



Another EMC resource
from EMC Standards



Good EMC Engineering practices for electrical cabinets systems and installations

Helping you solve your EMC problems

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Good EMC engineering practices for equipment, systems and installations

Helping to avoid electromagnetic interactions that cause delays and increase costs



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Good Electromagnetic (EM) Engineering...

- is cost-effective SI, PI and EMC engineering: well-proven to save time & money in all lifecycle stages, helping to increase profits & reduce financial risks...
- for sub-systems, equipment, systems, installations, etc., etc.; of any size, in all applications (inc. land, sea, subsea, air, space vehicles)
see Module 1 especially 1.15 (also in Webinar 1c) and 1.16 (also in Webinar 1d)
- **This** Module contains many EM Engineering guidelines that should *also* be used as an initial design checklist:
any that can't or won't be followed identify a project risk!
see Module 1, section 1.16 (also in Webinar 1d)
- to adapt any λ -based design guidelines to different EMC standards, see *Module 1, section 1.18* *(also in Webinar 1d)*

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Contents (1)

- 1. Introduction**
EMC Directive (2014/30/EU); Lightning protection (BS EN 62305); IET Wiring Regulations (BS7671): quick, cost-effective compliance with good EMC engineering
- 2. Good EMC practices for general use**
 - Planning
 - Dealing with legacy equipment, systems and installations
 - Buying equipment; and CE + CE ≠ CE
 - Power distribution systems; and power quality for EMC
 - Galvanic isolation for EMC
 - Segregation (EM Zoning)
 - Cable classification, segregation, and routing
 - Using Bonding Ring Conductors (BRCs)
 - Creating an RF Reference by RF-bonding conductors and/or metalwork
 - Reducing the 'accidental RF antenna' efficiency of cables
 - Terminating cable shields at EM Zone boundaries, at both ends
 - Using Parallel Earth Conductors (PECs)
 - Preventing corrosion

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Contents (2)

- 3. EM Mitigation Techniques**
 - Earthing/grounding for both Safety and EMC Zoning
 - Using Meshed Bonding Networks as RF References
 - What to do when EM Zones must be isolated
 - Filtering for EM Zoning
 - Shielding for EM Zoning
 - RF-bonding filters to shielded EMZs where cables enter/exit
 - RF-bonding cable shields/screens to shielded EM Zones at entry/exit
 - Surge and Lightning protection
- 4 Maintaining good EMC over the operational lifecycle**
- 5 Some useful references**
- 6 Bonus: Alain Charoy's presentation on EMC fixes and mistakes**

Keep up to date with this training course,
visit: www.emcstandards.co.uk/emc-for-systems-installations2

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1 Introduction

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Introduction

- This module is based on many years of solving EMC problems in a wide range of electrical / electronic assemblies, systems, and installations
 - to improve functionality and reliability (and also to meet EMC standards)
 - the methods described generally correspond with BS IEC TR 61000-5-2:1997 and BS IEC TR 61000-5-6
- This presentation uses examples based on industrial applications...
 - but these techniques can easily be extended to cover any electrical / electronic applications

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The new EMC Directive 2014/30/EU

- This requires all '*fixed installations*' to employ '*good engineering practices having regard to the state of the art*' ...
- And also requires a '*Responsible Person*' to document the *good engineering practices*
 - and keep the records ready for inspection, for as long as the fixed installation is in operation
- please note that the phrase: "*good engineering practices*" actually means: "*good EMC engineering practices*"

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Lightning protection for electronics

- The lightning protection standard applied all over Europe is now EN 62305 (which has four parts)
- EN 62305 requires the potential for lightning damage to electronic equipment/systems...
 - to be taken into account in all lightning risk assessments
 - the specific requirements are given in EN 62305-4

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National Wiring Regulations

- The UK's Wiring Regulations (BS7671) contain...
 - requirements to assess the electromagnetic compatibility of any equipment...
 - as regards other equipment, or the impairment of the AC mains supply...
 - and achieve EMC compliance – although they *go beyond the requirements in the EMC Directive*...
 - requirements for protection against voltage disturbances and electromagnetic disturbances...
 - which partially overlap with BS EN 62305
- Other national wiring regulations, especially in Europe, are probably similar

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But neither 2014/30/EU; EN 62305, or National Wiring Regulations actually describe how to do the necessary EMC engineering in practice

- But if you don't design and construct EMC engineering correctly – it won't work (and can even make EMC worse!)...
 - and many of the practical EMC techniques that are required, are not yet commonly used in electrical systems or installations
- So this course module is about how to do good, practical EMC engineering, *in real life*

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Up-to-date good EMC engineering practices...

- are outlined in the following slides,
and some are uniquely identified (e.g. METHOD “A”)
- **Quality-controlled Procedures and Work Instructions should define these practices and how they are to be used...**
 - designers should identify the appropriate EMC practices wherever they are needed on their drawings...
 - assemblers should follow the appropriate Work Instruction for each practice identified on a drawing
- **Organisations should develop the good EMC practices most suited to their own activities...**
 - many have used this course material as a starting point

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Use these guidelines as a checklist in design, commissioning, or fault-finding

- **Where a guideline can be followed, *it should be...***
 - to help control financial risks and achieve the lowest overall cost for a project
- **Trying to reduce costs by cutting corners generally ends up costing more *overall*...**
 - as well as risking penalty charges or liability lawsuits that can *easily* run into £millions (I have many case studies!)
- **But where a guideline can't be followed...**
 - something else will generally have to be done to achieve the same benefits for EMC...
 - even if you have got away with it so far, the increased risk will probably get you eventually

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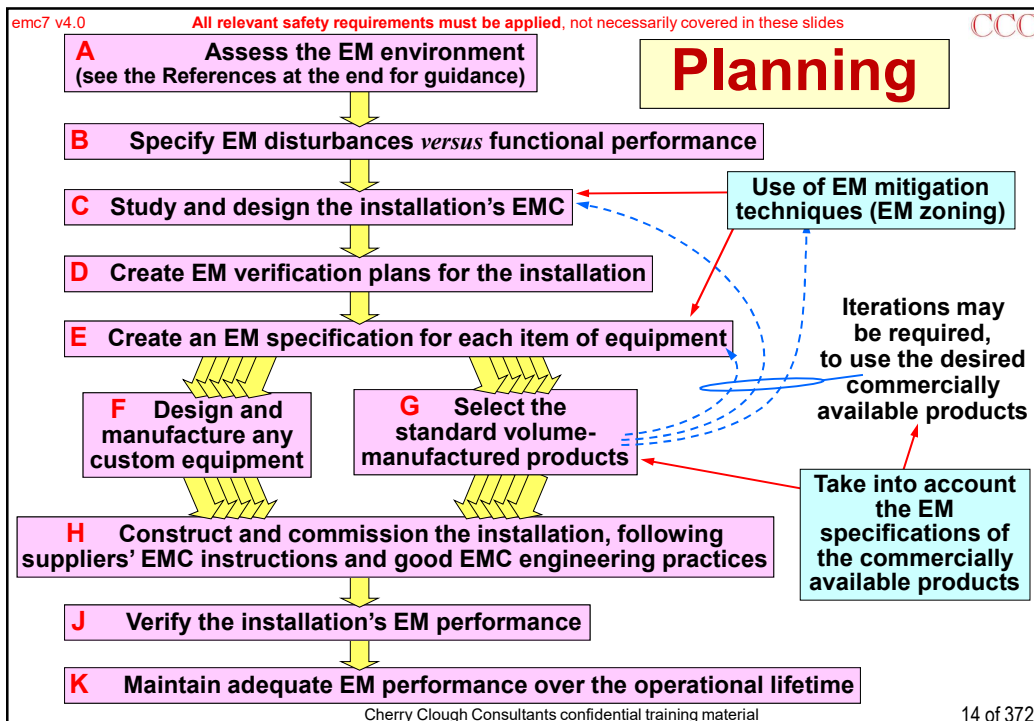
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Good EMC engineering practices for general use

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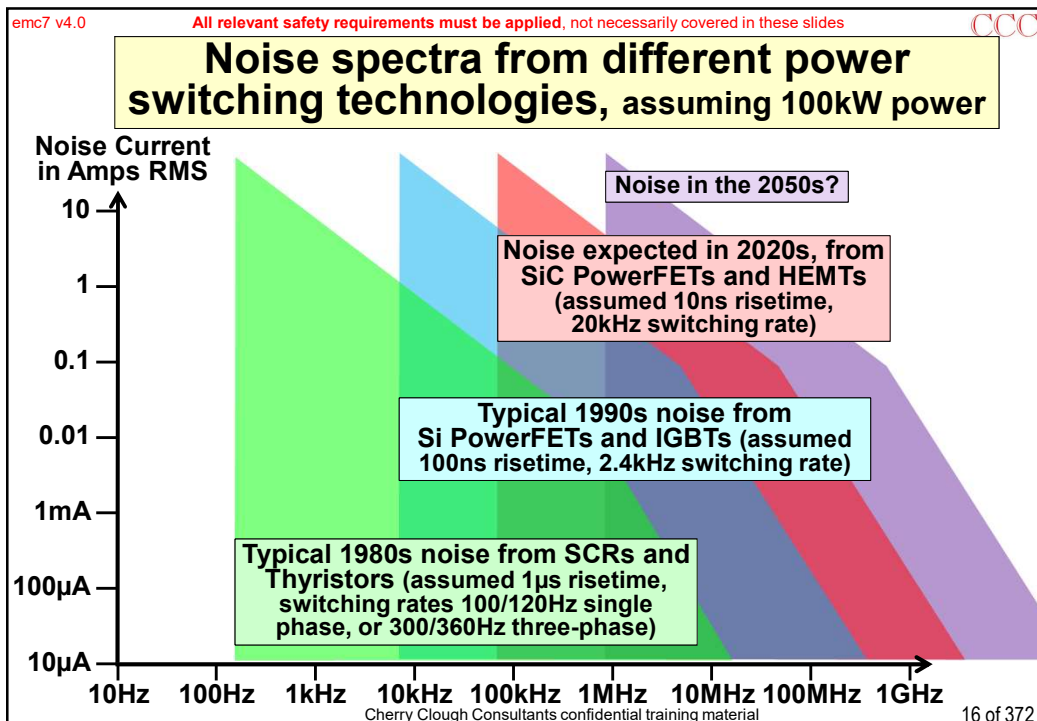
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EMI is getting worse...

- because modern industrial equipment uses technologies that emit more noise at higher frequencies...
- e.g. replacing thyristor/triac power controllers in battery chargers, heating controllers, etc., with smaller and more power-efficient modern types using PowerFET or IGBT pulse-width-modulation (PWM)...
- e.g. replacing magnetic-ballast fluorescent / HID lamp controllers with high-frequency power-switching types...
- and all lamp types now being replaced by LEDs powered by (noisy!) PWM switching power converters...
- and all PWM switching power converters will soon migrate to using SiC and GaN power switching devices, which will have switching rates from *10 to 100 times higher*

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Variable Speed Motor Drives (VSDs) are an ever-increasing cause of EMI

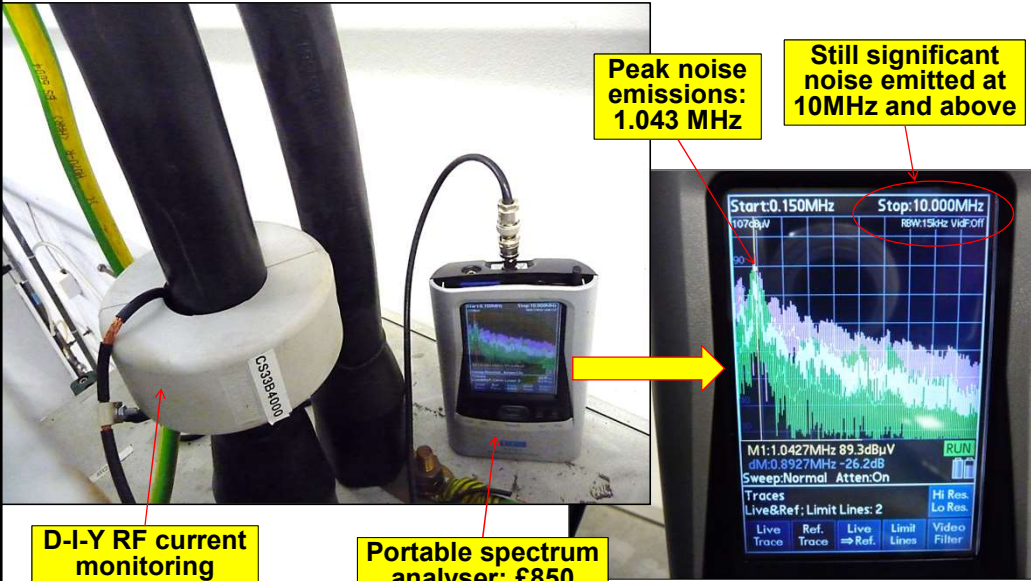
- A) Because they are increasingly replacing fixed-speed motors,
to reduce energy consumption and save the planet
- B) Because they are increasingly being used in
places where fixed-speed electric motors are
unsuitable,
e.g. replacing hydraulic and pneumatic systems in robotics
- C) Because they are always using faster power-
switching devices,
to reduce size/cost, and increase energy efficiency even more

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Example of 2012 VSD noise emissions



Peak noise emissions:
1.043 MHz

Still significant
noise emitted at
10MHz and above

D-I-Y RF current
monitoring
clamp: £150

Portable spectrum
analyser: £850

Start: 0.150MHz Stop: 10.000MHz
107dBµV RBW: 15kHz Vid: Off

M1: 1.0427MHz 89.3dBµV
dM: 0.8927MHz -26.2dB
Sweep: Normal Atten: On

Traces
Live&Ref: Limit Lines: 2 Hi Res. Lo Res.
Live Trace Ref. Trace Live Ref. Limit Lines Video Filter

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Dealing with legacy equipment, systems and installations

- Legacy equipment might not be immune to the RF noise generated by modern equipment, especially if it is so old that it was never tested for RF immunity
- Some older plants have control and/or safety systems dating from the 1970s...
 - when their 'RF-quiet' power converters fail they are usually replaced by modern 'RF-noisy' switching converters...
 - they will eventually be overwhelmed by aggregate RF noise from newer equipment, with unknowable results...
 - *even if* replacements are all CE marked, and *even if they really are compliant* with the EMC Directive when installed

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Dealing with legacy equipment, systems and installations (2)

- So, it is important for a legacy site owner to be aware of the EM environment of his site...
 - to help avoid increases in the background noise that could decrease productivity or increase safety risks
- It is also important for a supplier of equipment to a legacy site to be aware of the likely impact of his equipment on its EM environment...
 - to help avoid being held liable for the lost production and/or safety incidents/accidents caused...
 - when his equipment caused aggregate noise to exceed what the legacy control/safety systems could handle

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