

FT2025

SWEDISH AEROSPACE  AT THE CROSSROADS

The 12th Swedish
Aerospace Technology Congress
FT2025 in Stockholm
October 14-15, 2025

Airport electrification and electromagnetic emissions – standards and challenges

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FT2025, 14 October 2025

Project financed by:



TRAFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION

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1 Introduction

Sustainability (goals)

- Reduce emissions

Electrification increases the probability of electromagnetic emissions

Electromagnetic interference can disrupt sensitive aviation electronics with serious consequences.



<https://www.shutterstock.com>

“A new report from the Swedish National Electrical Safety Board shows that electrification and digitalization mean increased risks of [electromagnetic] interference and that society lacks sufficient competence and awareness to deal with them.”

National Electrical Safety Board / Els akerhetsverket, 16 September 2025, translated from Swedish
<https://www.elsakerhetsverket.se/om-oss/press/nyheter/2025/ny-rapport-bekraftar-kunskapsbehov-om-elektromagnetisk-kompatibilitet>

2 Introducing Electromagnetic Compatibility

Electromagnetic energy propagates

- Conductive (Conductive medium)
- Radiative (Non conductive medium)

Electromagnetic energy can be

- Desired
- Undesired

Electromagnetic Compatibility (EMC) regulates

- Emissions / Disturbances
- Immunity / Susceptibility

EMC Legislation

- European Regulation (EU) 2018/1139
- Electromagnetic Compatibility Directive (EMCD) 2014/30/EU
- Radio Equipment Directive (RED) 2014/53/EU

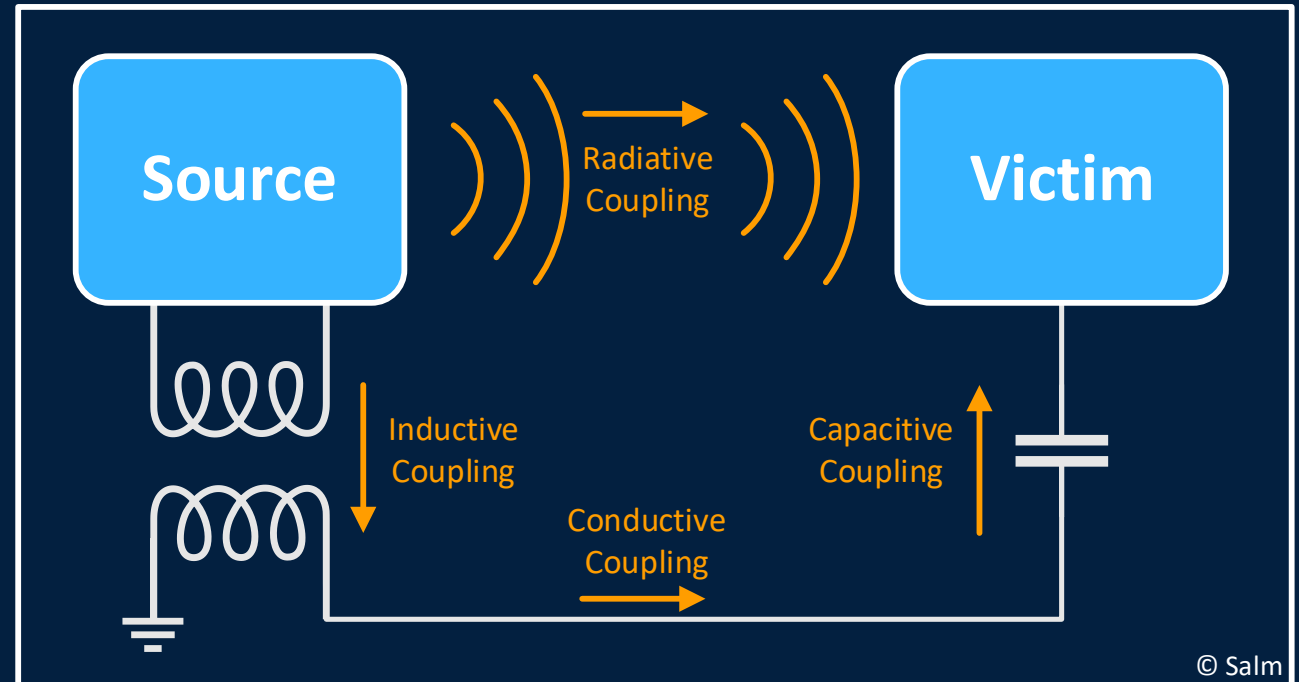


Figure: Concept of Electromagnetic Compatibility

3 Organisations

Legislation



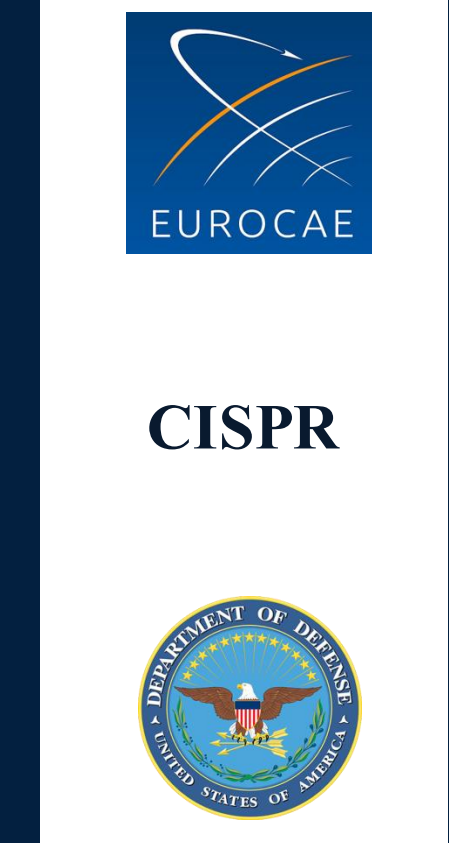
Commercial Standards



Aviation Certification



Additional Standards



3 About standards

Commercial

EMC (undesired) standards

1. EMC Product Standards
 - Specific products
2. EMC Product Family Standards
 - Simular products
3. Generic EMC Standards
 - Other products
4. Basic EMC Publications
 - Test methods

Radio (desired) standards

Military

Stricter requirements

Not limited to military use

US Department of Defense:

- MIL-STD-461
- MIL-STD-464

UK Ministry of Defence

- DEF STAN 59-411

Aviation

Airborne equipment is excluded from the EMCD and RED

EUROCAE / RTCA

- ED-14 / DO-160

International Civil Aviation

Organisation (ICAO)

- Annex 10
- Doc 9718

4 Analysis of Standards

Commercial

- Define emission levels with corresponding immunity levels
- Main focus intersystem EMC
- Standardised frequency bands and methods

Military

- Prioritise own safety with high immunity levels
- Main focus intra-system EMC
- Standardised frequency bands and methods

Aviation

- Prioritise own safety with high immunity and signal-to-noise levels
- Main focus intra-system EMC
- Specific frequency bands and methods



Figure: Example of an intersystem measurement

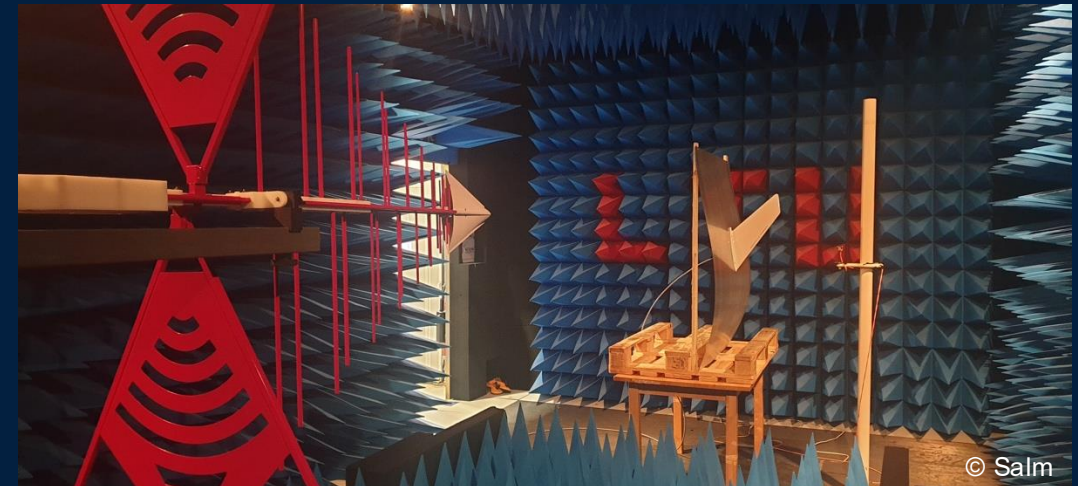


Figure: Example of an intra-system (component) measurement

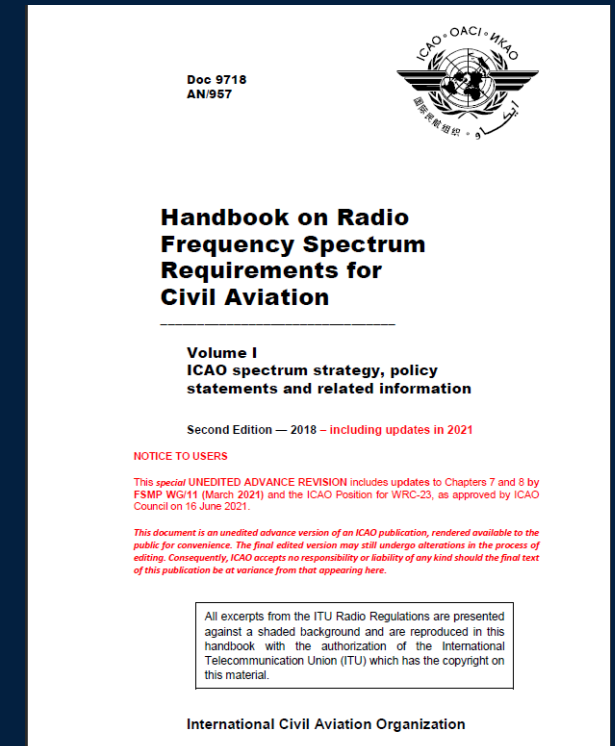
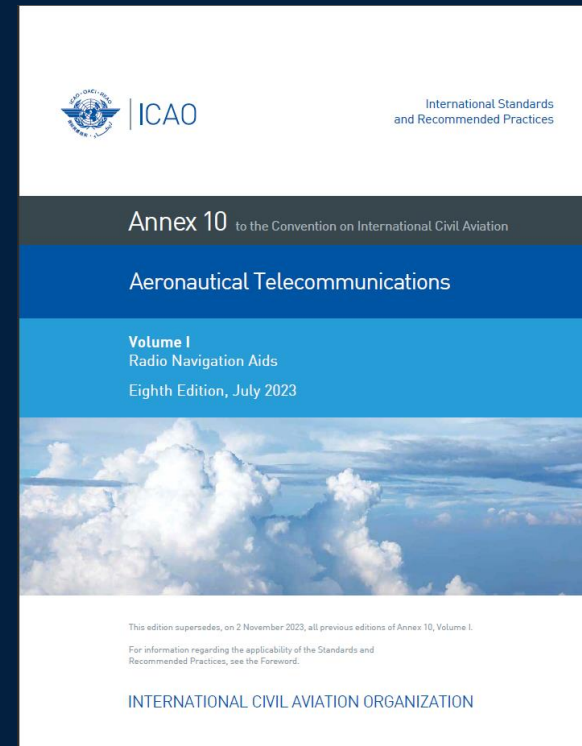
5 Airport regulations and requirements

European regulations mandate safe airport operational environments (EU 139/2014)

Implementation in ICAO's Annex 10 and Doc 9718

Airports themselves determine how to fulfill these requirements

- Swedish Civil Aviation Administration (Luffartsverket)
- Swedavia AB



6 Identified Challenges

Various Environments within an Airport

- Airports are similar to large independent cities
- Aviation specific equipment

Regulations set by airports in Sweden

- Enhance and safeguard radio systems
- Enforcement can be challenging

Unwanted electromagnetic radiation (radio signals) from equipment must not exceed limit values corresponding to the following standards

Zone	Requirement
Area marked in blue outdoors – within the EMC protection area	EN 61000-6-3 or alternatively EN 55022/32 Class B
Area marked in red outdoors	EN 61000-6-3 or equivalent The maximum field strength may not exceed: 21 dBµV/m for the frequency range 108 MHz–137 MHz 24 dBµV/m for the frequency range 380 MHz–430 MHz.
Indoors within the EMC protection area	EN 61000-6-3 or alternatively EN 55022/32 Class B

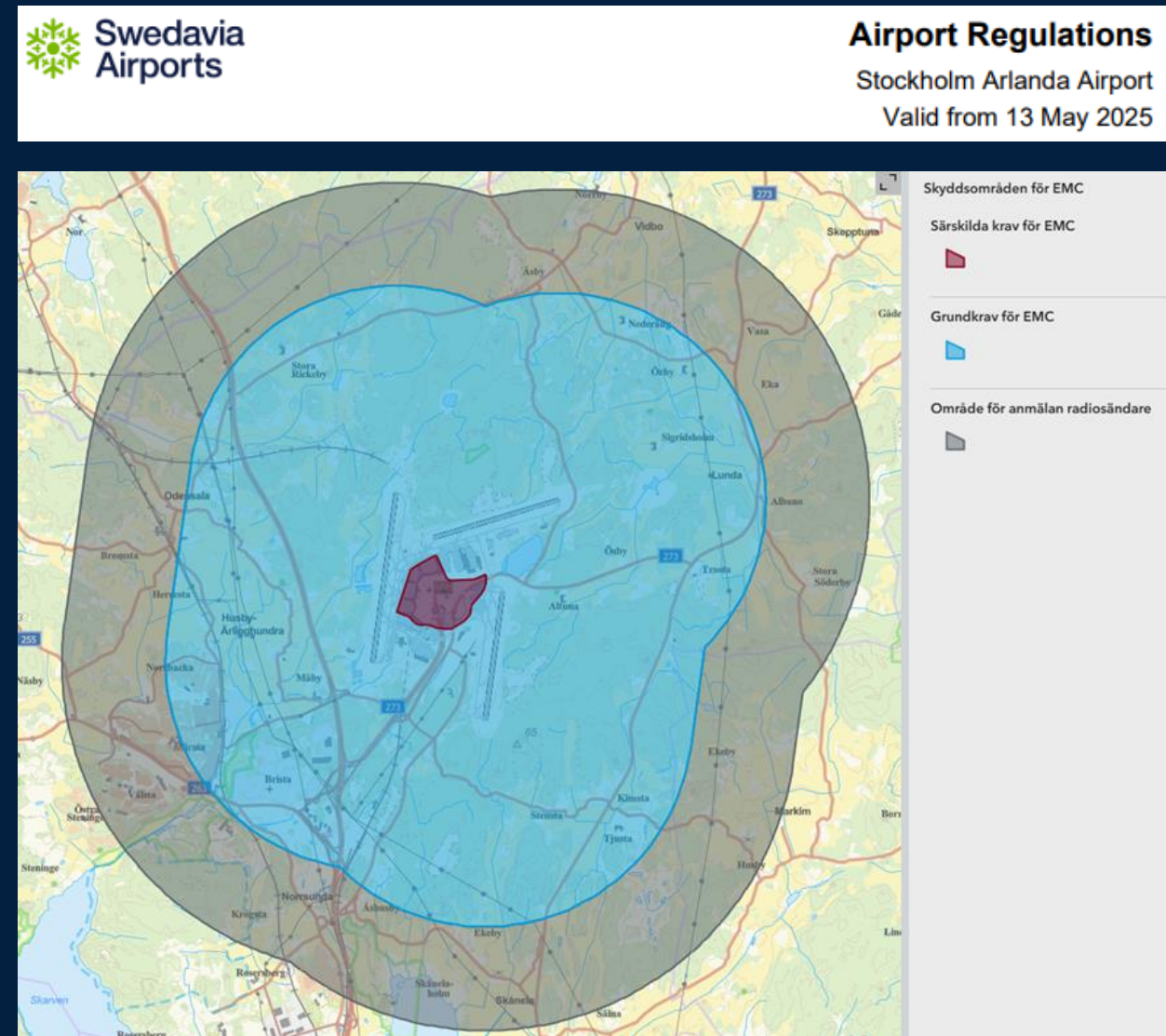


Figure: EMC areas Stockholm Arlanda

https://www.swedavia.net/airport/arlanda/airportregulations/Sidor/ARHuvudsida_en-us.aspx

6 Identified Challenges

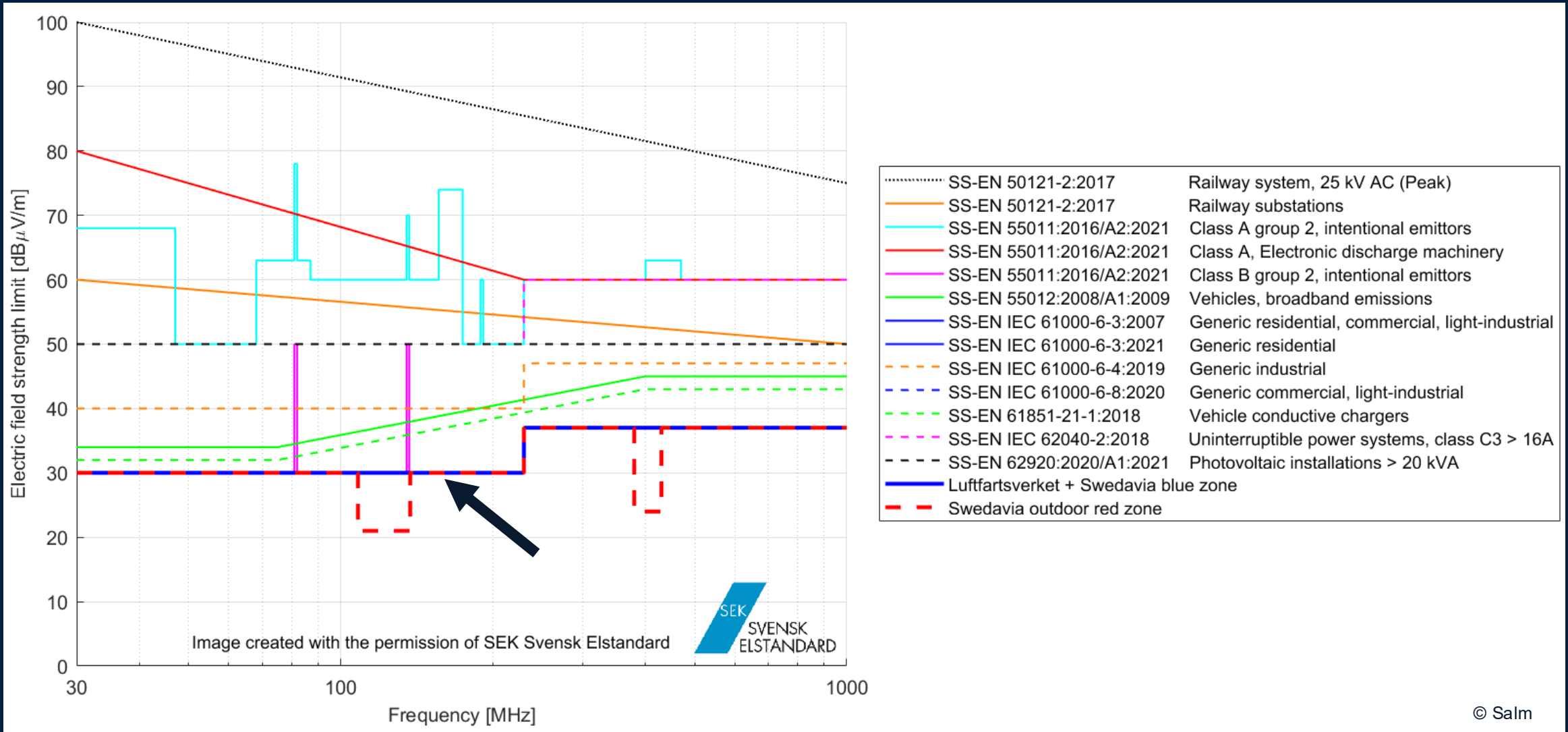


Figure: Emission limits specified by analysed common standards, compared to current airport regulations. 10 Meter, 120 kHz, Quasi-peak

6 Identified Challenges

Aircraft as Emission Source

- Airborne equipment is dismissed from the EMCD and RED according to European regulation (EU) 2018/1139
- Aviation standards do not account for emissions from an aircraft as a whole
- Identified by CENELEC* in 2000, report (CLC(SG)819)

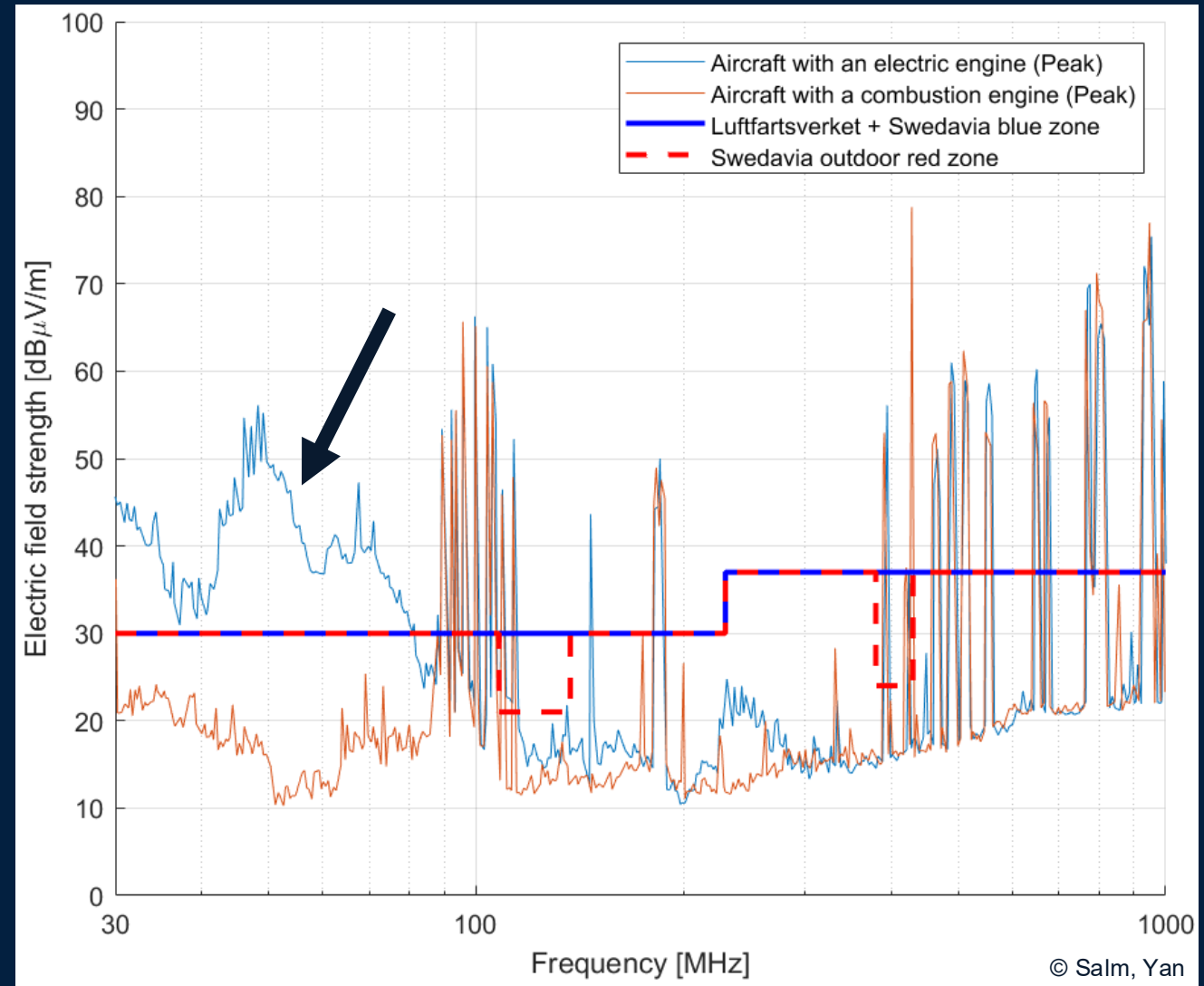


Figure: Measured electric field strength from an electric aircraft compared to a similar internal combustion propelled aircraft. 10 Meter, 120 kHz, Quasi-peak

* Comité Européen de Normalisation Electrotechnique
European Committee for Electrotechnical Standardization

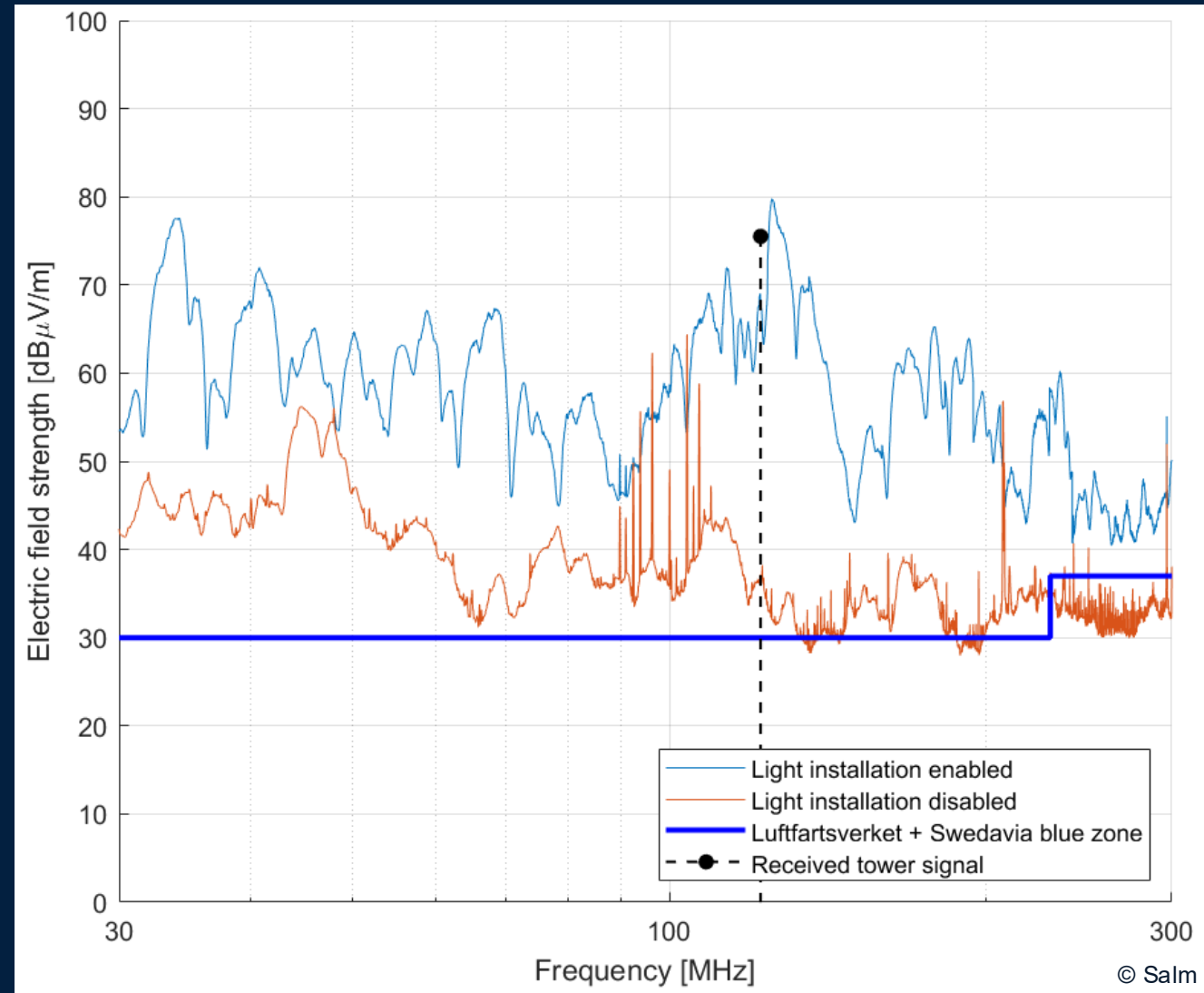
6 Identified Challenges

Certification of Installations

- Installations have no CE marking
- Installed according to handbooks and guidelines
 - SEK Handbok 444, SS 436 40 00
- Installations are usually not EMC validated with measurements

Example high power installations:

- Solar parks
- Vehicle chargers
- Energy storage (batteries)



6 Identified Challenges

Improvement of Switching Components

- Increase in power
- Decrease in switching time

SWITCHING CHARACTERISTICS						
Turn-On Delay Time	$t_{d(on)}$	$V_{GS} = -5/20\text{ V}$, $V_{DS} = 800\text{ V}$, $I_D = 20\text{ A}$, $R_G = 4.7\ \Omega$, Inductive Load	-	13	-	ns
Rise Time	t_r		-	20	-	
Turn-Off Delay Time	$t_{d(off)}$		-	22	-	
Fall Time	t_f		-	10	-	

Figure: Example of switching characteristics of an SiC MOSFET (NVHL080N120SC1)

20 ns → 50 MHz BW
 10 ns → 100 MHz BW
 9.26 ns → 108 MHz BW
 8.23 ns → 121.5 MHz BW

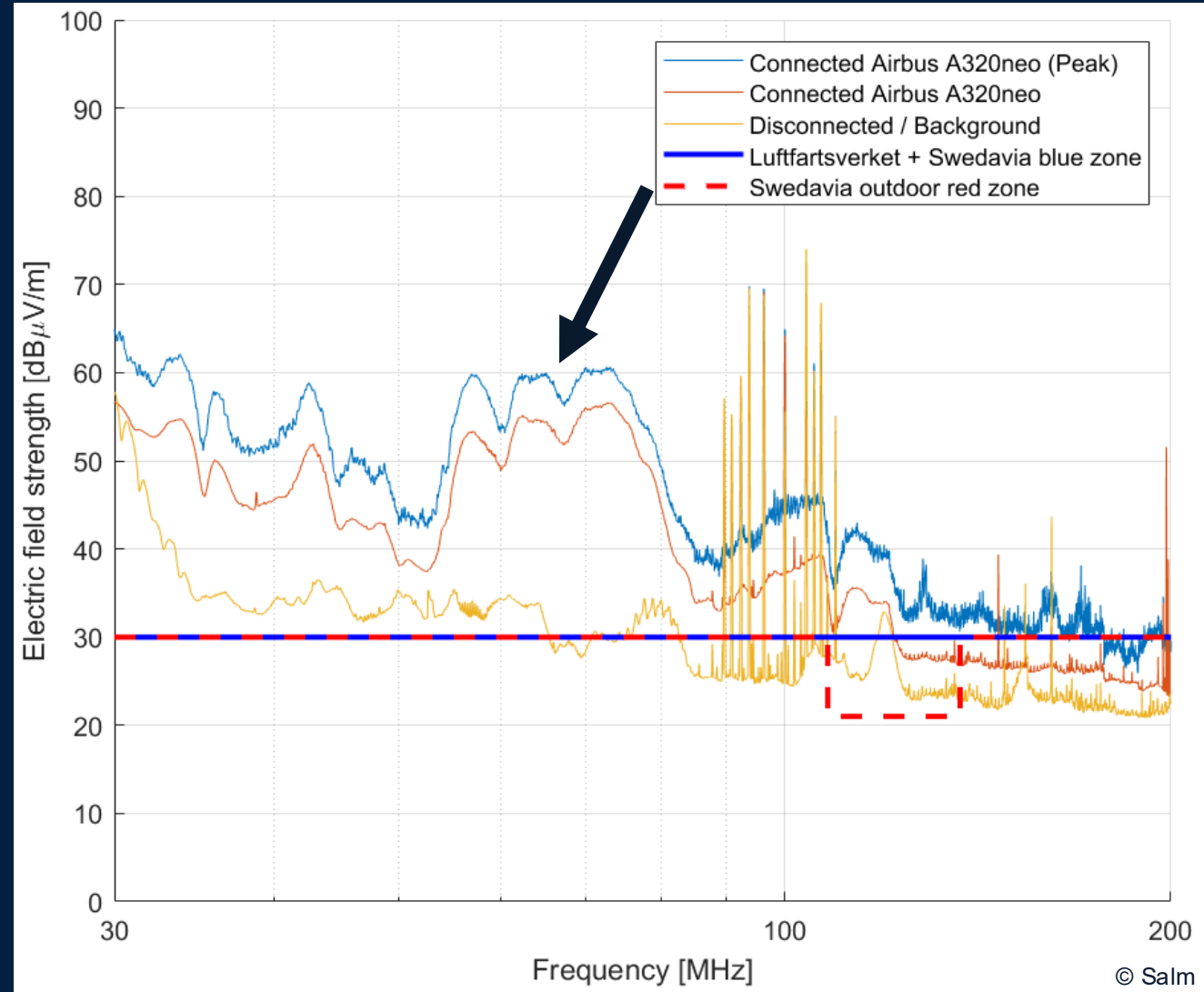


Figure: Measured electric field strength from a Ground Power Unit, both during operation and when disconnected. 10 Meter, 120 kHz, Quasi-peak

Conclusion

- Comparing standards is complex due to difference in methods
- Current requirements defined by Swedish airports are challenging to enforce
- Ongoing electrification presents challenges for airports and EMC in general
- Further analysis is relevant for future EMC requirements and airport operations

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Measured aircraft

Pipistrel Velis Electro

Pipistrel E-811-268MVLC electric motor, 57.6 kW (77.2 hp)



Piper Archer DX (PA28 Cherokee)

Continental CD-155 diesel engine, 114 kW (155 hp)



6 Identified Challenges

Aging of Components

- EMC performance may decrease over time

Outdated Standards

- Standards change and may not be (fully) applicable

Insufficient Certification

- The individual bringing a product to the European market is responsible
- Technical documentation is mandatory according to EU law

Responsible committee: SEK TK EMC - Electromagnetic compatibility

Status: **Cancelled**

Swedish designation: SS-EN 61000-6-3, edition 2:2007

CENELEC Publication: EN 61000-6-3:2007

IEC Publication: IEC 61000-6-3:2006

Determination date: 2007-02-26

Cancellation date: 2024-03-26

Conformity: Complete (IDT) ⓘ

Edition: 2

Number of pages: 17

Language: English

Used with: [SS-EN 61000-6-3, edition 2:2007/A1:2011](#)

Replaced by: [SS-EN IEC 61000-6-3, edition 3:2021](#) and partly by [SS-EN IEC 61000-6-8, edition 1:2020](#), [SS-EN IEC 61000-6-8, edition 1:2020](#), [SS-EN IEC 61000-6-3, edition 3:2021](#)

ICS: 33.100.10 Broadcasting

Figure: Status of outdated standard SS-EN 61000-6-3:2007
SEK Svensk Elstandard, translated from Swedish

forced to stop sales of battery chargers

Sales ban. [redacted] is forced to stop selling battery chargers as technical deficiencies can disrupt radio traffic and other products.

Figure: Sales ban due to insufficient testing and lacking documentation
National Electrical Safety Board / Els kerhetsverket, translated from Swedish