



Another EMC resource  
from EMC Standards



## The Safe Design of Electrical Equipment & LVD compliance, 2020 version

*Helping you solve your EMC problems*

LVD09 2.0 v2.4 CCC

# The Safe Design of Electrical Equipment, and compliance with the LVD or RED

(2 days, includes IEC 62368-1)

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## Change Record: v2.1 – v2.4, March 2020 (1)

- **New material added:** i) complying with the RED instead of LVD, ii) IEC 62368-1 (replacing IEC 60950-1 & IEC 60065 in Dec. 2020); So the number of slides has increased from 433 to **227**, and the duration increased from 1.5 to 2.0 days;
- **Overall Contents List:** section numbers D - F changed to E - G, and new section D added
- Slide 4, **Disclaimer**, now slide 7 – URLs added for IEEE and IET ethical policies
- Slides 5-11, now renumbered 8-14
- Slide 12, **Initial Risk Assessment**, now two slides 15 and 16 – **rewritten**
- Slides 13-15, now 17-19
- Slide 16, **Method of qualifying/quantifying hazards and risks**, now 20 – **rewritten**
- Slides 17-30, now 21-34
- Slide 31, **Hazard and risk assessment (continued)**, now 35 – **text improved**
- Slides 32-36, now 36-40
- Slide 37, **Hazard and risk assessment (continued)**, now 41 – **text improved**
- Slide 38, **Hazard and risk assessment (continued)**, now 42 – **text improved**
- Slides 39-40, now 43-44
- Slide 41, **Common but incorrect assumptions (continued)**, now 45 – **text improved**
- Slide 42, now 46
- Slide 43, **Ariane V**, now 47 – **rewritten**
- Slides 44-46, now 48-52
- Slide 47, **Dealing with EMI**, now 53 – **rewritten**
- Slide 48 – **deleted**
- **Two new slides 47 & 48 added, on Space Shuttle disasters**
- Slides 49-51, now 54-56
- Slides 52, **Dealing with EMI**, now 57 – **updated**
- Slide 53, now 58
- Slide 54 – **deleted**
- Slides 55-62, now 59-66
- Slide 63, **All safety-related work should be done by competent people**, now 67 – **rewritten**
- Slides 64-69, now 67-72
- Slide 70, **E.g. a battery charger for a laptop**, now 74 – **improved**
- Slides 71-74, now 75-78
- Slide 75, **Some EU safety Directives do not involve CE**, now 79 – **updated**
- Slides 76-78, now 80-82
- Slide 79, **The Product Liability Directive (continued)**, now 83 – **corrected**
- Slides 80-84, now 84-88
- Slides 85-86 – **both deleted**
- Slides 87-89, now 89-91

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## Change Record: v2.1 - v2.4, March 2020 (2)

CCC

- Slides 90-91, now renumbered 92-93 – both updated
- Slide 92, **But Beware!**, – deleted (replaced by new section D)
- Slides 93-106, now 94-107
- Slide 107, **LVD conformity assessment procedure**, now 108 – text clarity improved
- Slides 108-114, now 109-115
- Slide 115, **It can be dangerous to rely solely**, now 116 – text clarity improved
- Slides 116-122, now 117-123
- Slide 123, **A Single Declaration of Conformity for all Directives**, now 124 – updated
- Slides 124-125, now 125-127
- Slide 126, **LVD enforcement**, now 127 – updated and improved
- Slide 127, **Management of LVD compliance**, now 128 – updated
- Slides 128-133, now 129-134
- Slide 134, **Control of purchasing (continued)**, now 135 – updated
- Slides 135-141, now 136-142
- Slide 142, **COTS compliant with different safety standards**, now 143 – updated
- Slides 143-151, now 144-152
- Slides 152-153, now 167-168
- Slide 154, **Using the most relevant standards**, now 169 – improved
- Slides 155-156, now 170-171
- Slide 157, **This section E is mostly**, now 172 – updated to include IEC 62368-1
- **Two new slides 173-181 added – introducing IEC 62368-1**
- Slide 158, **National and EU versions of international standards**, now 182 – improved
- Slides 159-161, now 183-185
- Slide 162, **Injuries from electric shocks**, now 186 – updated
- Slide 163, now slide 187
- Slide 164, **Physical separation**, now 188 – improved
- Slides 165-168, now 189-192
- **New section D added: 13 new slides 153-166, on: 'Complying with the RED instead of the LVD'**
- Slides 169-170, now 200-201
- Slides 171-172, **What is meant by 'accessible'**, renumbered 208-209
- Slides 173-176, renumbered 202-205
- Slides 177-197, renumbered as 212-232
- **Three new slides 193-195 added, on 'Electric Shock classifications in IEC 62368-1'**
- Slides 198-219, now 234-256 – and updated with information from IEC 62368-1
- **Two new slides added: 206 and 207 – on: 'The additional shock requirements in IEC 62368-1'**
- Slides 220-222, now 260-262 – and slides 260 & 262 updated by IEC 62368-1
- Slides 223-250, now 263-290 – and slide 289 updated by IEC 62368-1

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## Change Record: v2.1 - v2.4, March 2020 (3)

CCC

- **New slide 233 added – on: 'IEC 62368-1 is tougher than most...'**
- Slides 251-254, now renumbered 196-199: **'Touch' and Protective Earthing Conductor currents – re-written**
- Slides 255-256, now 210-211
- Slides 257-261, now 291-297 – with slides 293 & 294 updated by IEC 62368-1
- **Three new slides 257-259 added – on: 'Effects of frequency on insulation'**
- **New slide 260 added – more details on preventing corrosion**
- Slides 262-267, now 276-302
- Slides 268-269, now 303-304 – improved
- Slide 270, now 305
- Slide 271, now 306 – updated by IEC 62368-1
- Slides 272-274, renumbered as 307-309
- Slide 275, now 310 – updated by IEC 62368-1
- Slide 276, now 311
- Slide 277, now 312 – updated by IEC 62368-1 and improved
- **New slide 313 added – on: 'Methods of preventing ignition (2)'**
- Slides 278-288, now 314-324
- Slide 289-292, now 325-328 – improved
- Slide 293, now 329
- **New slide 330 added – on: 'Limited Power Circuits in IEC 62368-1'**
- Slides 295-297, now 331-333
- Slide 298, now 334 – updated by IEC 62368-1
- Slides 299-301, now 335-337
- Slide 302, now 338 – updated
- Slide 303, now 339
- **Two new slides 340-341 added – on: 'Some examples of the very detailed flammability requirements', including IEC 62368-1**
- Slides 304-305, now 346-347
- Slide 306, now 348 – updated by IEC 62368-1
- Slide 307, now 349
- Slides 308-309, now 350-351 – updated by IEC 62368-1
- Slide 310, now 355 – updated by IEC 62368-1
- **New slides 352-354 added – on: 'Overview of some of the new fire enclosure requirements in IEC 62368-1'**
- Slide 311, now renumbered as 356
- Slides 312-313, now 343-344
- Slide 314, now 357
- **New slide 358 added – on: 'Classifying the safety of touchable temperatures, from IEC 62368-1 Clause 9'**
- Slides 315-320, now 359-364
- **New slide 366 added – on: 'Classification of Mechanical Energy Sources, from IEC 62368-1 Clause 8'**

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## Change Record: v2.1 - v2.4, March 2020 (4)

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- Slide 321, now renumbered 367 – updated by IEC 62368-1
- Slide 322, now 368
- **New slide 369 added – on: 'IEC 62368-1 has very different stability requirements (in Clause 8.6)'**
- Slide 323, now 370 – updated by IEC 62368-1
- Slide 324, now 371
- Slide 325, now 372 – updated by IEC 62368-1
- **New slide 373 added – on: 'Wheels, castors, and carts' from IEC 62368-1**
- Slide 326, now 365 – updated by IEC 62368-1
- Slides 327-328, now 374-375 – and updated by IEC 62368-1
- **New slide 376 added – on: 'Examples of the radiation protection requirements in IEC 62368-1 Clause 10'**
- **New slide 377 added – on: 'Non-ionising electromagnetic energy'**
- Slide 329, now 378 – improved
- Slide 330, now 379 – updated by IEC 62368-1
- Slides 331-338, now 380-387
- **Seven new slides 388-394 added – on: 'Safety of MOVs used on AC mains'**
- Slide 339 now 395 – updated by IEC 62368-1
- Slide 340, now 396 – improved
- Slide 341 now 397 – updated by IEC 62368-1
- Slides 342-355, now 398-411
- Slide 356, now 412 – updated by IEC 62368-1
- Slides 357-363, now 413-420
- Slides 364-365, now 421-422 – improved
- Slides 366-371, now 423-428
- Slide 372, now 429 – improved
- Slides 373-377, now 430-434
- Slide 378, now 435 – updated by IEC 62368-1
- Slides 379-380, now 436-437
- **Two new slides 438-439 added – on: 'Machinery control systems: choosing between ISO 13849-1 and IEC 62061'**
- **Ten new slides 440-450 added – on: 'What is Functional Safety?'**
- Slide 381, now 451
- Slide 382 – deleted
- Slides 383-392, now 452-461
- Slide 393, now 462 – updated
- Slide 394 – deleted
- Slides 395-396, now 463-464
- Slides 397-398 – deleted
- Slides 399-404, now 465-470
- **Six new slides 471-477 added – on: 'Verification and validation approaches'**

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## Overall contents list

CCC

- A Basic Safety Principles,  
including doing Hazard and Risk Assessments**
- B Non-CE Marking Safety Directives**
- C Complying with the Low Voltage Directive (LVD)  
2014/35/EU**
- D Complying with the Radio Equipment Directive (RED)  
2014/53/EU (instead of with the LVD)**
- E Design and Validation for INHERENT Safety**
- F Design / Validation for FUNCTIONAL Safety**
- G Appendix: Some safety resources**

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## Disclaimer

### This course is only a *brief guide*

- Responsibility for safety of your equipment, employees, customers and third parties...  
***–is yours alone !!!!***
  
- Each individual *must*, in their work, apply the latest safety knowledge, laws, standards, technology...
  - and should act in accordance with accepted ethical standards of professional conduct...
  - e.g. see: <https://www.ieee.org/about/corporate/governance/p7-8.html>
  - and: <https://www.theiet.org/about/governance/rules-of-conduct/>

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# A.

## Basic Safety Principles

**Note**

Where an IEC or ISO standard is mentioned in this course,  
an EN version might now be available

Although an EN is usually identical to the IEC or ISO it comes from,  
sometimes there are differences, so for EU compliance it is best to follow the EN

**Note**

Safety standards are always being improved, amended and up-issued, so it is  
very important to apply the latest versions and amendments of the relevant  
standard(s), rather than rely on the text in this course

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## Contents of the section on Basic Safety Principles

- What do we mean by 'safe'?
- Good practices in safety engineering
- Example of project safety flowchart
- The hierarchy of safety design techniques
- Hazards and risks assessments
- Doing hazard/risk assessments
- Overall safety documentation
- Qualifying and quantifying hazards and risks
- Keeping up to date with safety standards
- National safety laws
- Marketing and Sales and safety
- Making equipment for in-house use
- Competency
- Some examples of useless legal arguments
- It isn't enough to simply apply the more relevant published standard
- HALT and HASS

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## What do we mean by "Safe" ?

- A **HAZARD** is anything with potential to do **HARM...**
  - and we are interested in the **severity** of that harm
- A harm has a likelihood (**probability**) of occurrence
- The **RISK** is the product of the severity of the harm and its probability
- Nothing can ever be 100% safe....
  - whether it was *safe enough* is determined by the courts after a safety incident, using the relevant safety laws

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## What do we mean by Safe? continued...

- **Safe design requires analysis of foreseeable hazards and their risks, to achieve...**
  - functionality at a reasonable cost...
  - the degree of safety required
- **The degree of safety required depends upon Directives and laws...**
  - but also upon the application area and the type and numbers of people exposed...
  - and whether national media involvement is likely

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## Two types of Safety

- 1) *(what I am calling)* **INHERENT SAFETY...**
  - i.e. shock, fire, burns, cuts, explosion, toxic fumes, etc...
    - this term is used by the chemical industry, but 'intrinsic' safety is used by the explosive atmospheres industry
- **2) FUNCTIONAL SAFETY...**
  - i.e. safety risks caused by operation not as intended...
    - e.g. ABS failing to work; robots moving outside program parameters; process control allowing temperatures or pressures to rise too high; flight control errors, etc., etc...
  - a rapidly increasing problem because electronics is now being used to control *everything*

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## Good practices in safety engineering

- **“Hazard identification and risk assessment” is well-known good engineering practice...**
  - without this, it is difficult for an engineer to justify adding costs to improve safety
- **Under many safety or liability laws it could prove difficult to make a good legal case for an equipment’s safety....**
  - if a hazard identification and risk assessment had not been done

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## Two stages of Risk Assessment — the *Initial* Risk Assessment

- **Before anything is designed,**  
an **‘Initial Risk Assessment’** is required, ...
  - to determine the ‘Safety Requirements’ that guide the design, realisation, verification, validation, etc. and the rest of the project
- **But since the hardware and software have not yet been designed...**
  - detailed risk assessments like FMEA, Fault Tree, etc. cannot yet be applied

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## The Initial Risk Assessment continued...

- **All of the hazards that could *possibly* occur, are identified...**
  - and graded by severity of the harms they could cause
- **The physical, climatic, biological, electromagnetic, user, etc., environments over the lifecycle are determined...**
  - then a risk assessment determines the likelihood (i.e. probability) of each hazard occurring during the lifecycle, and these probabilities are then graded
- **For each reasonably foreseeable hazard:  
Severity Grade x Probability Grade = **the Risk****

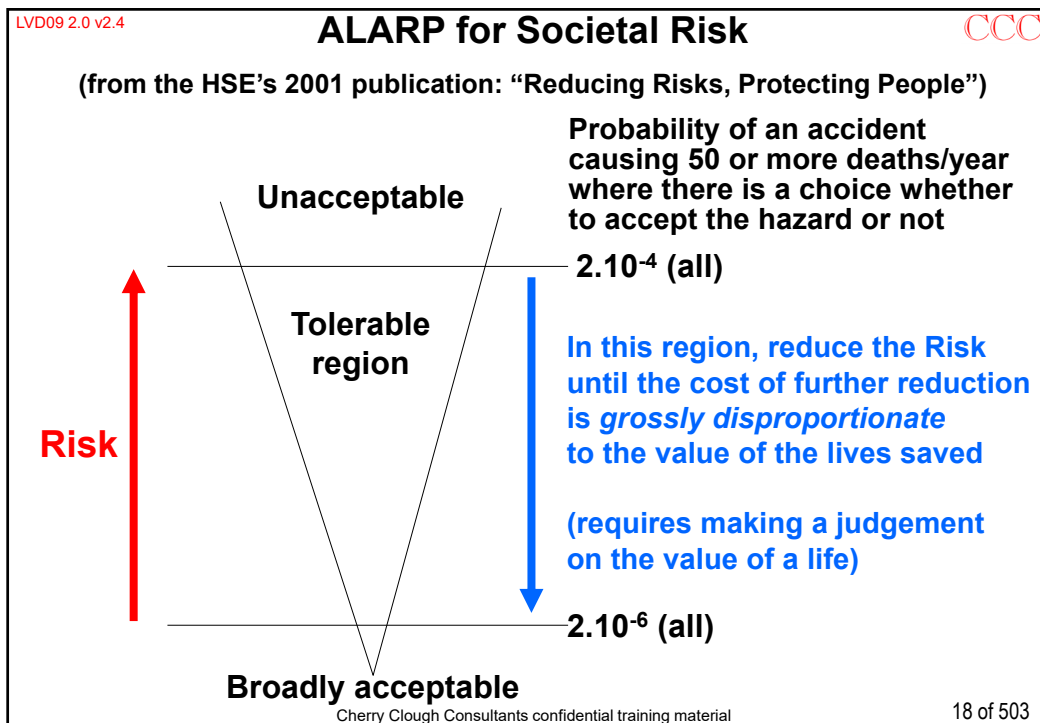
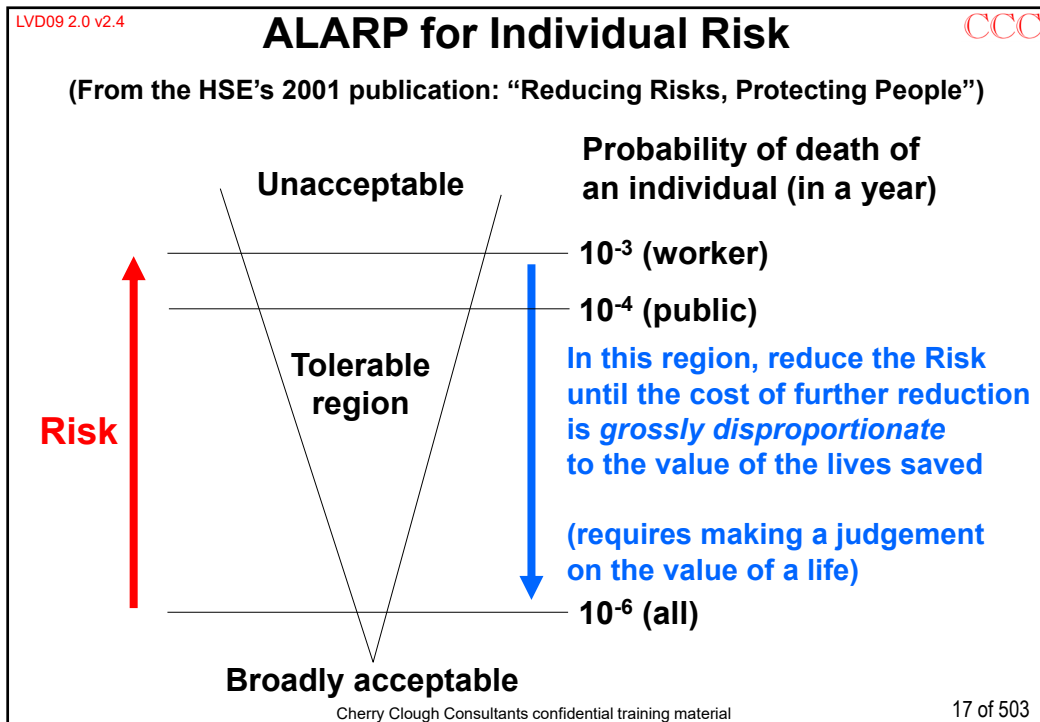
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## The Initial Risk Assessment continued...

- **For each hazard:**  
the Risk is compared with what is considered to be acceptable (some people say 'tolerable')...
  - sometimes there are no fixed Risk levels to comply with, and Risks are required to be ALARP...
    - i.e. 'As Low As Reasonably Practical'
- **Decisions are then made about how much risk reduction to apply, to each hazard...**
  - and the project's 'Safety Requirements Specification' is written on that basis

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## The Initial Risk Assessment continued...

- **The Safety Requirements will eventually be used for the final validation of the project...**
  - *after* its design, development and realisation (which includes manufacture, integration, installation, commissioning, etc., as appropriate to the type of project)
- **Some of the methods listed at the end of these notes can help create the Initial Risk Assessment**

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## A method of qualifying/quantifying hazards and risks (from [1])

The green bracketed comments on this slide are examples which are only for indication and not for use

- **The severity of each hazard is graded as being...**
  - Very serious (e.g. lethal)...
  - Serious (e.g. irreversible)...
  - Slight (e.g. reversible, full recovery in < 6 months)
- **The probability that each hazard could occur is graded as being...**
  - Very High (e.g.  $\geq$  once per day)...
  - High (e.g.  $\geq$  once per month *and* < once per day)...
  - Medium (e.g.  $\geq$  once per year *and* < once per month)...
  - Low (e.g.  $\geq$  once per system life *and* < once per year)...

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