EMC

Avoiding weird problems!

John Aitken
Aitken & Partners

EMC – What is it?

Electromagnetic Compatibility

- Making sure that electrical and electronic systems can work together.

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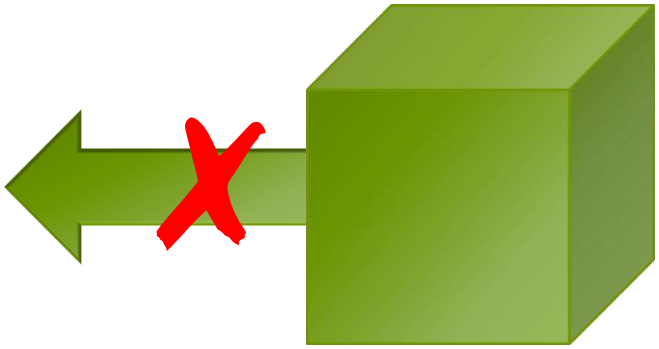
- Making sure that electrical and electronic systems can work together.
- We start with the smallest component.

EMC – What is it?

Electromagnetic Compatibility

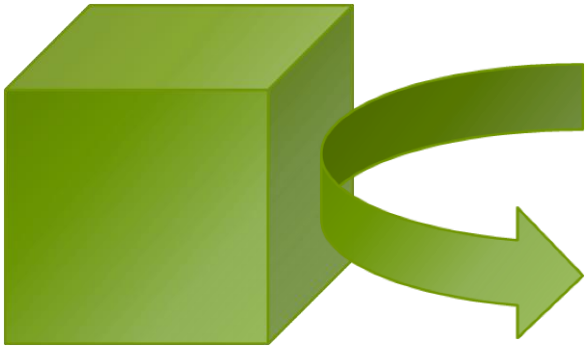
- Don’t let unwanted energy out of the component.



EMC – What is it?

Electromagnetic Compatibility

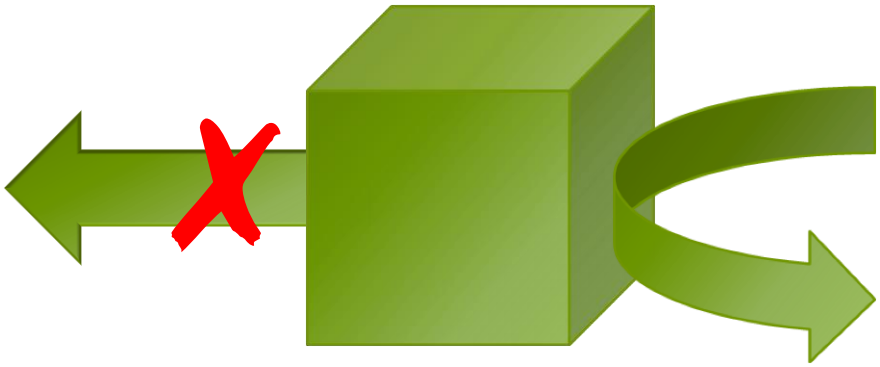
- Don’t let unwanted energy into the component.



EMC – What is it?

Electromagnetic Compatibility

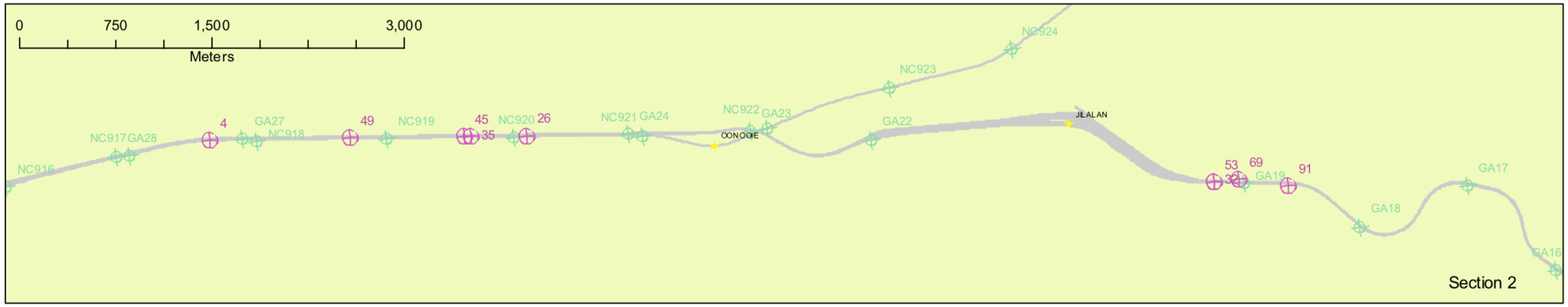
- Minimise unwanted energy
- Make systems that are compatible.

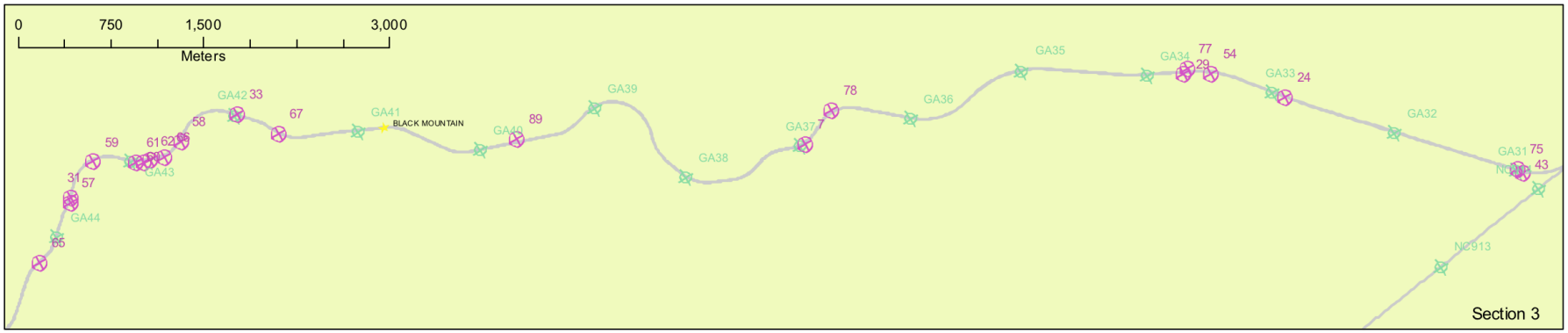


Weird and Wonderful

Weird and Wonderful

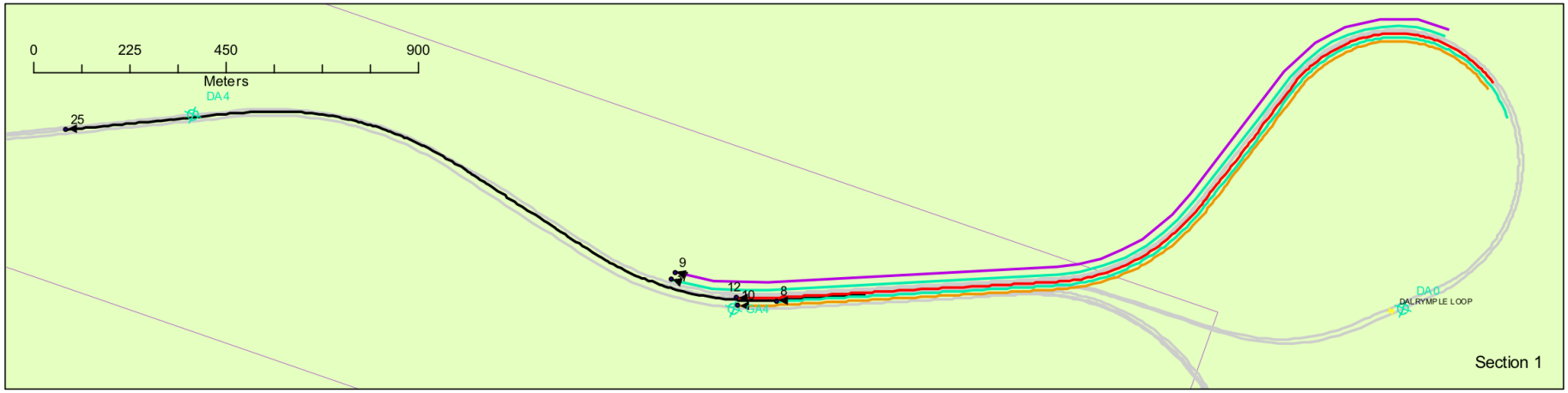
It can happen with trains





Sudden, unexplained emergency brake application

It can happen with trains



Often at the same place – but not always

Many observations:

- Only with ECP
- Not always, but usually in electrified area
- Usually associated with dynamic brake operation
- More often on the steep grades on the mountain range
- Happens sometimes when you cut off power
- Very frequently at the port.

On-train and trackside

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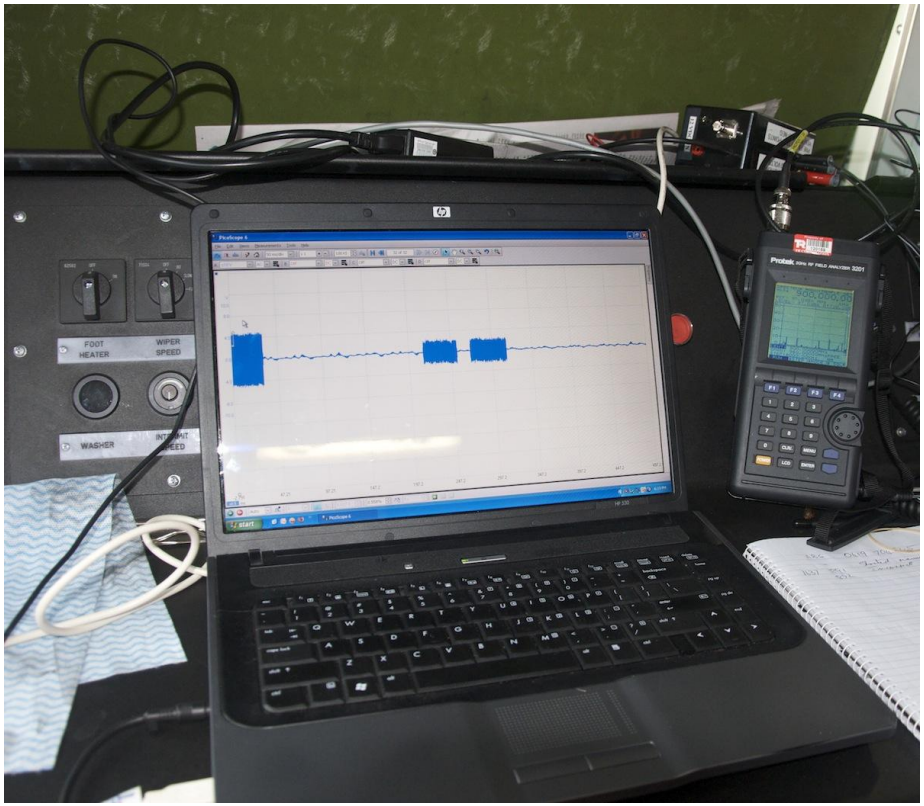

On-train and trackside

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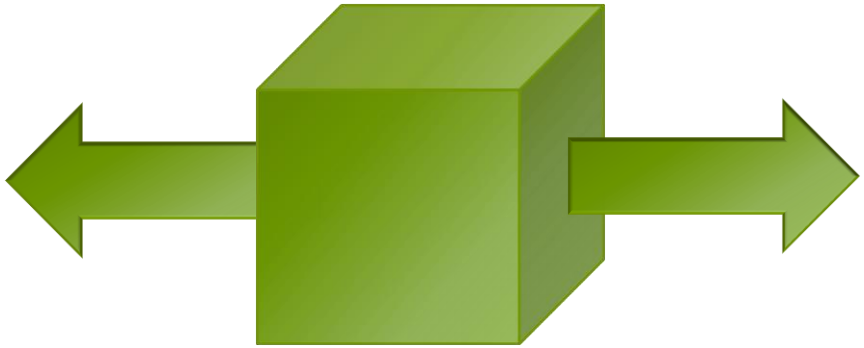
The cause!

Locomotive Harmonics

- Always there
- Even when the train is not moving, the auxiliary plant is generating harmonics.

Locomotive Harmonics

- Always there:
  - Absorbed into traction circuit under load
  - Distributed on overhead system when in dynamic brake or stationary



Why me?

- All equipment passed EMC tests
- All locomotives passed EMC tests
- I comply!

- The trains still stopped.
- Why?

Compliance with Standards

- Standards prescribe tests to identify known problems
- The tests cover a limited number of circumstances
- Tests are done sequentially.

- Real life is not like that. Things happen.
- They don’t check the standards first!
- Careful, consistent design is essential.

Immunity

- Was the equipment on the train designed for the environment?
- Did the locos comply with their specifications?
- Yes.
- But the trains still stopped.

On-train and trackside tests

- Very expensive!
- Very time consuming!
- Very effective!

On-train and trackside tests

- The problem was found – a design issue in a power supply.
- The balanced line for ECP was not balanced at all frequencies because the power supply designer put in a component to pass an EMC test. The component shunted unwanted frequencies from the power supply to ground.

Fix one, fail another

- The work-around for the EMC problem in the power supply created susceptibility at certain frequencies.
- The trains radiated harmonics at those frequencies.
- When there were three or more trains idle in a power feed section, the sum of the harmonics interfered with the ECP operation on some trains.
- The trains stopped.

It won’t happen to us!

Not if we can help it ….

- So we design to minimise leakage.
- We design to maximise immunity.
- We expect the unexpected.

James Reason:

If the price of liberty is eternal vigilance,

the price of safety is eternal unease.

A useful resource

Factile

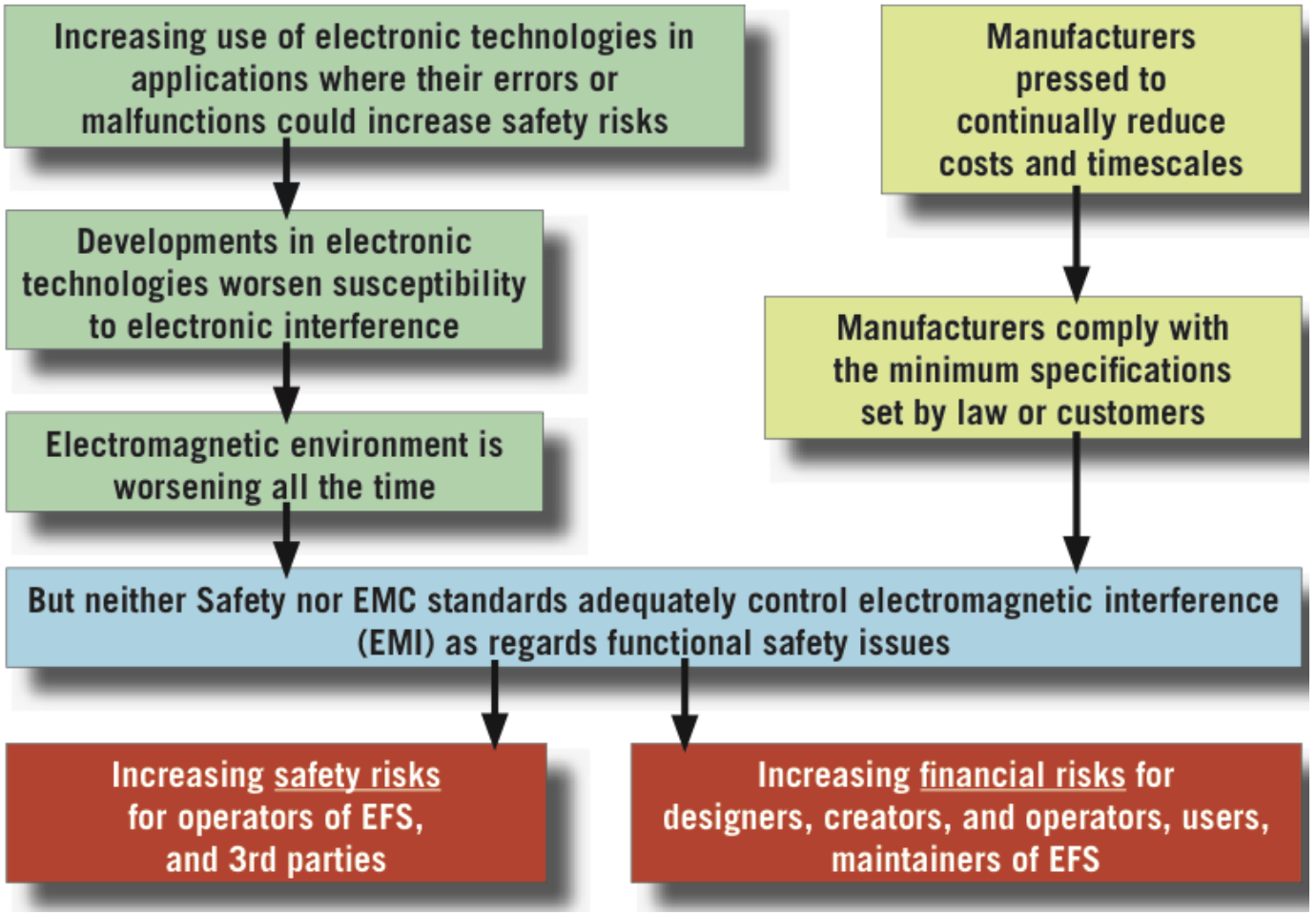
The Institution of Engineering and Technology

Electromagnetic Compatibility for **Functional Safety**

Risk management and EMC

- The UK Institution of Engineering Technology (IET) suggests a risk management approach to EMC.
- EMC for Functional Safety –
  - IET Guidelines
  - checklists and
  - assessment processes.

Increasing risks due to EMI



Thank you.