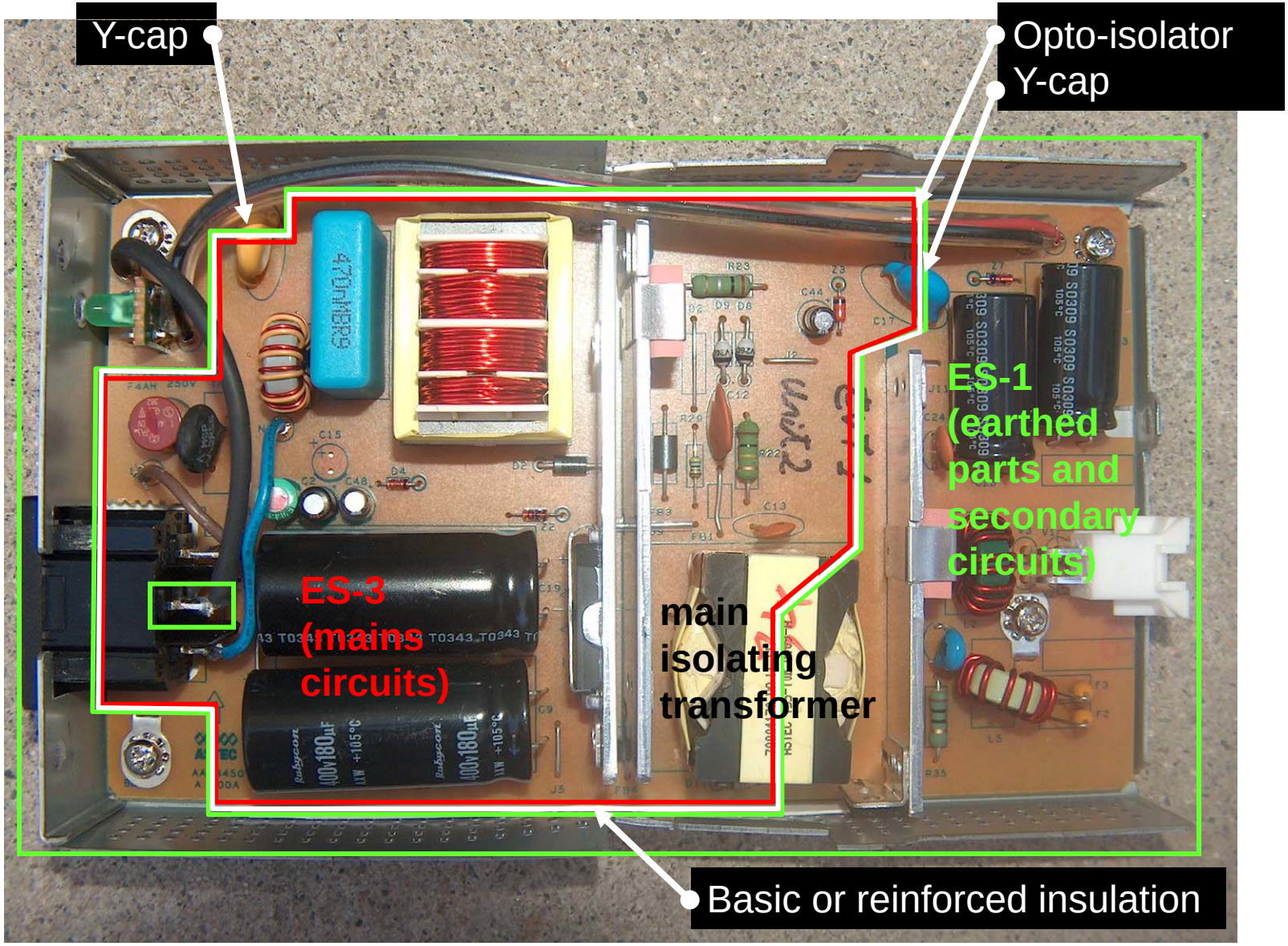
ES1 and ES3 CIRCUIT IDENTIFICATION



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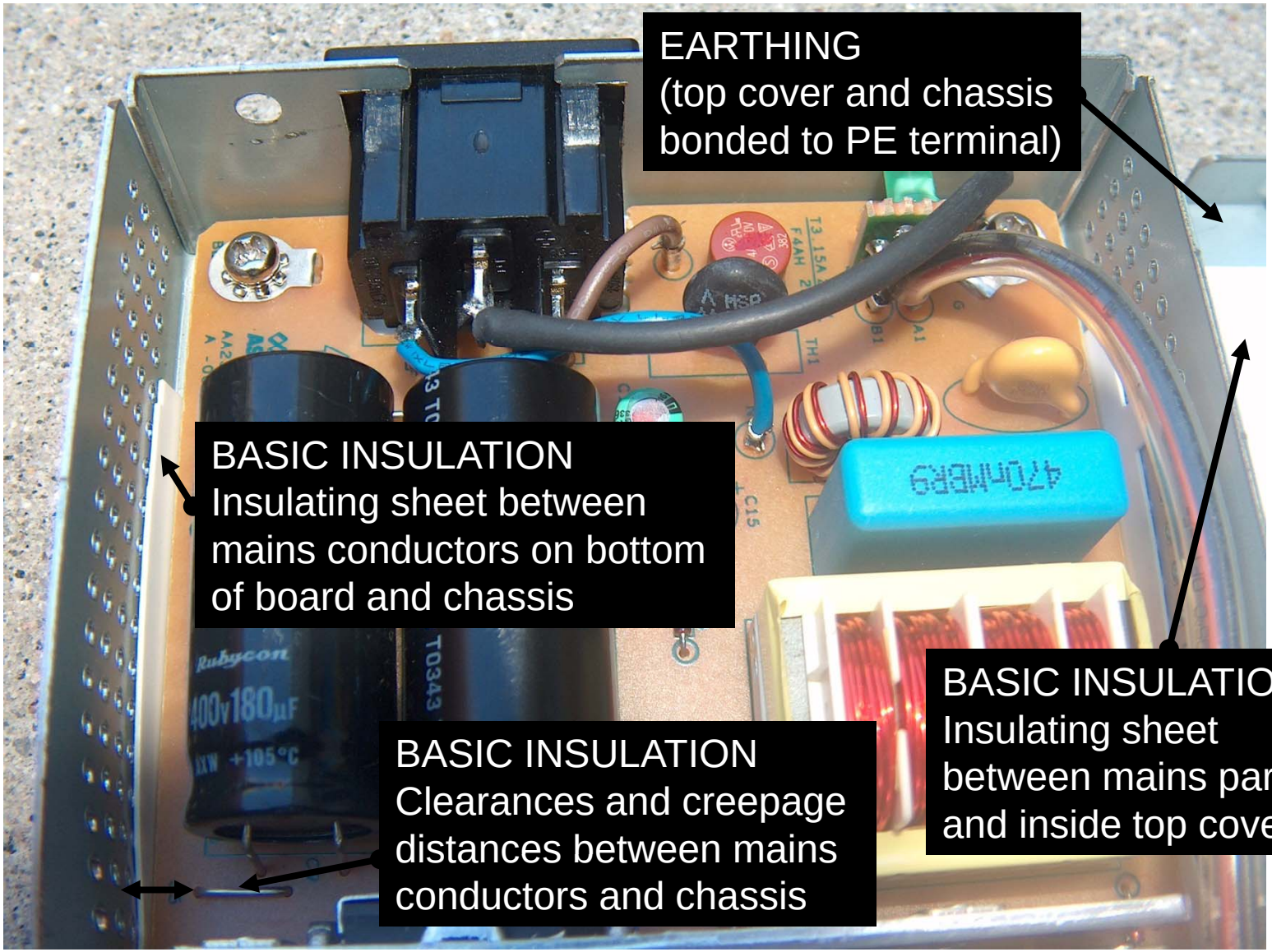
CLASS I SAFEGUARDS
BASIC INSULATION AND EARTHING



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PRODUCT INVESTIGATION – ELECTRIC SHOCK

- **What are the ES1, ES2, and ES3 parts and circuits?**
- **What are the product safeguards against electric shock?**

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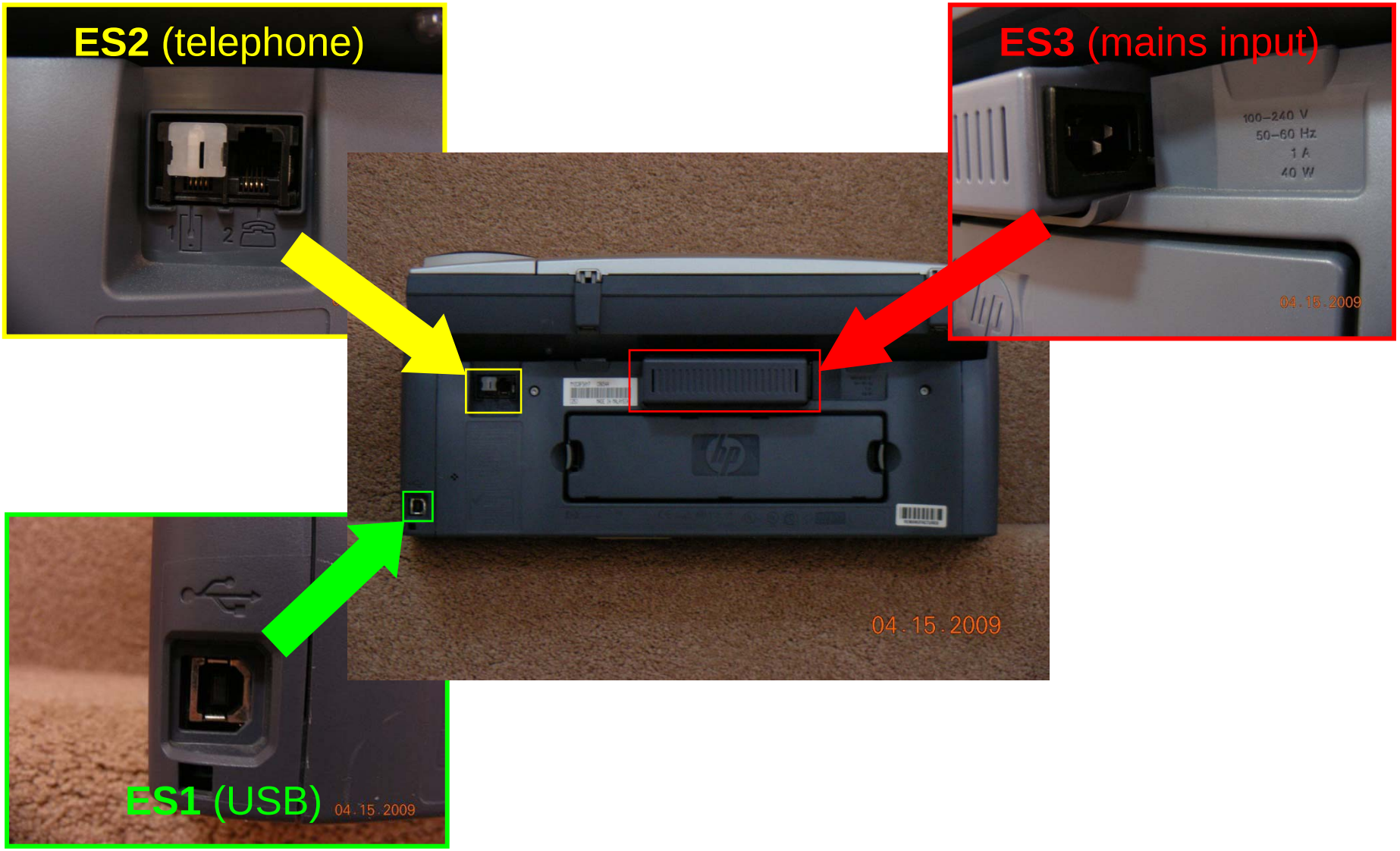
ES1, ES2, and ES3 parts



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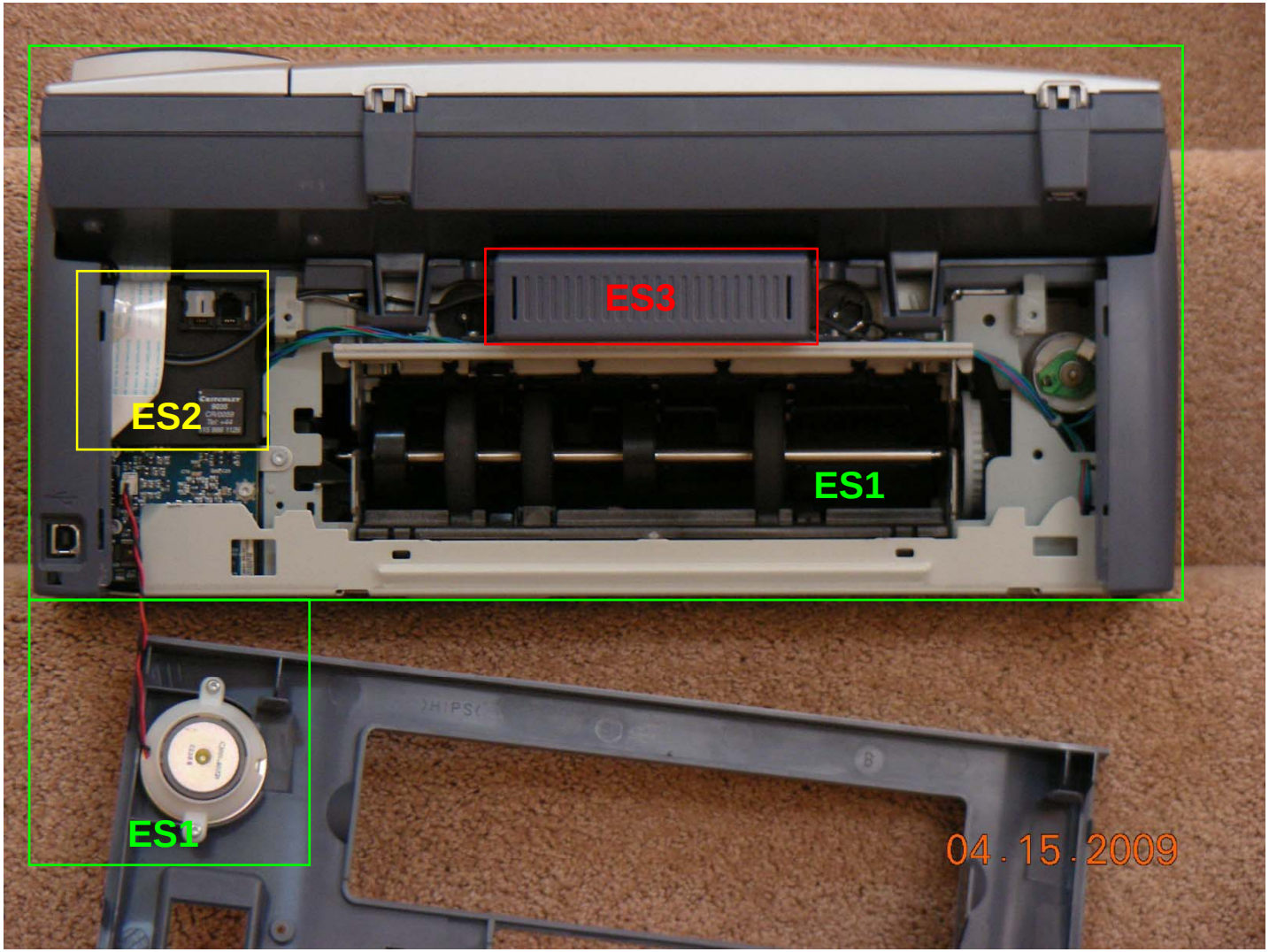
ES1, ES2, and ES3 parts



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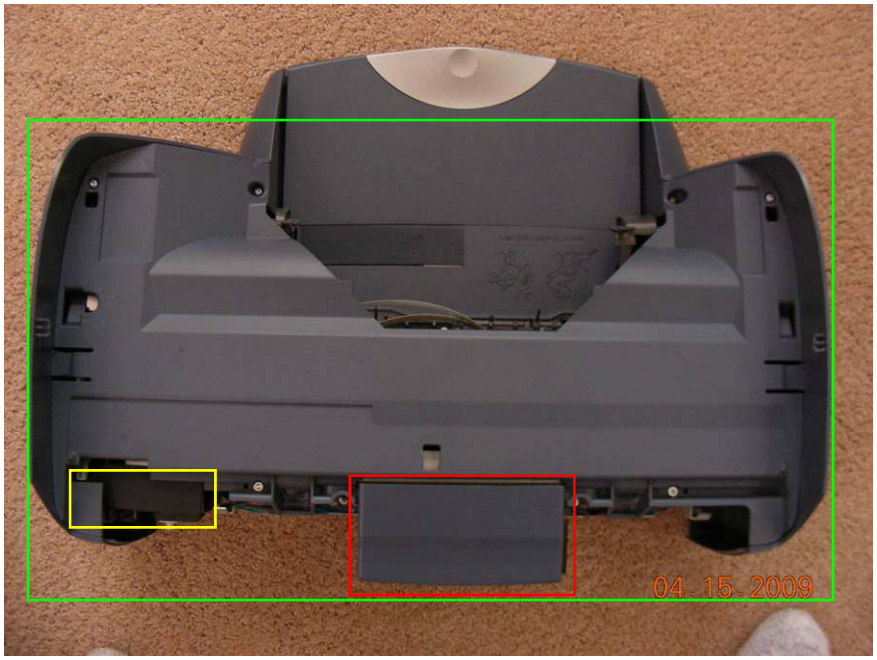
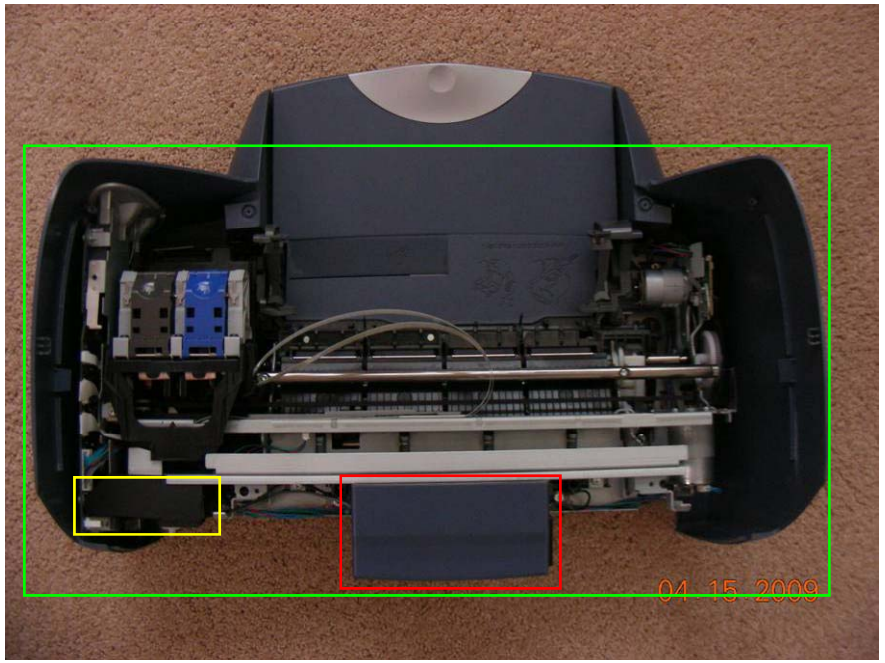
ES1, ES2, and ES3 parts





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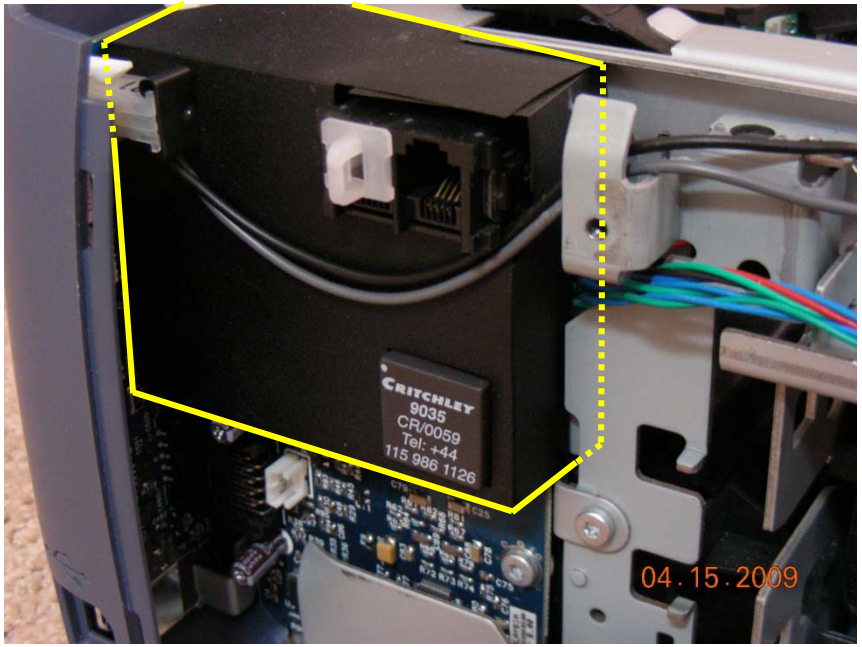
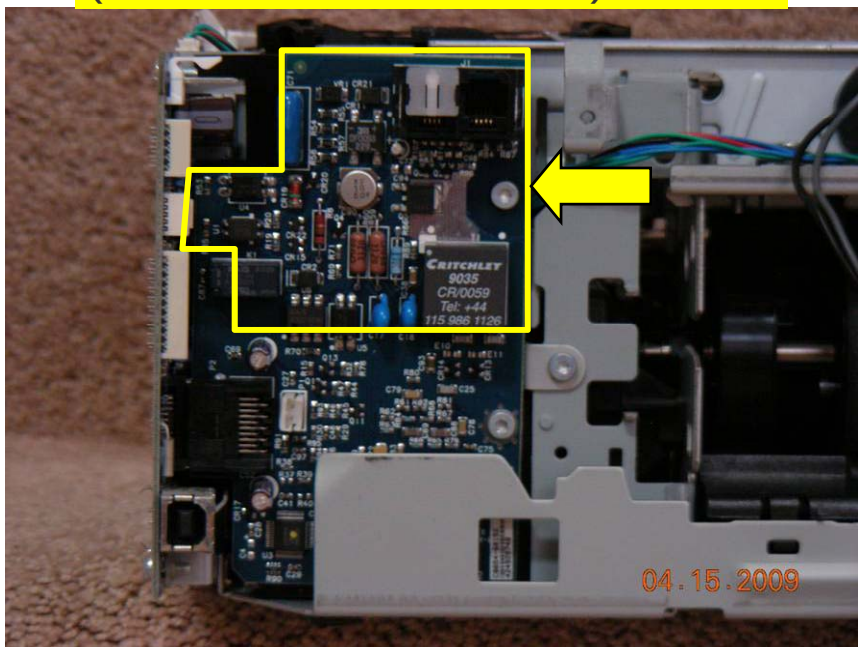
SAFEGUARDS AGAINST ES2



Solid insulation behind board Air insulation between board and barrier (enclosure)
(Between ES2 and ES1)



Creepage and clearance
(Between ES2 and ES1)

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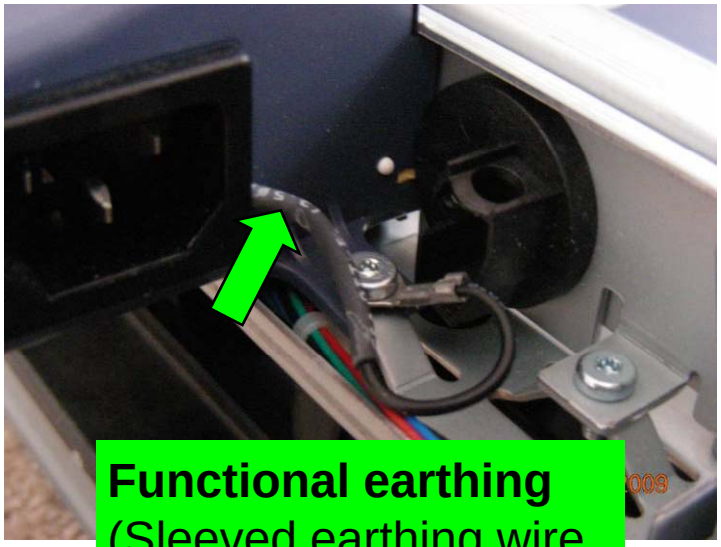
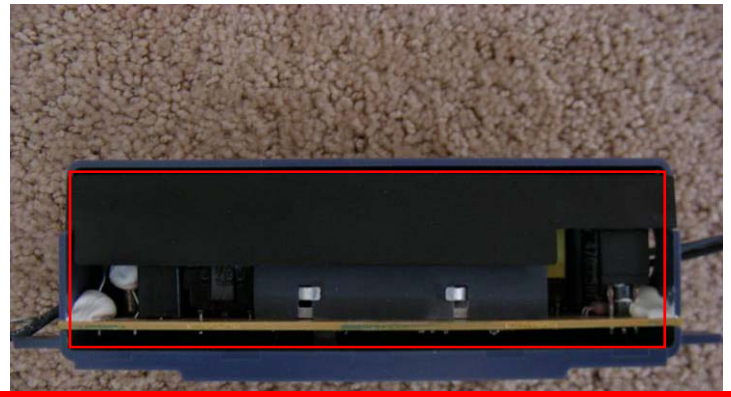
SAFEGUARDS AGAINST ES3

Reinforced insulation (Between ES3 and ES1)



Functional earthing (Sleeved earthing wire between ES1 and ES3)



Reinforced creepage and clearance (Between ES3 and ES1)

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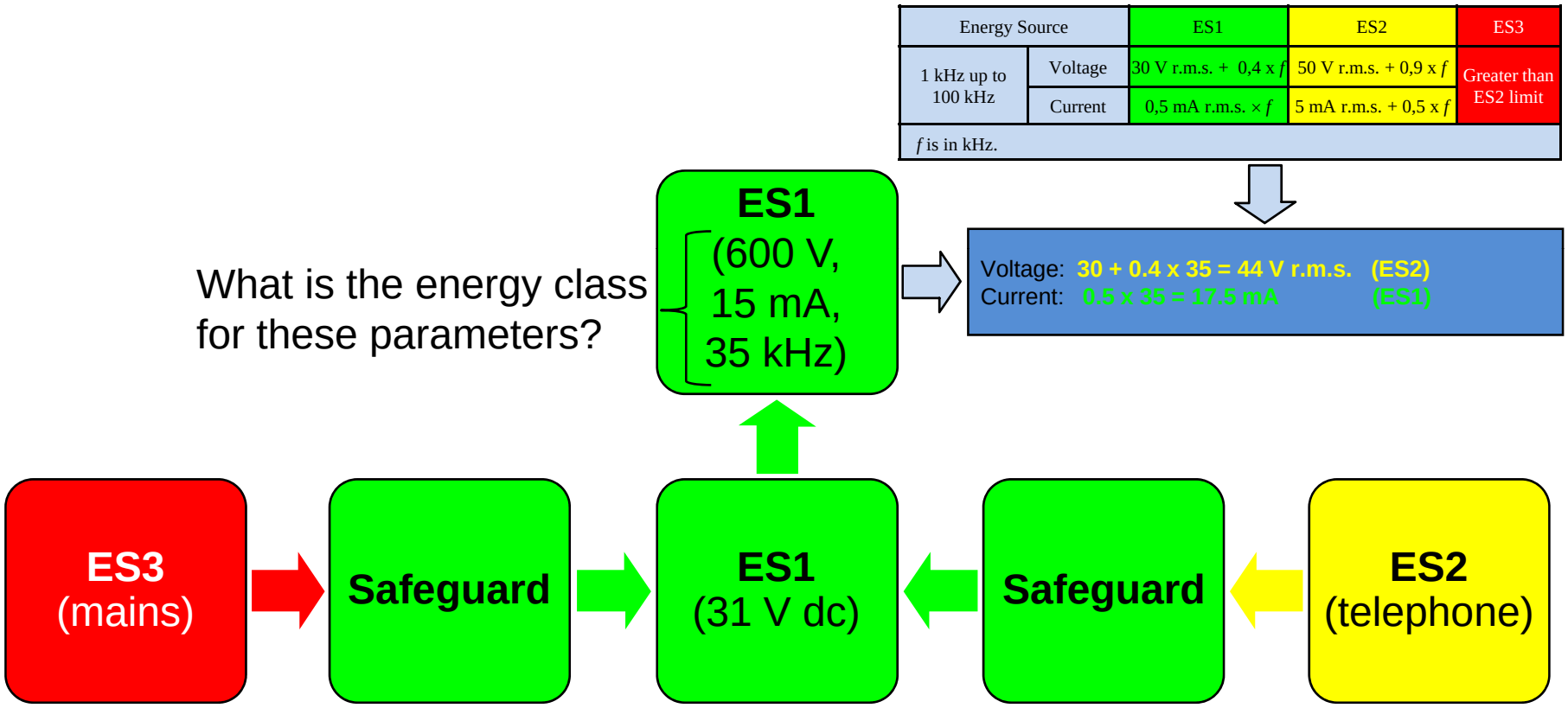
SAFEGUARD BLOCK DIAGRAM



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PRODUCT INVESTIGATION – FIRE

- What are the PS1, PS2, and PS3 circuits?
- What are the product safeguards against fire?

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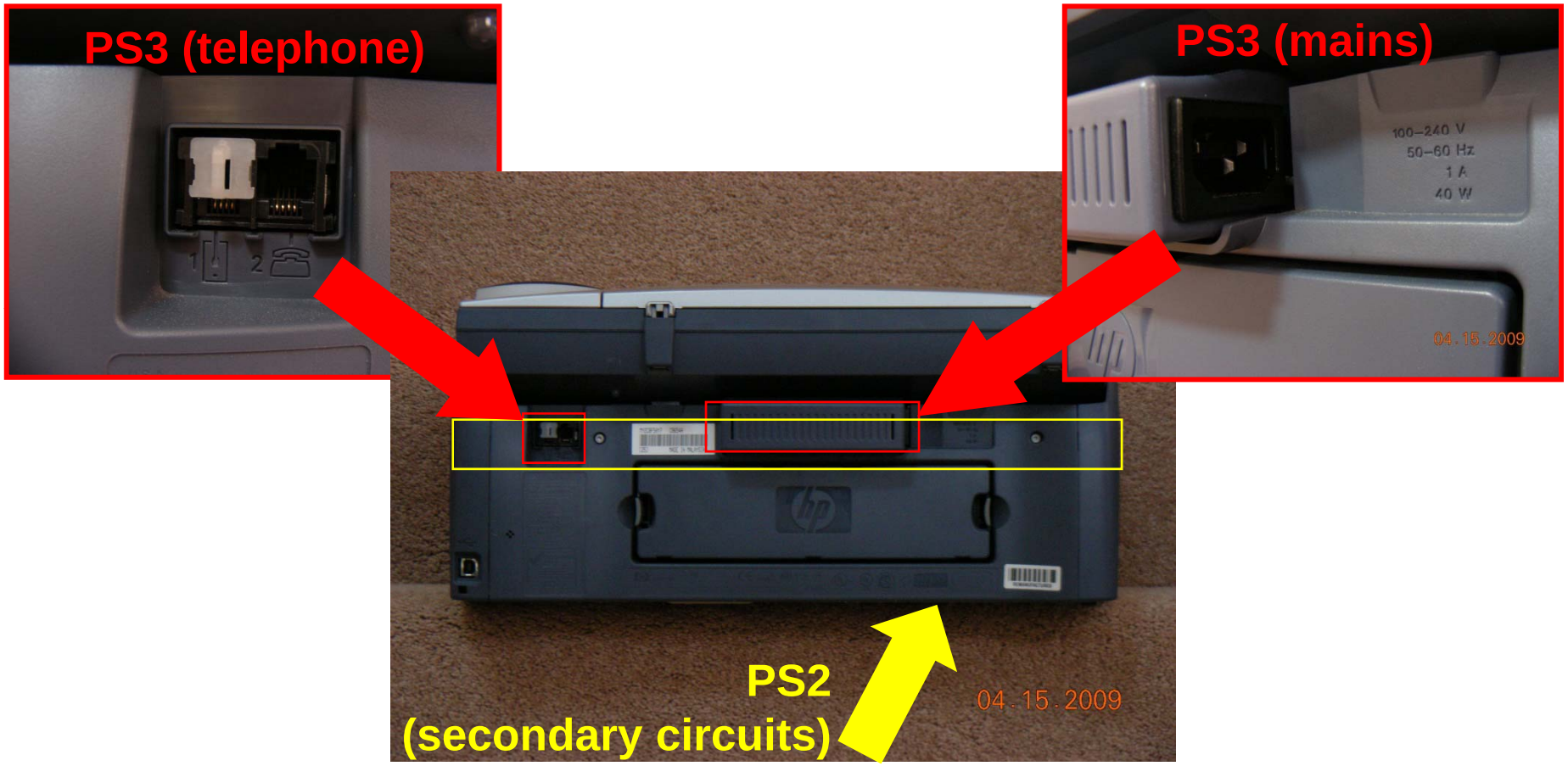
PS1, PS2, and PS3 circuits



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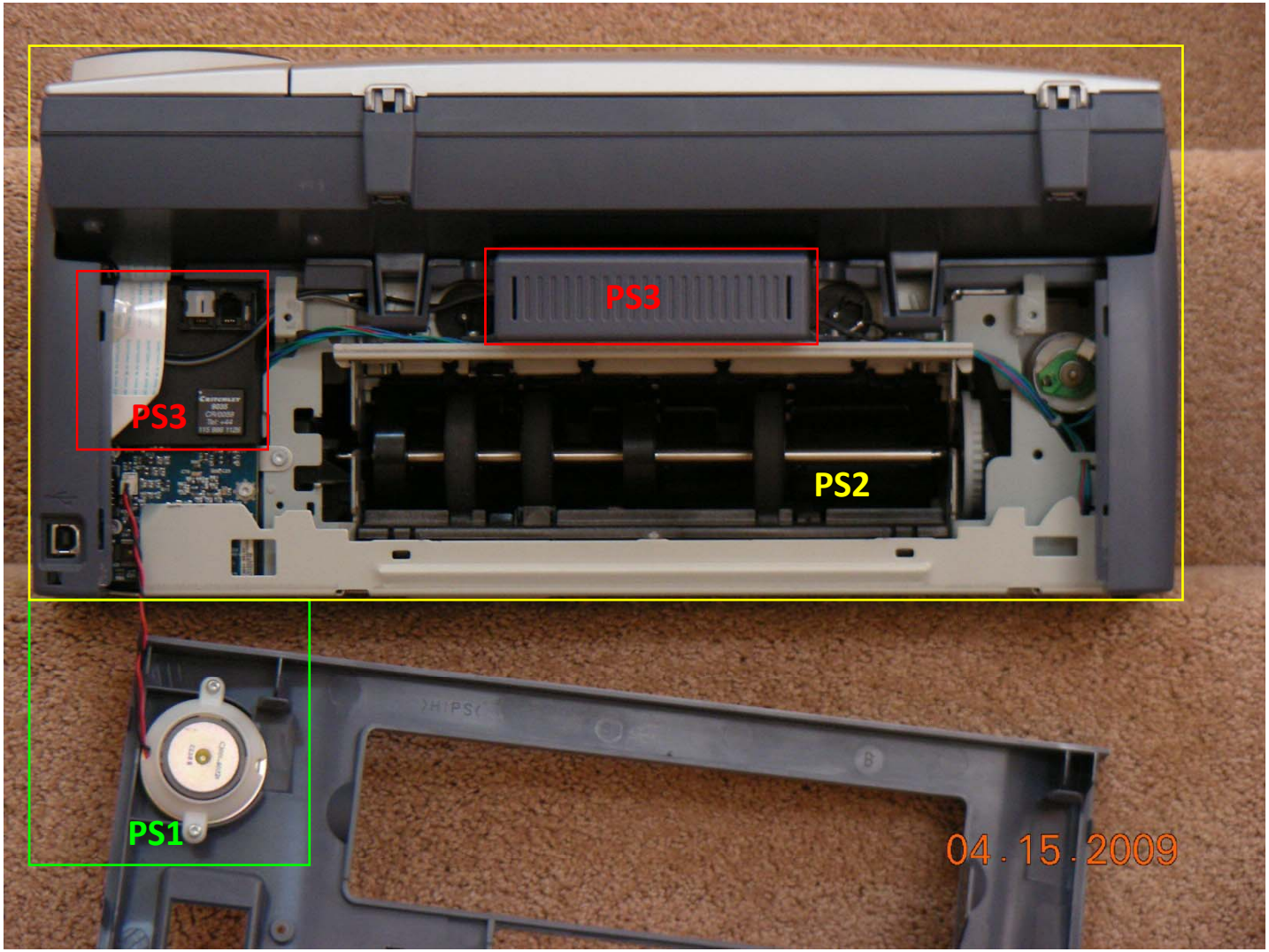
PS1, PS2, and PS3 circuits



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FIRE SAFEGUARDS

Ignition Prevention Safeguards
(applicable to PS2 circuits)

- **Fault condition testing to determine if ignition will occur**
- **Distances from potential ignition source (PIS) to ignitable materials**

Spread of Fire Safeguards
(applicable to PS2 and PS3)

- **Flame-retardant material**
- **Fire-containing enclosure**

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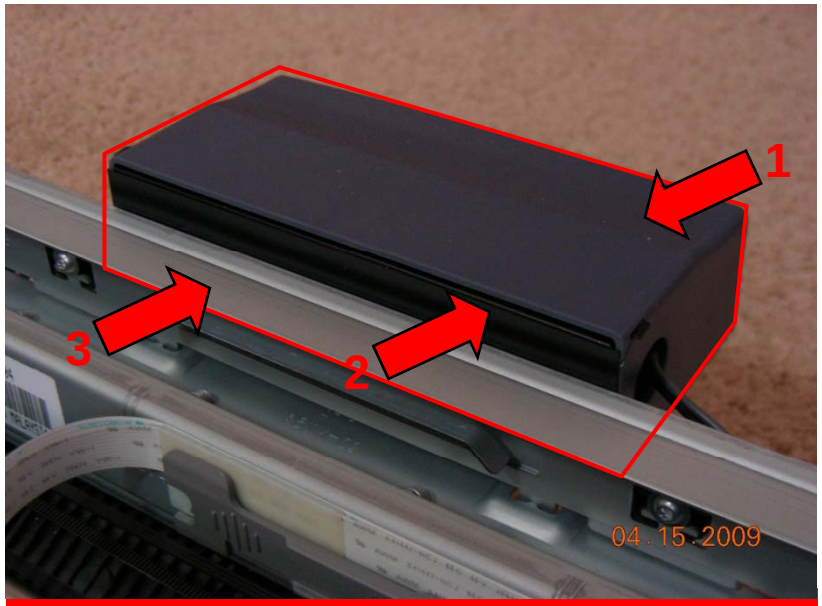
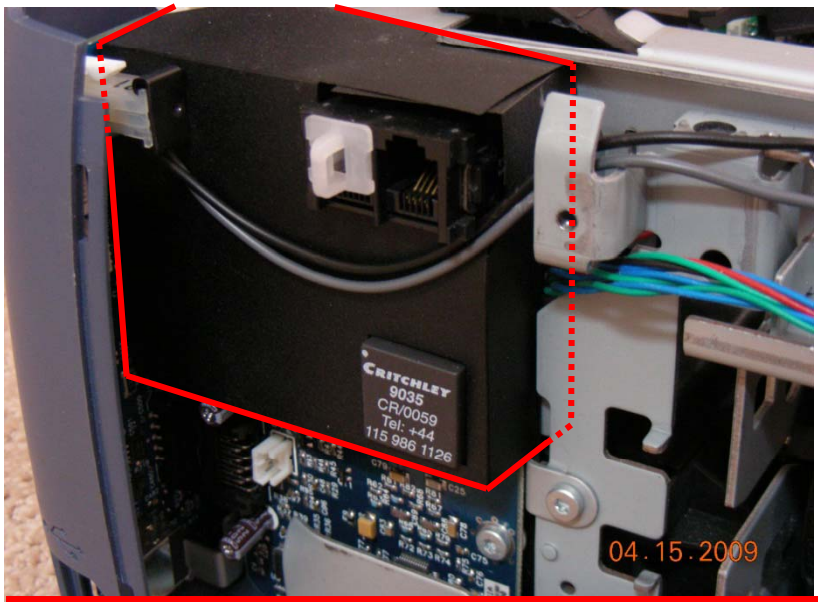
SAFEGUARDS AGAINST PS3



Fire enclosure
(encloses mains)
1 Flame-retardant molded plastic
2 Flame-retardant sheet
3 Metal



Fire enclosure
(encloses telephone circuits)
Flame-retardant sheet

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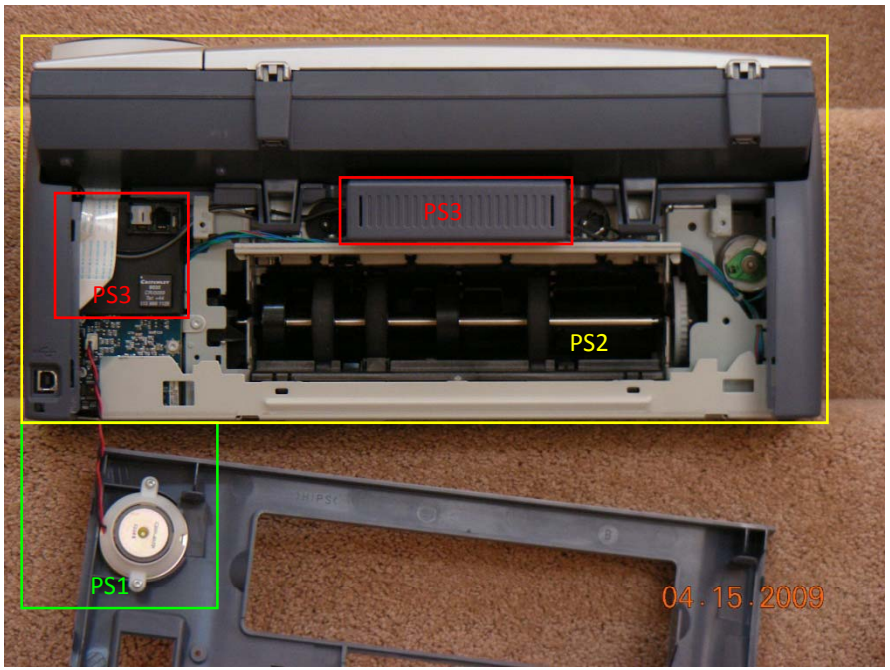
SAFEGUARDS AGAINST PS2

Ignition Prevention Safeguards
(applicable to PS2 circuits)

- **Fault condition testing to determine if ignition will occur**
- **Distances from potential ignition source (PIS) to ignitable materials**



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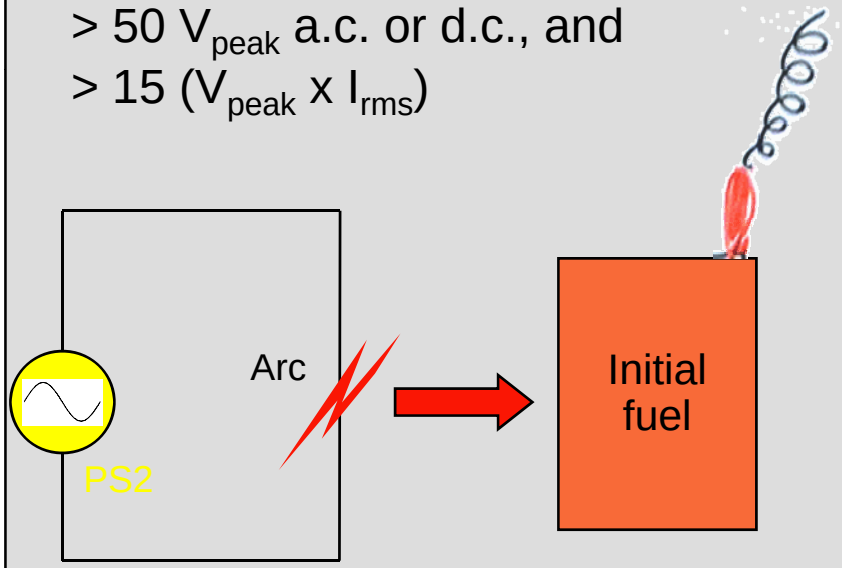
POTENTIAL IGNITION SOURCES (PIS)

Arcing PIS

where an arc may occur due to the opening of a conductor or a contact

> 50 V_{peak} a.c. or d.c., and

> 15 (V_{peak} x I_{rms})



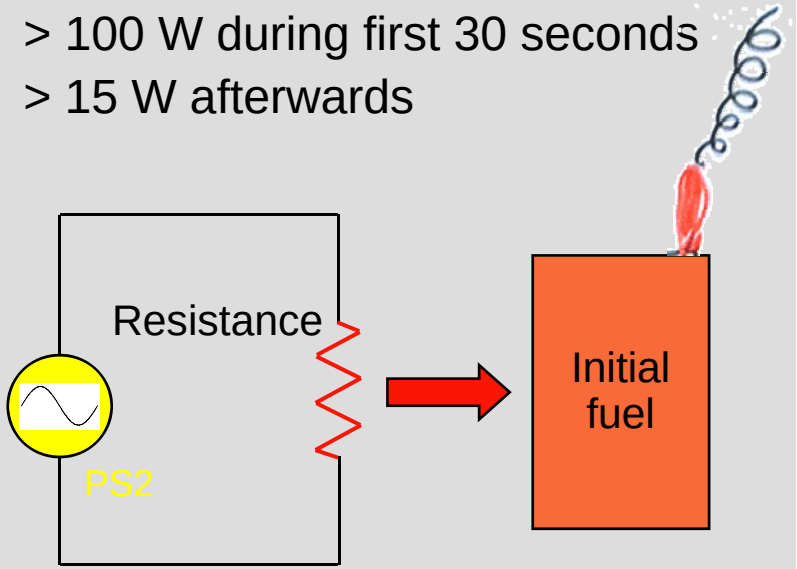
Power converted to thermal energy → Conduction, convection, radiation → Fuel heated to ignition temperature

Resistive PIS

where power may be dissipated in a resistance

> 100 W during first 30 seconds

> 15 W afterwards



Power converted to thermal energy → Conduction, convection, radiation → Fuel heated to ignition temperature

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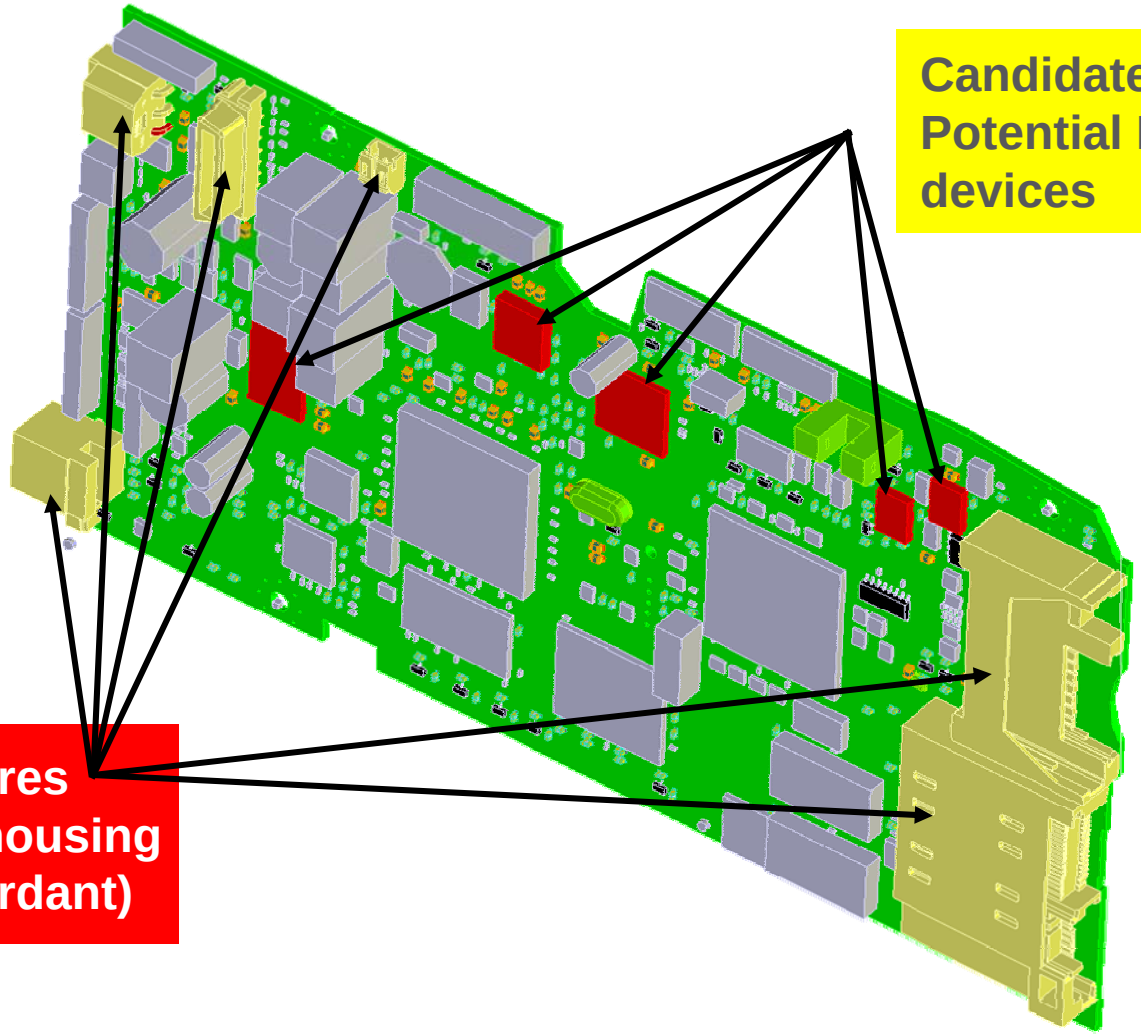
CANDIDATE PIS DEVICES IN PS2 CIRCUITS



Candidate Potential Ignition Source devices

Fire enclosures (connector housing is flame-retardant)

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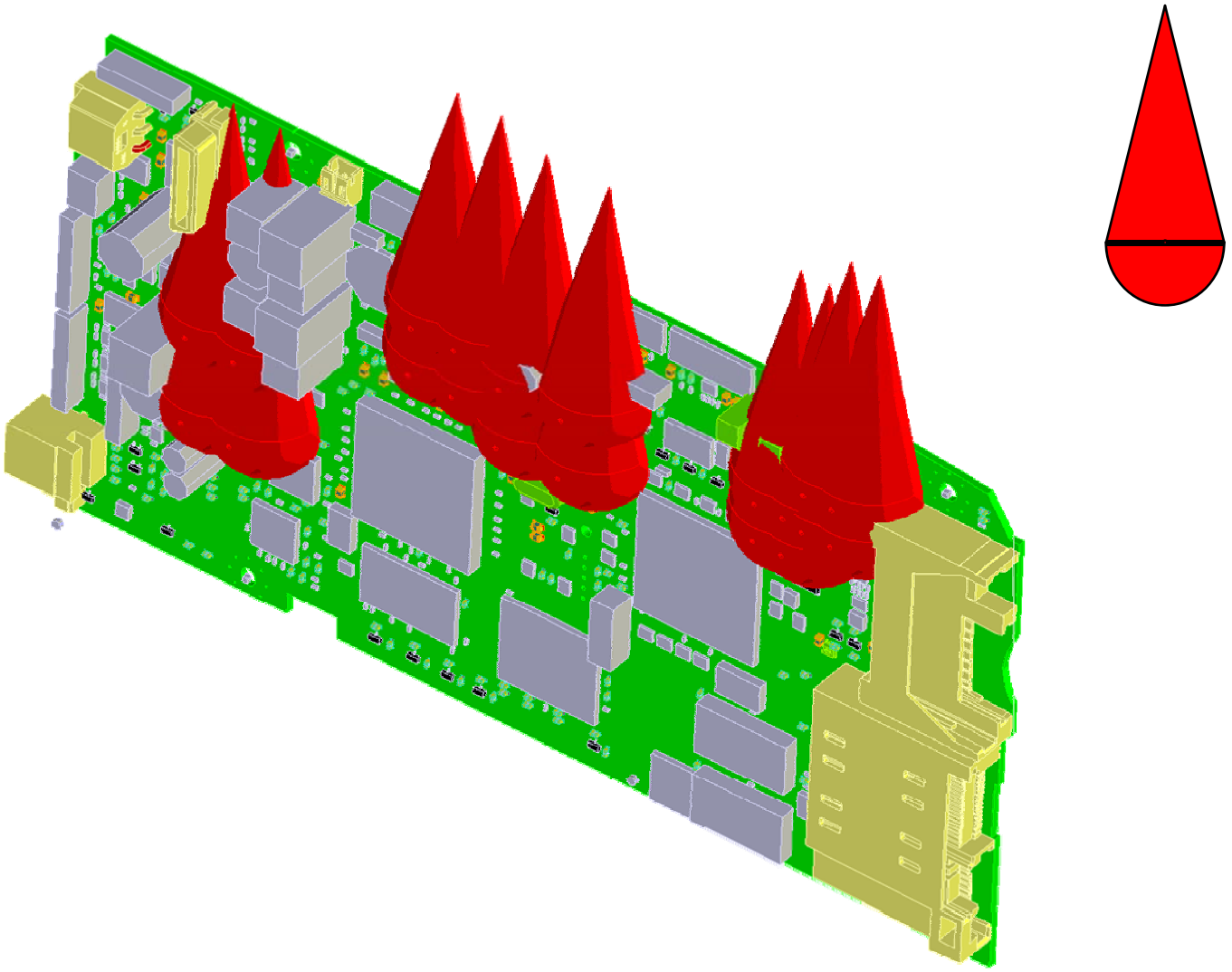
PIS WITH FLAME CONES



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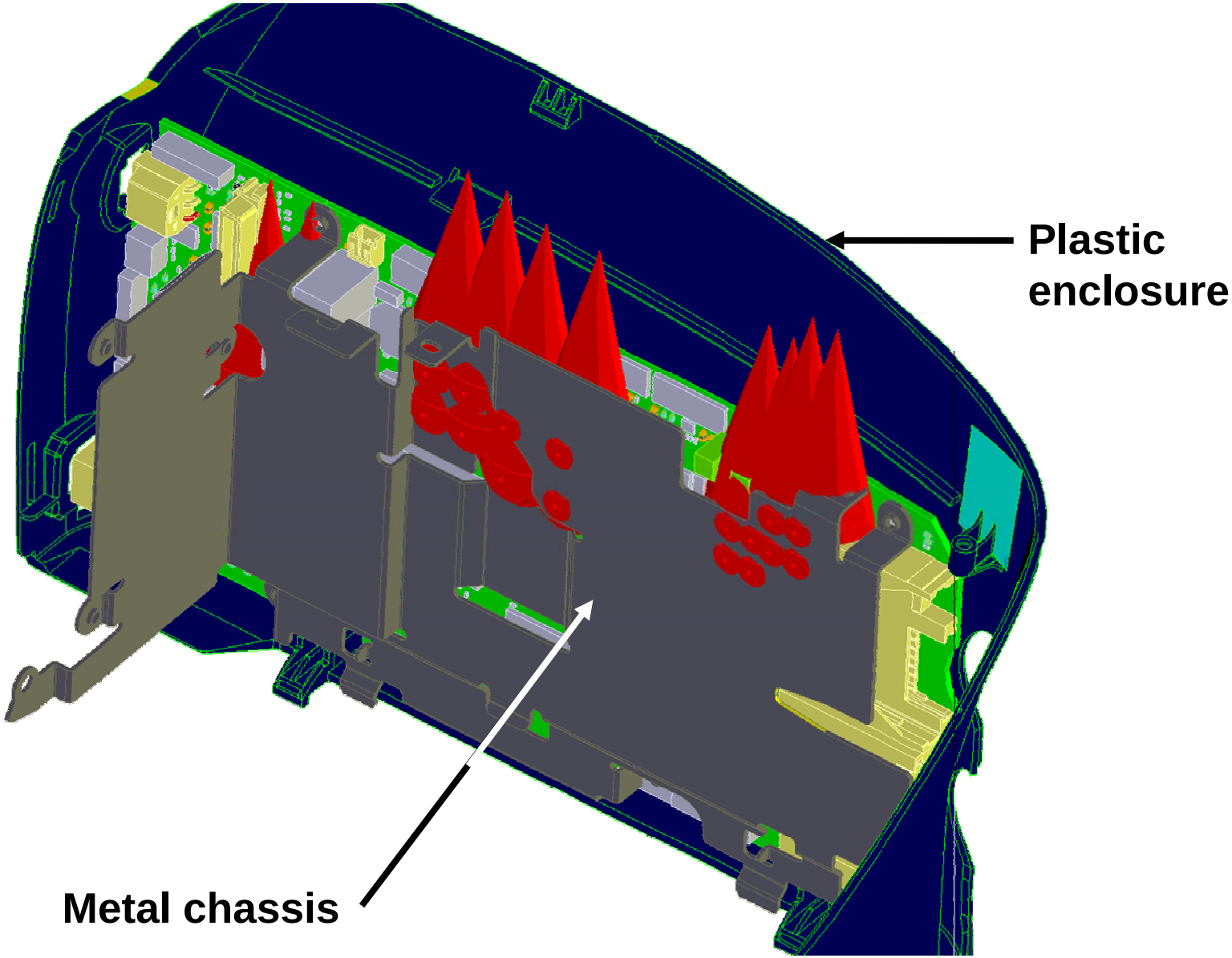
PIS WITH FLAME CONE AND ADJACENT PARTS - 1



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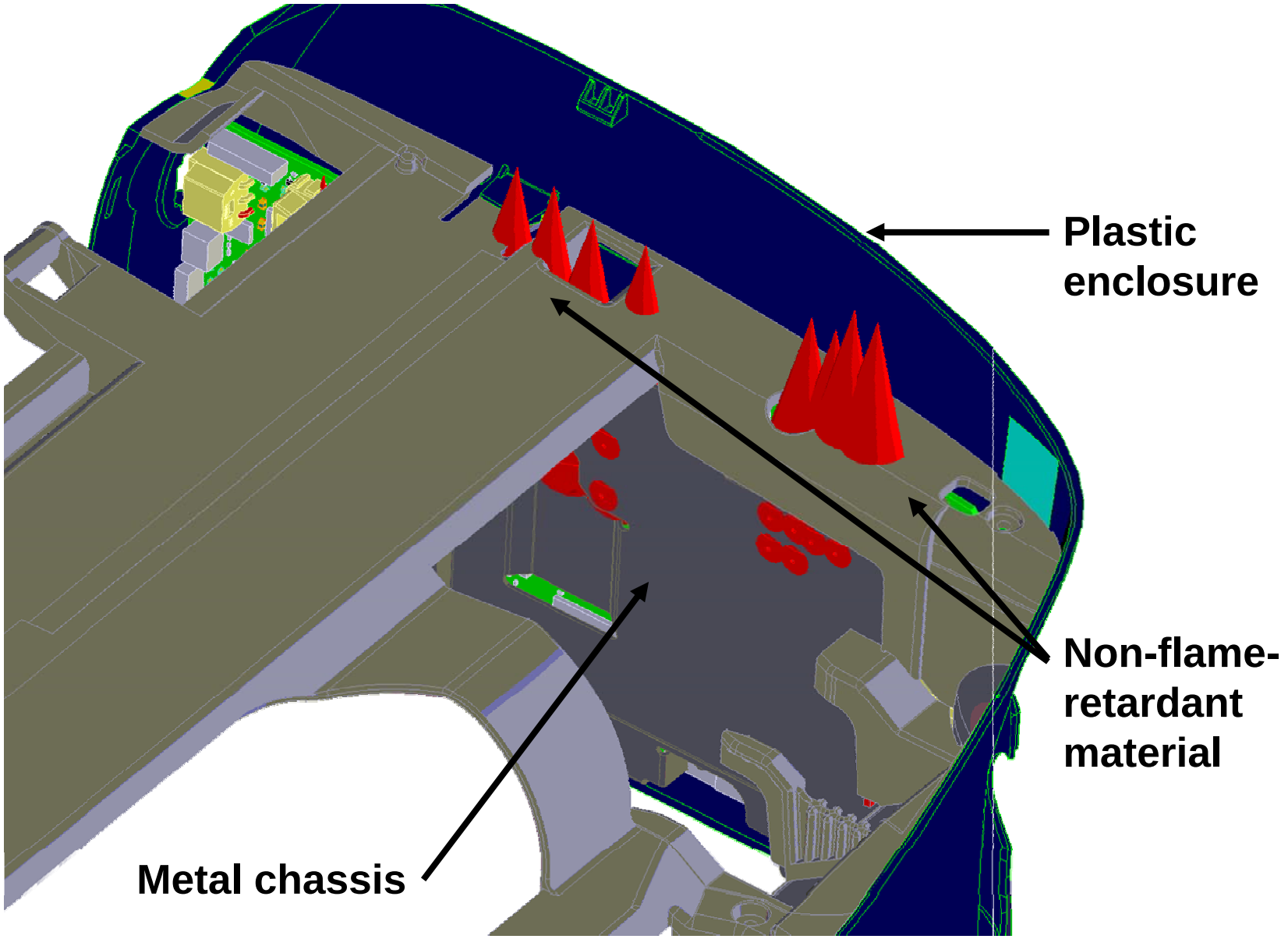
PIS WITH FLAME CONE AND ADJACENT PARTS - 2



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PRODUCT INVESTIGATION – MECHANICAL INJURY

- **What are the MS1, MS2, and MS3 parts?**
- **What are the product safeguards against mechanical injury?**

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IS THE MOVING PART MS1, MS2, or MS3?

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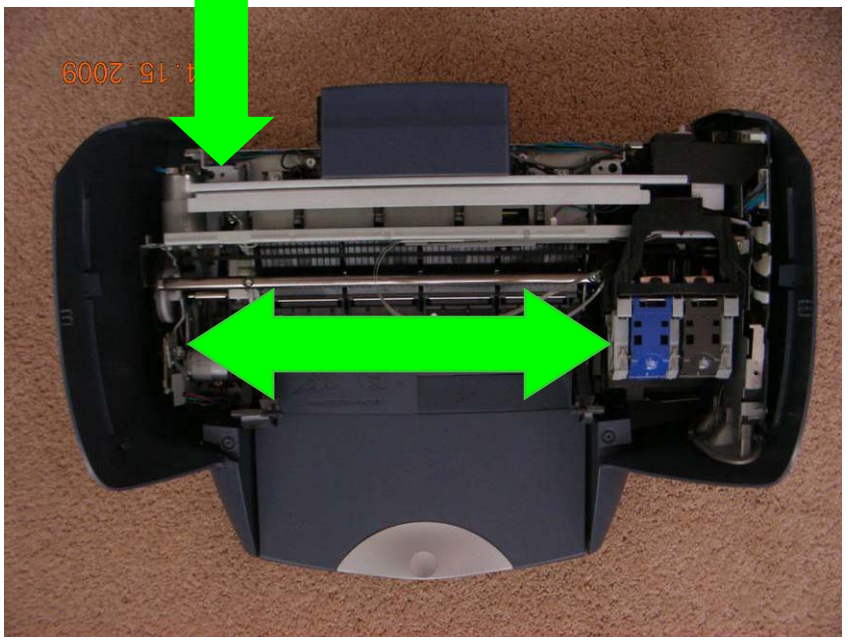
MS1, MS2, MS3 PART IDENTIFICATION

MS1 (moving carriage)

MS1 (rotating gear)



MS1 (moving carriage)

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PRODUCT INVESTIGATION – THERMAL INJURY

- **What are the TS1, TS2, and TS3 parts?**
- **What are the product safeguards against thermal injury?**

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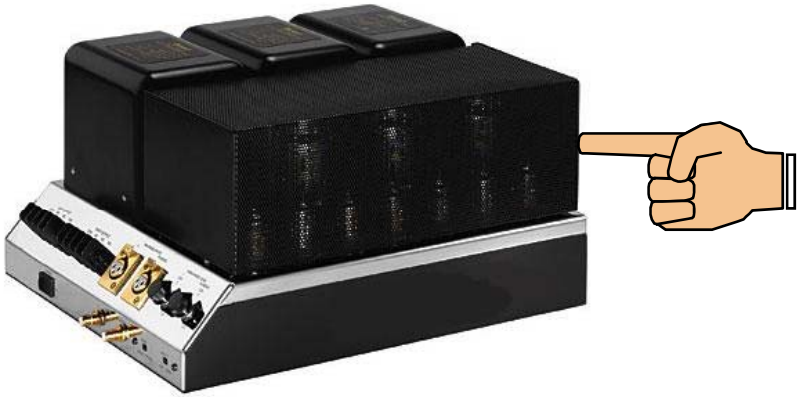
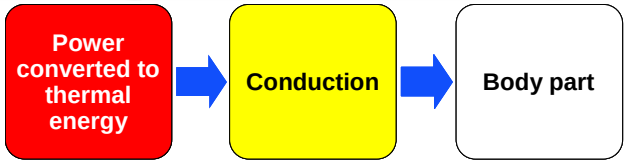
EXAMPLE OF THERMAL INJURY and THERMAL SAFEGUARD





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Body susceptibility does not vary with products!

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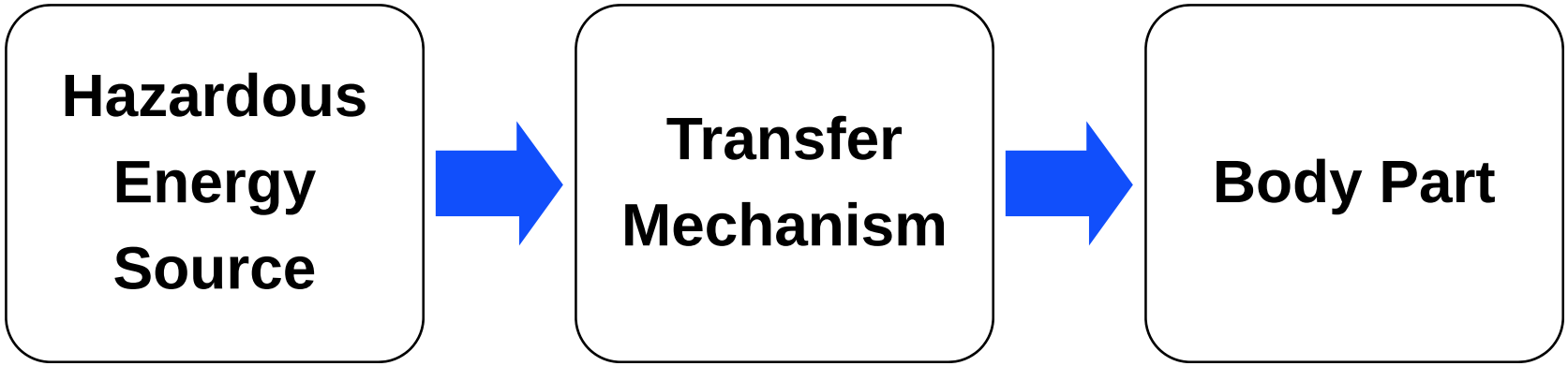
HBSE premise

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



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Technology independent

- incident-based safety standards
  - based on inversion of bad experiences
  - comprised of historical safety measures
  - prescribe limited acceptable constructions
- hazard-based safety standards
  - based on known **body susceptibility** (e.g., thresholds of various physiological effects with respect to energy sources)
  - any technology can be reduced to **forms of energy**
  - energy sources are **definable** and **quantifiable**
  - **safeguards** can be designed with respect to parameters defined by the hazardous energy source

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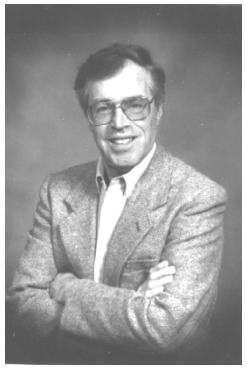
PRODUCT INVESTIGATION

1. Identify the ES1, ES2 and ES3 parts and circuits and their respective safeguards.
2. Identify the PS1, PS2, and PS3 circuits and the fire safeguard methods.
3. Identify the MS1, MS2, and MS3 parts and circuits and their respective safeguards.
4. Identify the TS1, TS2, and TS3 parts and circuits and their respective safeguards.

Richard Nute



Richard Nute Product Safety Consultant
Vancouver, Washington, U.S.A.
Life Senior Member, IEEE, and member of Board of Directors, IEEE/PSES
Charter member, IEEE/PSES
Chief Technical Officer, IEC TC108/HBSDT
Co-author and licensed teacher of the world-famous Hazard-Based Safety Engineering course

Mr. Nute is a product safety consultant engaged in safety design, safety manufacturing, safety certification, safety standards, and forensic investigations. Mr. Nute holds a B.S. in Physical Science from California State Polytechnic University in San Luis Obispo, California. He studied in the MBA curriculum at University of Oregon. He is a former Certified Fire and Explosions Investigator.

Mr. Nute has over 35 years experience in product safety. He was employed by Tektronix, Inc., Beaverton and Wilsonville, Oregon for 25 years and was a major contributor to UL 1244 safety standard for test and measurement equipment. While at Tektronix, he participated in the development of a ground isolation monitor for which he was awarded a patent. He was employed by Hewlett Packard Company, in Vancouver, Washington, Barcelona, Spain, and San Diego, California, for 19 years as a Senior Product Safety Engineer. While at HP Vancouver, Mr. Nute co-developed the world-famous *Hazard Based Safety Engineering*, an HP and Agilent proprietary course (now taught by UL under license to HP). In 1994, Mr. Nute transferred to HP Spain (Barcelona) where he joined Ecma TC12 and is now Chairman pro tem. This committee initiated the HBSE concepts into a draft safety standard, ECMA-287, which was then handed over to IEC TC 108 for completion as IEC 62368-1.

Mr. Nute is the IEC TC108 Technical Officer for the new IEC 62368-1 safety standard for audio/video, information, and communication technology equipment. He initiated the work on IEC 60990 *Measurement of Touch Current*. For his work in the IEC, Mr. Nute received the prestigious IEC *1906 Award* that "honors IEC experts around the world whose work is fundamental to the IEC."

Mr. Nute is a Life Senior Member of the IEEE, a charter member of the Product Safety Engineering Society (PSES), and a Director of the IEEE PSES Board of Directors. He was Technical Program Chairman of the first 5 PSES annual Symposia and has been a technical presenter at every Symposium. He is author of more than 40 columns, *Technically Speaking*, in the IEEE EMCS TC8 *Product Safety Newsletter* and the IEEE PSES *Product Safety Engineering Newsletter*. Some of his articles have been re-published in national and international magazines.

Mr. Nute has been a guest speaker at Orange County, Santa Clara, San Diego, and Portland IEEE PSES chapters. He has also been invited guest speaker at UL's annual Professional Engineers program in Santa Clara and Brea, California and twice at NEMKO's annual client seminar in Oslo, Norway. He initiated and was a speaker at the 2009 IEEE PSES workshop in Beijing, China. He is author of original research, "Dynamic Aspects of Body Impedance," appearing in *Electrical Shock Safety Criteria, Proceedings of the First International Symposium on Electrical Shock Safety Criteria*, edited by J.E. Bridges, Pergamon Press. He was the first recipient of the Michael J. DeMartini award for education in product safety. He holds a patent as co-inventor of a ground isolation monitor that enables safe use of an oscilloscope without a ground.

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Questions?

Discussions?