Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

Functional Safety and EMC

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IEC ACOS Workshop, Frankfurt, February, 2004

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- Chapter one – General Considerations
- Chapter two – Comparison of Approach of EMC & Functional Safety Standards
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General Considerations (1)

- Functional safety – safety that relies on correct functioning of electrical/electronic equipment
  - Failure or malfunction of the equipment could result in harm to people (property or environment)
- What is the connection between functional safety and EMC?
- Do functional safety requirements influence EMC requirements?
- If so – how?

General Considerations (2)

- Emphasis is on achieving necessary EM immunity of equipment used in applications where failure or malfunction could cause, or significantly increase the likelihood of harm
- Taking into account EM emissions from nearby equipment and the general EM environment according to the application
  - Including intended emitters, e.g. mobile telephones
- Overall requirements for EM immunity of safety-related systems are given in IEC 61508 and a methodology is presented in IEC TS 61000-1-2

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Functional Safety Standards

- Systems based
- Failure based
  - Require that consequences of failure are assessed (hazardous events)
  - Require that causes of equipment/system failure are considered
- Cover entire lifecycle (e.g. IEC 61508)
  - Concept through to decommissioning
- Define ‘good practice’ to underpin legal requirements

EMC Immunity Standards

- Equipment based
- Focussed on testing
- Only consider equipment in normal operation (without faults)
- Intended to support product certification

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Types of System

1. ‘Designated safety-related systems’ (e.g. IEC 61508)
   - Significant risk control or risk reduction (SIL1 to SIL4)
   - Example – gas pipeline pressure control system
2. Other systems with an impact on safety
   - Low level of risk reduction / control
   - Not in scope of IEC 61508 (no SIL rating)
     - Except as a source of demands on safety-related systems
   - Example – Chemical plant distributed control system
3. Systems with no impact on safety

Equipment Types

1. Not intended for use in a safety-related system or in an application with an impact on safety
   - 'Normal' EMC standards are adequate
2. Intended for use in applications with an impact on safety (but not in a safety-related system)
3. Intended for use as part of a designated safety-related system
   - e.g. 'Safety PLC'
4. Equipment contains a safety-related system
   - e.g. HV tester with electronic interlock

- **'Normal' EMC immunity standards <u>may</u> not be adequate for equipment types 2,3,4 above**

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Confidence Required for Safety Applications

- Principle concern is to ensure that EM immunity is adequate to give required confidence in equipment performance in the final application
  - For the lifetime of the application
- Higher confidence is required if the equipment is more critical for safety
  - Does not always require a higher immunity level

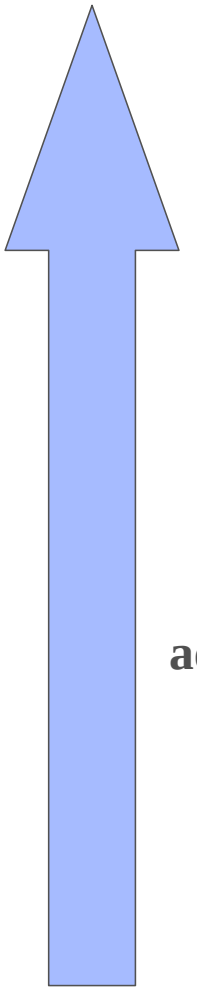
Required Confidence

Equipment intended for use in a safety-related system

- **SIL4 safety function(s)**
- **SIL3 safety function(s)**
- **SIL2 safety function(s)**
- **SIL1 safety function(s)**

Equipment intended for use in applications with an impact on safety

Equipment not intended for use in safety applications



Increasing confidence required that EM immunity of equipment is adequate at all times <u>for lifetime of the application</u>

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EMC Immunity Testing – Considerations for Functional Safety

- Test environment is likely to be different than the operating environment
  - Disturbance types, levels, combinations of disturbances
  - Equipment operating modes
  - Compromises made to limit test time and costs
- Behaviour under fault conditions not tested
- Performance degradations “allowed” without assessment of hazards & risks
- EMC testing does not address design or maintenance aspects

Principal Electromagnetic Disturbances

Conducted low-frequency phenomena:

a) harmonics, interharmonics;
b) signals superimposed on power lines;
c) voltage fluctuations;
d) voltage dips and interruptions;
e) voltage unbalance;
f) power frequency variations;
g) induced low frequency voltages;
h) d.c. component in a.c. networks.

Radiated low-frequency field phenomena:

a) Magnetic fields
   1) continuous;
   2) transient.
b) Electric fields.

Conducted high-frequency phenomena:

a) Induced voltages or currents
   1) continuous wave;
   2) modulated waves.
b) Unidirectional transients[1)]
c) Oscillatory transients [1)]

Radiated high-frequency field phenomena:

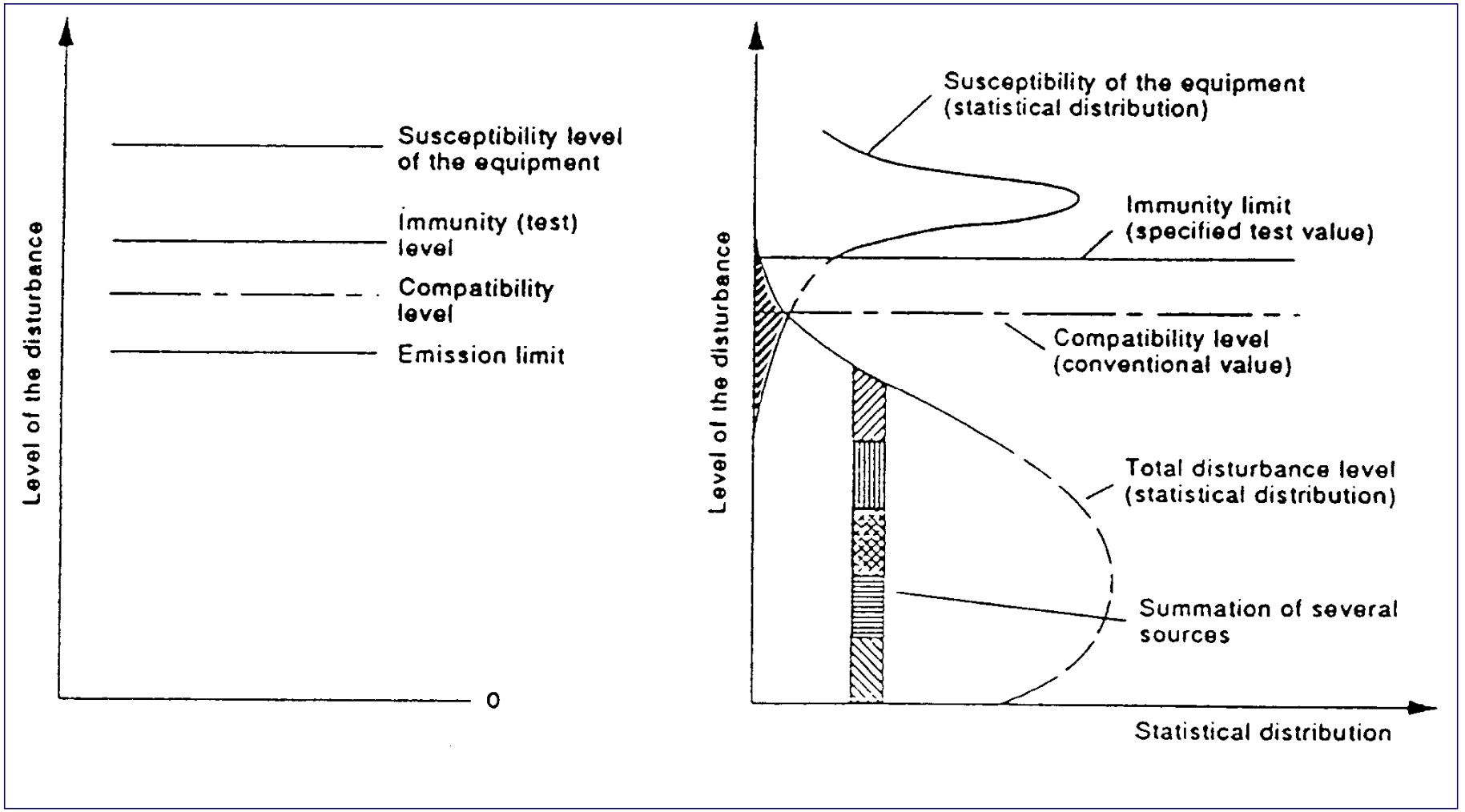
a) Magnetic fields;
b) Electric fields;
c) Electromagnetic fields
   1) continuous waves;
   2) modulated waves;
   3) transients[2)].

Electrostatic discharge phenomena (ESD)

High altitude electromagnetic pulse (HEMP)

[1)] single or repetitive (bursts)
[2)] single or repetitive

Selection of EMC Immunity Test Levels



Selection of EMC Immunity Tests and Levels

- There are over 20 specific EMC phenomena-based immunity test standards
- Only a few of the EM environments are common
  - Radio-frequency EM fields, electrostatic discharge, power and data line disturbances (both low and high frequency), etc.
- Generic EMC standards have been developed to advise product committees on the “essential” immunity tests and their levels depending on the location of the equipment (home, industry, power substations, etc.)
- The problem is that some of the EM environments not considered “essential” for EMC could produce a safety hazard in some systems

Sufficiency of Testing

EM immunity testing alone (even at higher levels than normally applied for EMC testing) does not give the necessary confidence that equipment is acceptable, for use in a safety application

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Methodology for EM Aspects of Functional Safety (1)

- EM immunity should be addressed as a key aspect of equipment design
  - Design should be assessed from an EM viewpoint
- Assess the EM environment in the intended application
- Immunity tests should replicate, as far as possible, the intended environment and operating modes of the equipment
- All performance degradations observed in immunity testing should be documented and reported in the equipment documentation

Methodology for EM Aspects of Functional Safety (2)

- Performance degradations should be evaluated from viewpoint of safety
- Testing should be performed at highest practical level of integration
- Report required covering all above aspects
- This methodology is presented in IEC TS 61000-1-2

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Future Work

- Basic requirements for EM immunity in IEC 61508 are being reviewed by SC65A/MT13
  - To be included in CD for 2nd edition of IEC 61508, due June 2004
- Maintenance of IEC TS 61000-1-2 is starting in TC77/MT15
  - Further development is necessary
  - Grading of measures and techniques according to SIL?
    - To support ‘SIL capability’ concept of IEC 61508
  - Immunity under fault conditions?
  - Publication as a standard?

Thank you for your attention. Any questions?