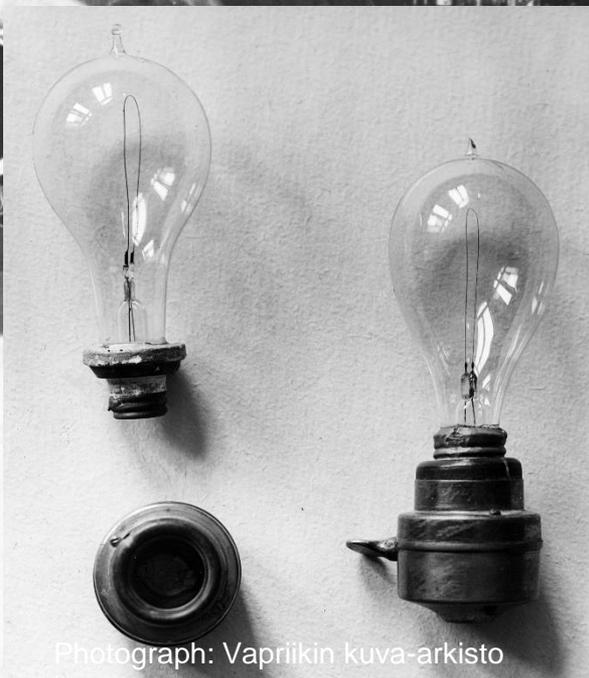
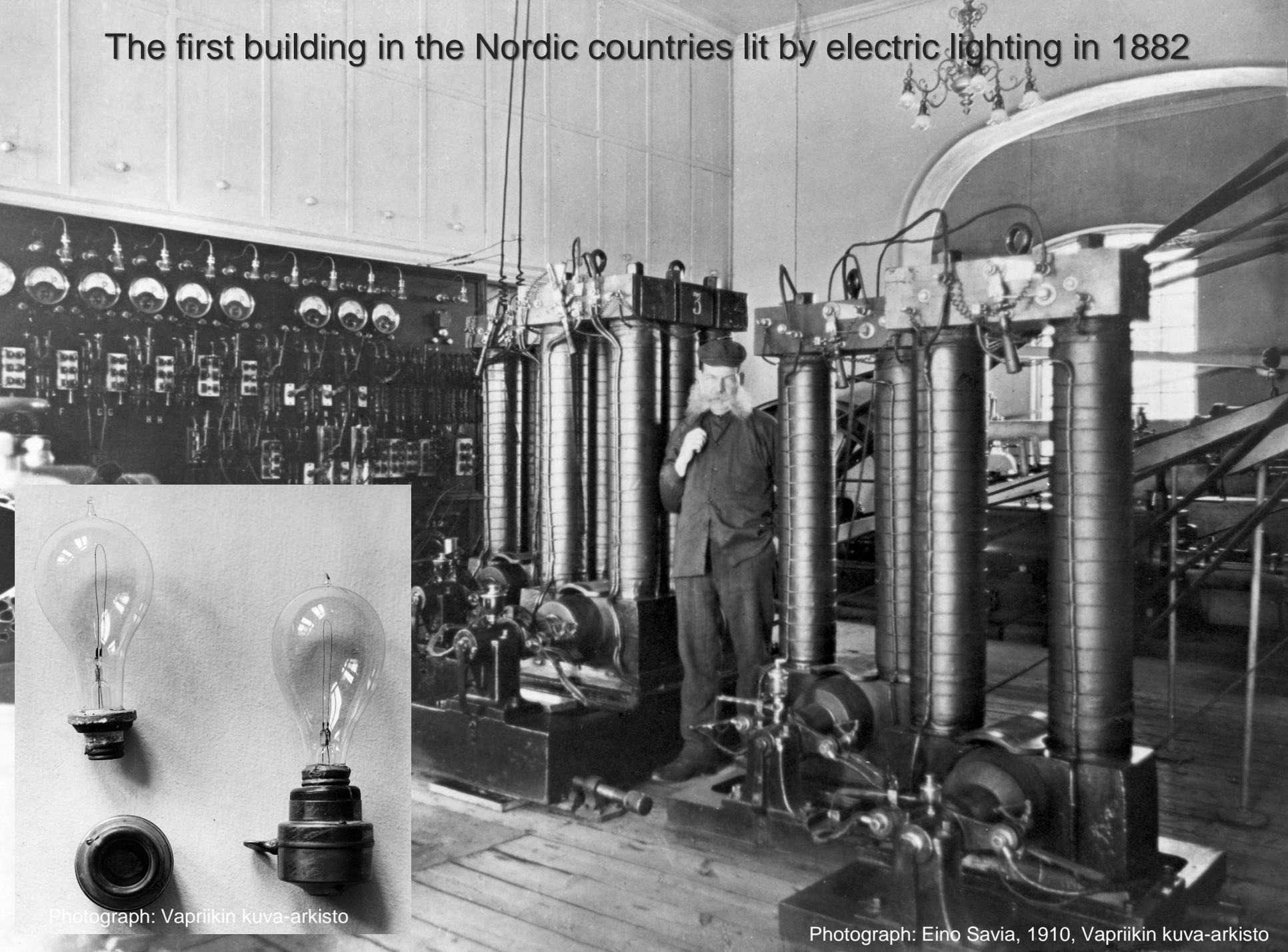


# The first building in the Nordic countries lit by electric lighting in 1882



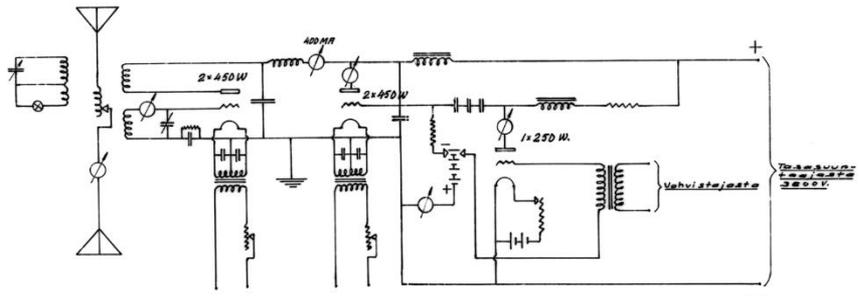
Photograph: Vapriikin kuva-arkisto

Photograph: Eino Savia, 1910, Vapriikin kuva-arkisto

# The first radio broadcast station in Finland in 1923 and 1924



*Tampereen Radio.  
Koskenrannan asema.*





Did they have any EMI problems?



# Effects of NATO membership on EMC requirements management in Finnish Defense Forces

KOTEL EMC seminar  
5<sup>th</sup> of February 2025, Tampere

Lt Col (Eng.) Lic.sc (Tech) Janne Pulkkinen  
Technical Chief, Electronics and C4I Systems (land based)  
Finnish Defence Forces, Joint Systems Centre

This presentation is based on public information and documents available online from internet, see list of sources on the slide number #32 of this presentation.





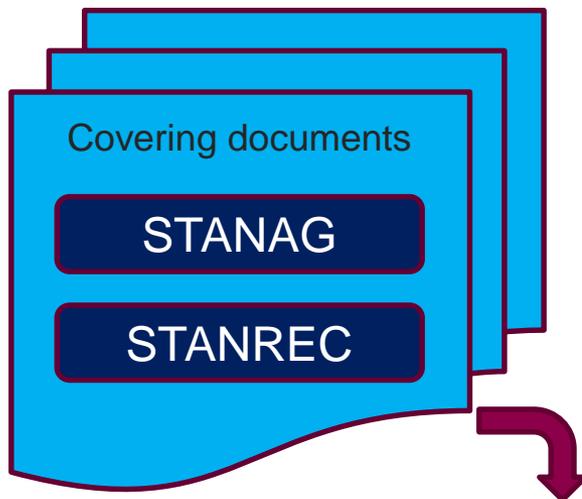
# OUTLINE

1. NATO Standardization Documents
2. NATO Standardization Document Development Process
3. NATO Standardization Office
4. STANAG 4370
5. AECTP-250
6. AECTP-500
  - Category 500 – Introduction to Electromagnetic Environmental Tests and Verification, Example
  - Category 501 – Equipment & Sub System EMI Testing
  - Category 507 – Land Platform and System Verification And Testing, Example
7. New STANAGs and new versions of AECTP-250 and 500
8. Effects of NATO membership on EMC requirements management in Finnish Defence Forces - Conclusions





# NATO Standardization Documents

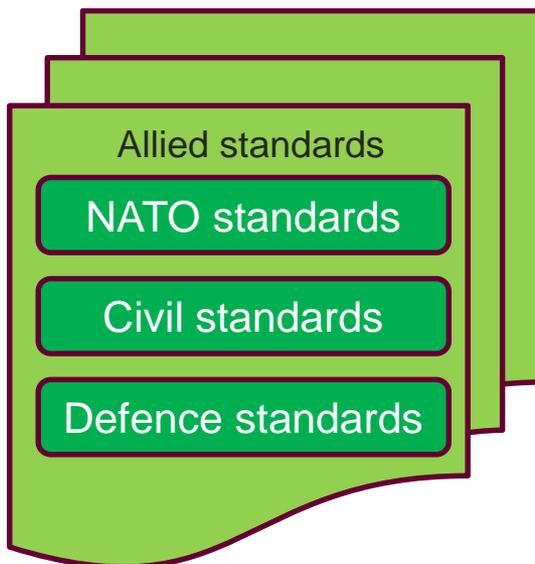


## NATO Standardization Agreement (STANAG)

A Standardization Agreement is a NATO standardization document that specifies the agreement of member nations to implement a standard, in whole or in part, with or without reservation, in order to meet an interoperability requirement.

## NATO Standardization Recommendation (STANREC)

A STANREC is a NATO standardization document used exclusively in the materiel field of standardization that lists one or several NATO or non-NATO standards relevant to a specific Alliance activity unrelated to interoperability.



## Allied Standards

Allied standards are standards developed or selected in the framework of the NATO standardization process.

A.....PAllied .... Publication

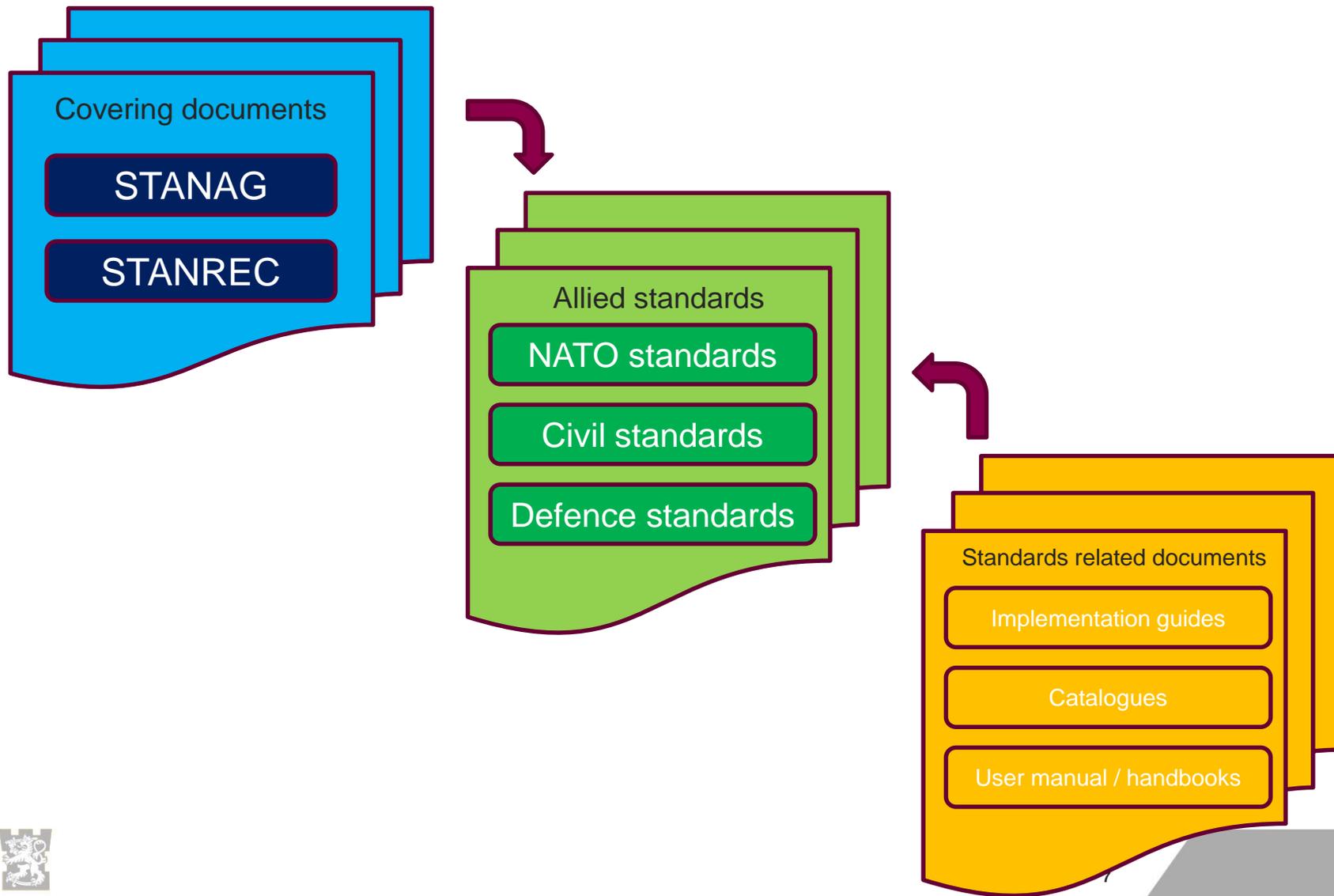
IEC, IEEE, CISPR

MIL, DEF-STAN, VG





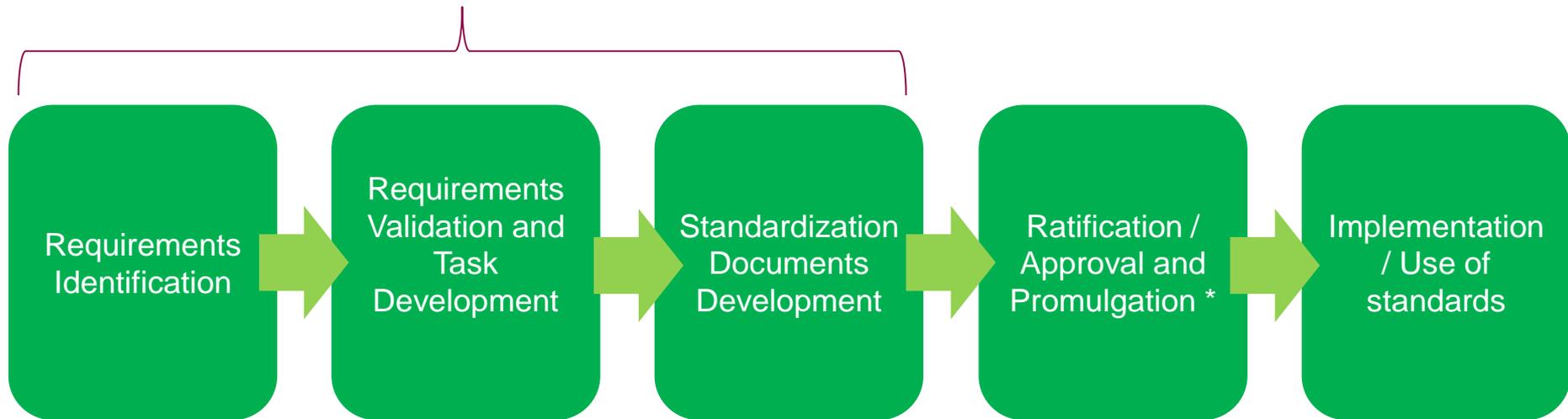
# NATO Standardization Documents





# NATO Standardization Document Development Process

Working Groups, Actions Teams (for example E3 Action Team)



## Ratification responses

1. Ratifying and implementing
2. Ratifying and implementing – with reservations
3. Ratifying, future implementation
4. Ratifying, future implementation – with reservations
5. Not ratifying
6. Not participating



\* STANAG – Ratification  
STANREC – Approval



# NATO Standardization Office

Go to [nso.nato.int](https://nso.nato.int)

https://nso.nato.int/nso/home/main/home



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05 July 2024

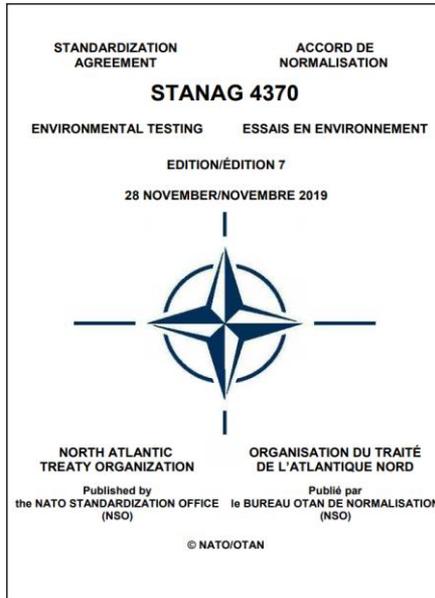
On 1 July 2024, Major General Thierry POULETTE (France - Army) assumed responsibilities of Director, NATO Standardization Office...

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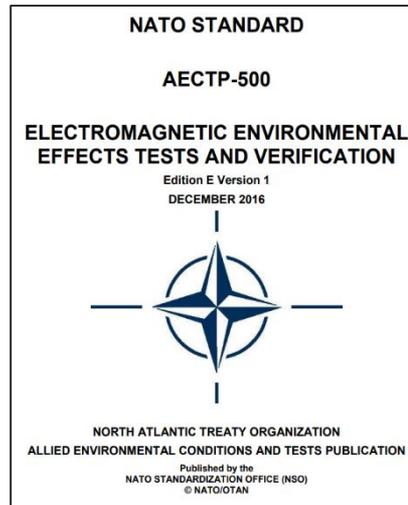
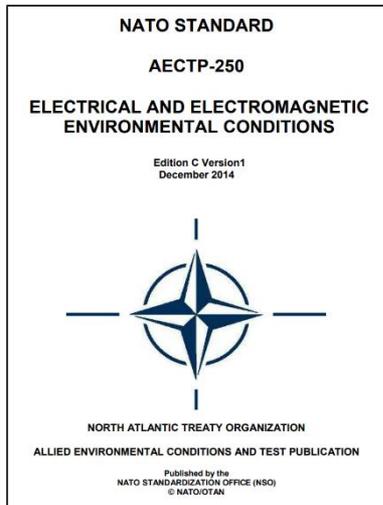
# STANAG 4370



## NATO Standardization Agreement STANAG 4370 ENVIRONMENTAL TESTING

### INTEROPERABILITY REQUIREMENTS

Acceptance the series of Allied Environmental Conditions and Test Publications (AECTP) which give guidelines on the management of environmental testing of defence materiel, to characterise environments and to standardise environmental testing processes.



### Allied Standards

Allied Environmental Conditions and Test Publication (AECTP)

- AECTP-100
- AECTP-200
- AECTP-230
- AECTP-240
- AECTP-250**
- AECTP-300
- AECTP-400
- AECTP-500**
- AECTP-600

Electromagnetic Environmental Standards





# STANAG 4370 Standardization Documents on NSO Website

Search for Standards

**BASIC SEARCH**

**Search in**

All  
 Covering Documents  
 Allied Standards  
 Standards Related Documents

**Search by**  
 Cover numbers, short and long titles (English)

**Status**  
 Active Documents  
 Language:  English  French

**Sponsor**  
 Tasking Authority

Delegated Tasking Authority

Group

Sub Group

Sub Sub Group

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Item No	Doc. Type	Short Title  (Std)	Long Title / Link To Document (if available)	Status	Sponsor
1	Cov	STANAG 4370 Ed. 7	ENVIRONMENTAL TESTING - AECTP-100 - 600	PROMULGATED	CNAD, AC/327 LCMG, WG/6
	Std	AECTP-100 Ed. E Ver. 1	ENVIRONMENTAL GUIDELINES FOR DEFENCE MATERIEL	PROMULGATED	CNAD, AC/327 LCMG, WG/6
	Std	AECTP-200 Ed. 4	ENVIRONMENTAL CONDITIONS	PROMULGATED	CNAD, AC/327 LCMG, WG/6
	Std	AECTP-230 Ed. 1	CLIMATIC CONDITIONS	PROMULGATED	CNAD, AC/327 LCMG, WG/6
	Std	AECTP-240 Ed. 1	MECHANICAL CONDITIONS	PROMULGATED	CNAD, AC/327 LCMG, WG/6
	Std	AECTP-250 Ed. C Ver. 1	ELECTRICAL AND ELECTROMAGNETIC ENVIRONMENTAL CONDITIONS	PROMULGATED	CNAD, AC/327 LCMG, WG/6
	Std	AECTP-300 Ed. D Ver. 1	CLIMATIC ENVIRONMENTAL TESTS	PROMULGATED	CNAD, AC/327 LCMG, WG/6
	Std	AECTP-400 Ed. D Ver. 1	MECHANICAL ENVIRONMENTAL TESTS	PROMULGATED	CNAD, AC/327 LCMG, WG/6
	Std	AECTP-500 Ed. E Ver. 1	ELECTROMAGNETIC ENVIRONMENTAL EFFECTS TESTS AND VERIFICATION	PROMULGATED	CNAD, AC/327 LCMG, WG/6
	Std	AECTP-600 Ed. 2	THE TEN STEP METHOD FOR EVALUATING THE ABILITY OF MATERIEL TO MEET EXTENDED LIFE REQUIREMENTS AND ROLE AND DEPLOYMENT CHANGES	PROMULGATED	CNAD, AC/327 LCMG, WG/6

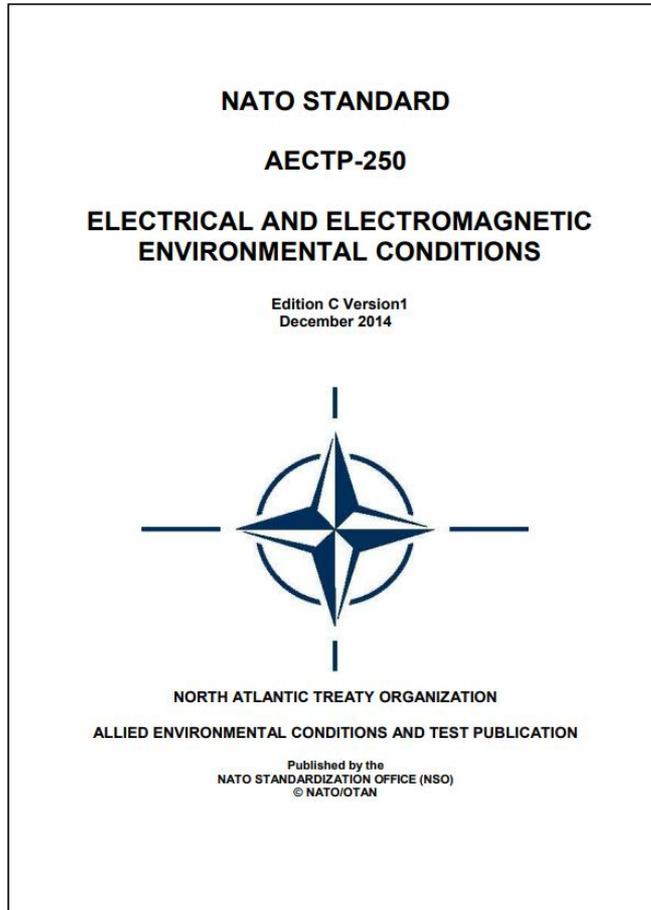
<< < 1 > >> 50

1 - 1 of 1 entries





# AECTP-250



253 pages

## AECTP-250 ELECTRICAL AND ELECTROMAGNETIC ENVIRONMENTAL CONDITIONS

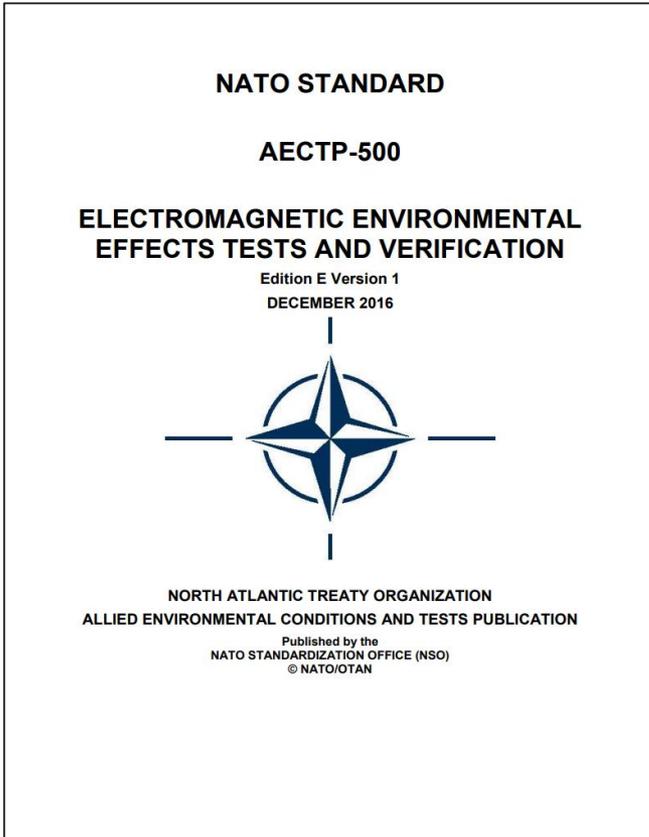
1. The purpose of the **AECTP 250 series of leaflets** is to present characteristics and sources for electrical and electromagnetic conditions that influence the design and operation of defence materiel.
2. This series of leaflets provides sufficient data on electrical and electromagnetic conditions for an item of defence materiel which, when used in conjunction with AECTP 500, should facilitate the development of a comprehensive and cost effective set of electrical/electromagnetic environmental definitions and tests in response to project requirements.

- Leaflet 252** – Radio Frequency (RF) Ambient Environments
- Leaflet 253** – Electrostatic Charging, Discharge and Precipitation Static (P-Static)
- Leaflet 254** – Atmospheric Electricity and Lightning
- Leaflet 255** – Direct Current (DC) Magnetic and Low Frequency (LF) Fields
- Leaflet 256** – Nuclear Electromagnetic Pulse (NEMP/EMP)
- Leaflet 257** – High Power Microwave (HPM)
- Leaflet 258** – RF Electromagnetic Environments (EMEs)
- Leaflet 259** – Intra-System EMEs – Electrical Power Quality





# AECTP-500



1125 pages

## AECTP-500 ELECTROMAGNETIC ENVIRONMENTAL EFFECTS TESTS AND VERIFICATION

The documents in AECTP 500 contain Electromagnetic Environmental Effects (E3) test requirements and procedures necessary to ensure military Platforms, Systems, Subsystems, and Equipment have been designed for Electromagnetic Compatibility (EMC) and evaluated to verify, by test, analysis, or modeling and simulation as appropriate, that the desired performance requirements will be met when subjected to the Electromagnetic Environment (EME). In doing so, AECTP 500 establishes E3 interface requirements and verification criteria for airborne, sea, space, and land systems, including associated ordnance.

**Category 500** – Introduction to Electromagnetic Environmental Tests and Verification

**Category 501** – Equipment and Subsystem Testing

**Category 502** – Man-Worn and Man-Portable Equipment Testing

**Category 503** – Support Equipment Testing

**Category 504** – Introduction to Platform and System Verification and Testing

**Category 505** – Air Platform and System Verification and Testing

**Category 506** – Sea Platform and System Verification and Testing

**Category 507** – Land Platform and System Verification and Testing

**Category 508** – Ordnance/Munitions Verification and Testing

**Category 509** – Space

**Category 510** - Miscellaneous





# AECTP-500 Subcategories

## Category 500 – Introduction to Electromagnetic Environmental Tests and Verification

Category 501 – Equipment and Subsystem Testing



Category 502 – Man-Worn and Man-Portable Equipment Testing



Category 503 – Support Equipment Testing



Category 505 – Air Platform and System Verification and Testing



Category 506 – Sea Platform and System Verification and Testing



Category 507 – Land Platform and System Verification and Testing



## Category 504 – Introduction to Platform and System Verification and Testing

Category 508 – Ordnance/Munitions Verification and Testing



Category 509 – Space (reserved to cover the requirements for space (vehicles and terrestrial stations) in the future)





# **Category 500 – Introduction to Electromagnetic Environmental Tests and Verification**

## **Example**

### **Annex A Risk Assessment of COTS/MOTS Procurement**





# Risk Assessment of COTS/MOTS Procurement

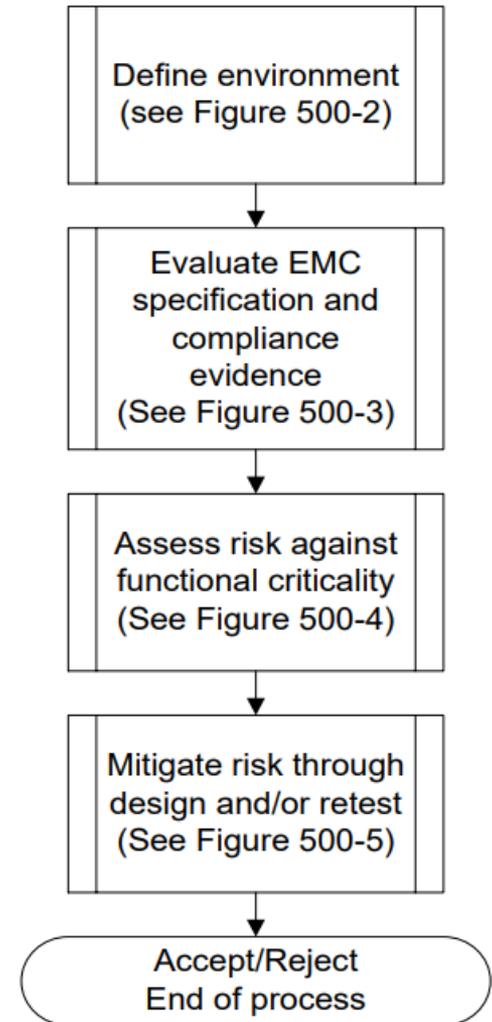
- Annex A of category 500 describes a risk assessment method for the use of commercial off-the-shelf products (COTS) products in military applications.
- This Annex A is a very useful part of the standard as the COTS products are typically much cheaper than the military off-the-shelf products and also in some cases appropriate military off-the-shelf products are not available. And nowadays, unlike in the past, COTS products typically offer also the latest technology.
- COTS products are obviously designed and tested to be used in much less demanding electromagnetic environment than the military off-the-shelf products. Electromagnetic compatibility requirements are very demanding in military electromagnetic environment where low emission and high immunity levels are required. This leads to risks which should be mitigated with appropriate method. The risk assessment method is one of the options.





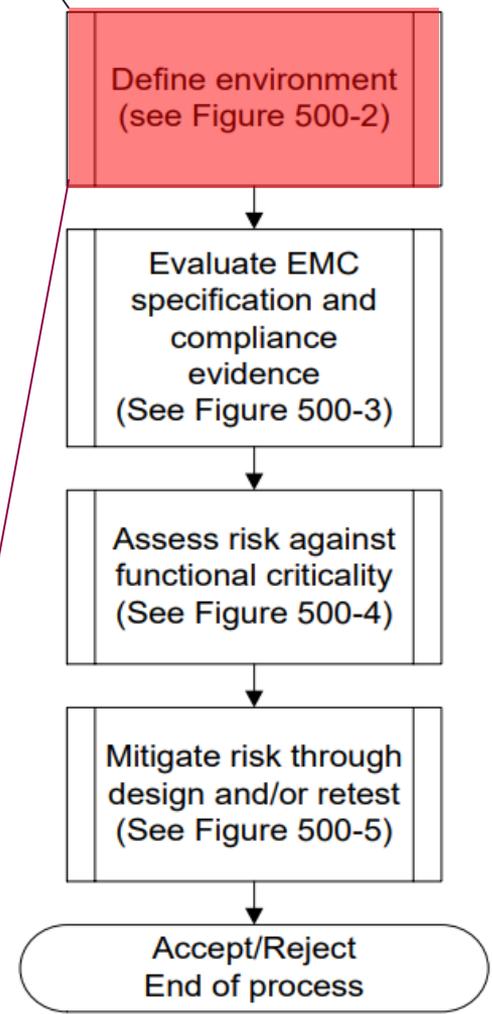
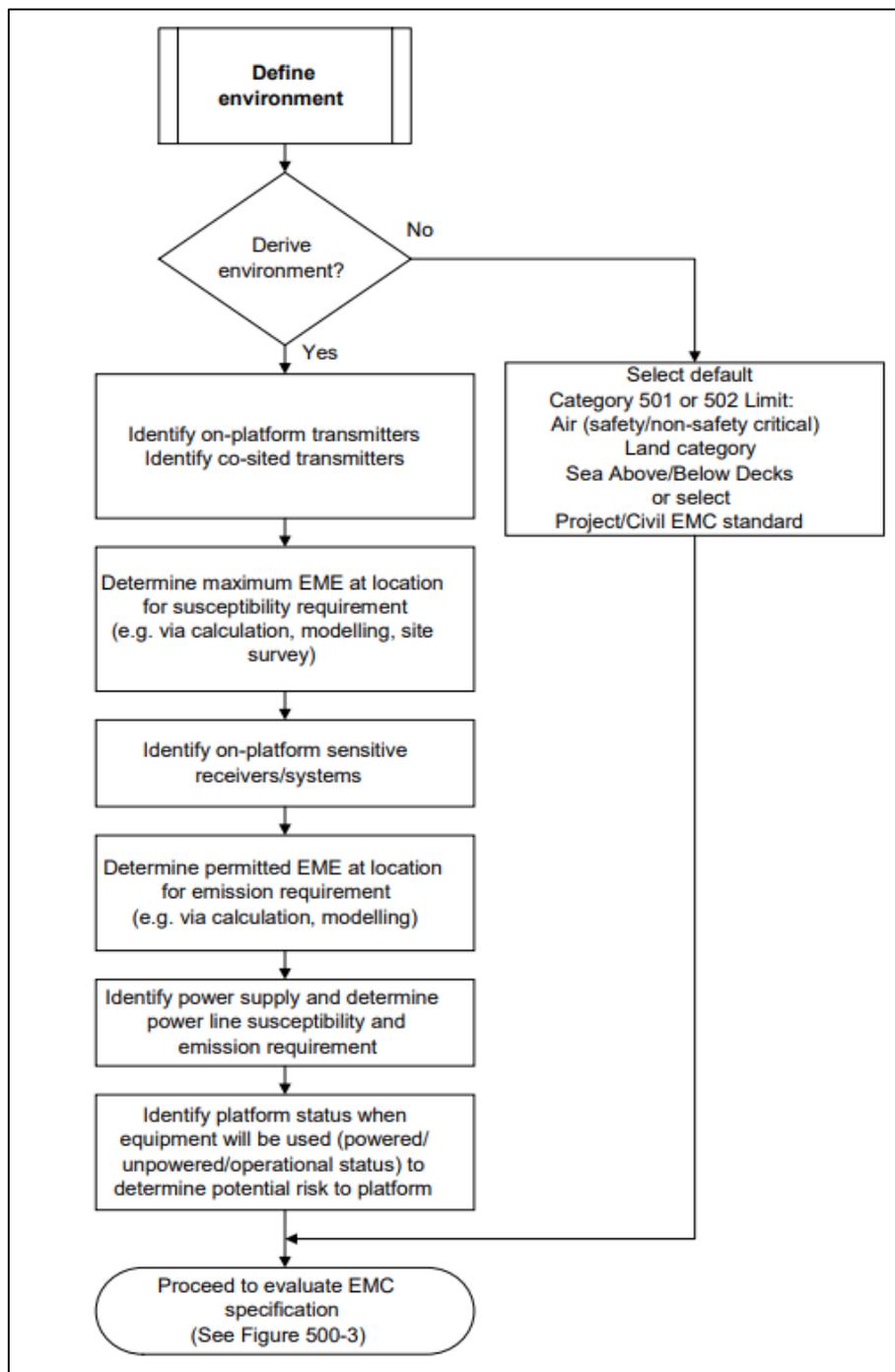
# Risk Assessment of COTS/MOTS Procurement

- Define the EME in which the equipment will be operated.
- Use default environment or derive a new one.
- Identify EMC standards to which equipment complies.
- List EMC tests that have been performed and perform a gap analysis (= comparison to AECTP requirements.)
- Score the resulting risk as Low, Medium or High.
- Identify whether equipment/platform is safety/mission critical or non-critical.
- Determine acceptability of risks and list unacceptable risks.
- Mitigate risk through design and/or retest.
- Modify equipment/installation EMC design.



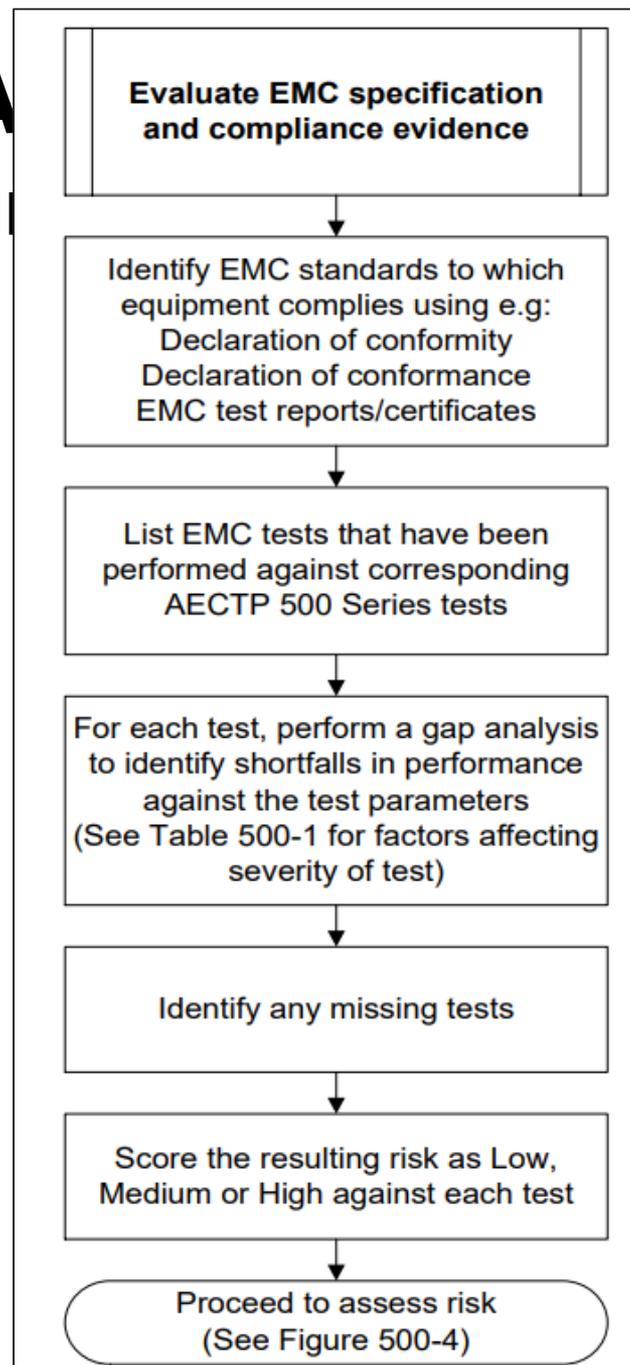


# OTS/MOTS

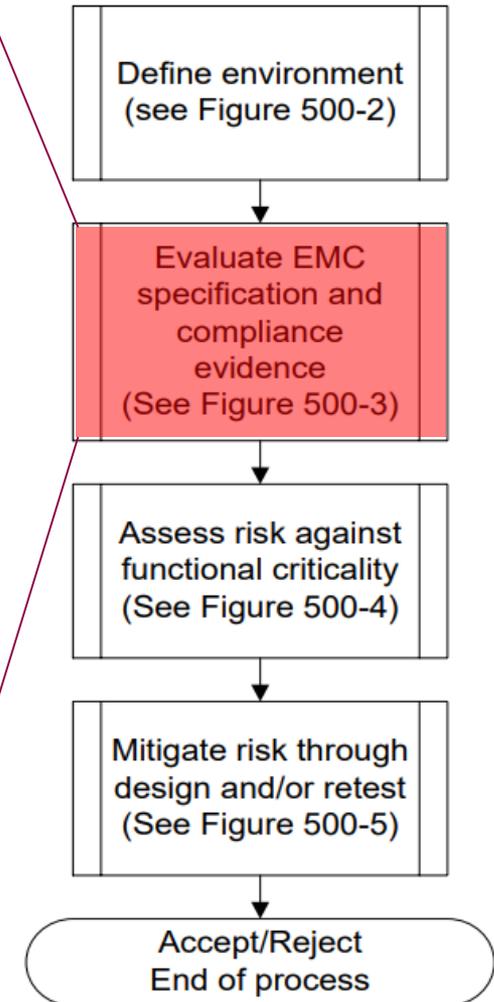




# Risk Assessment Procedure

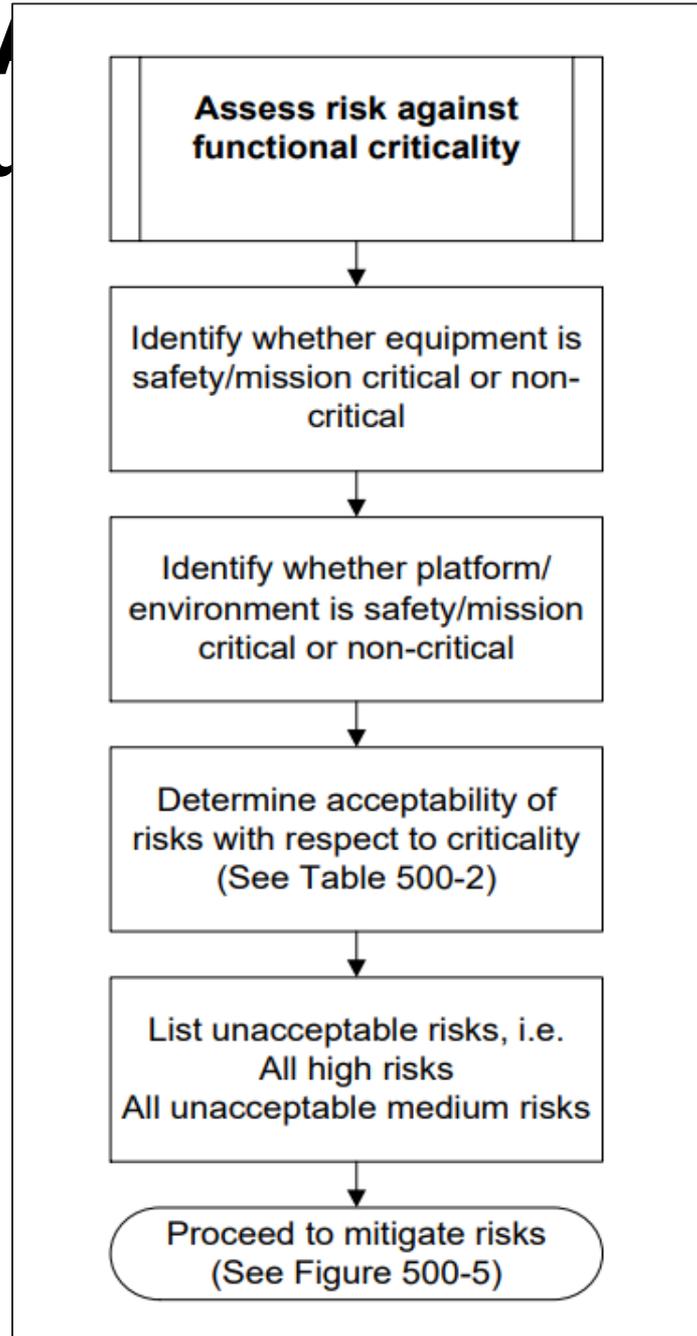


# DTS/MOTS

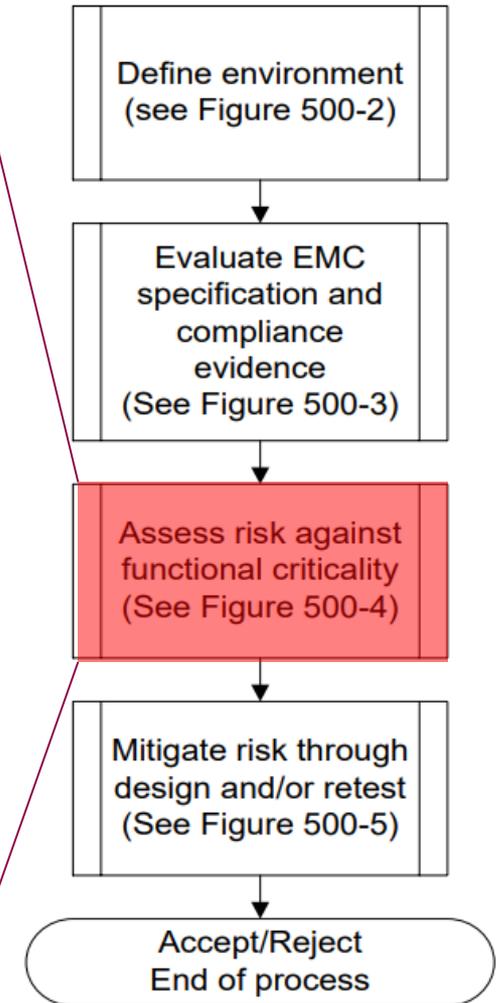




# Risk Assessment Procedure

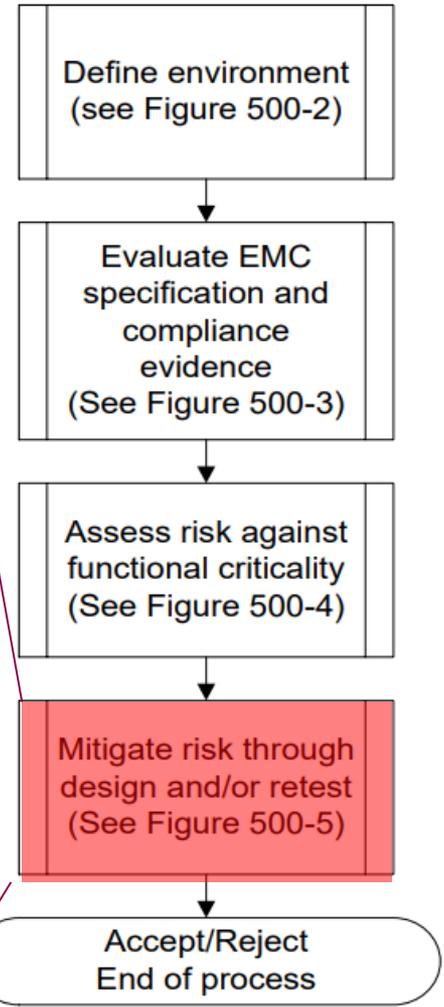
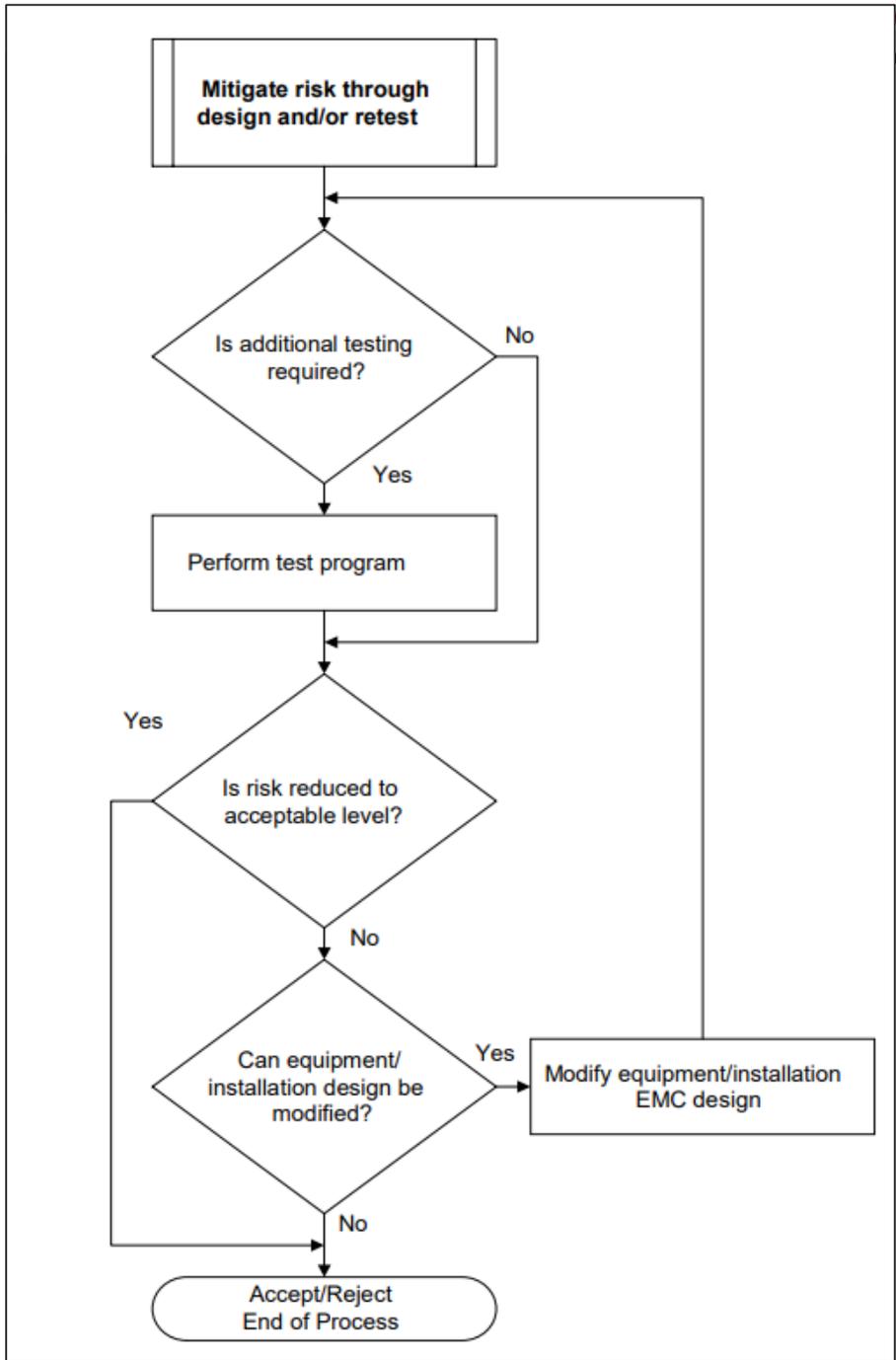


# TS/MOTS





# TS/MOTS





# Risk Assessment of COTS/MOTS Procurement

- The described risk assessment method and process is quite laborious and time consuming. It is not an easy task! Sometimes it may be easier to just buy military equipment instead of COTS equipment.
- We have tailored and used this method for example in our SQ2020 project and have some experience and proposals for further development.
  - Method should be scalable which means that the method can be used in case of one single stand-alone equipment and also in case of a complex subsystem as part of a larger installation.
  - Method should be more numerical which means that new elements with necessary numerical parameters (probabilities etc.) should be included and applied in the risk assessment.
  - Available statistical data should be used in risk assessment (see for example my article “Statistical analysis of MIL-STD-461 emission test reports of commercial off-the-shelf products”).





# Category 501 – Equipment & Sub System EMI Testing





# Category 501 – Equipment and Subsystem Testing

- Emission and Susceptibility Requirements

Requirement	Description	Test derived from
NCE01	Conducted Emissions, Power Leads, 30 Hz to 10 kHz	Mil Std 461
NCE02	Conducted Emissions, Power Leads, 10 kHz to 10 MHz	Mil Std 461
NCE03	Conducted Emissions, Antenna Terminal, 10 kHz to 40 GHz	Mil Std 461
NCE04	Conducted Emissions, Exported Transients on Power Leads	Def Stan 59-411
NCE05	Conducted Emissions, Power, Control & Signal Leads, 30 Hz to 150 MHz	Def Stan 59-411
NCS01	Conducted Susceptibility, Power Leads, 30 Hz to 150 kHz	Mil Std 461
NCS02	Conducted Susceptibility, Control & Signal Leads, 20 Hz to 50 kHz	Def Stan 59-411
NCS03	Conducted Susceptibility, Antenna Port, Intermodulation, 15 kHz to 10 GHz	Mil Std 461
NCS04	Conducted Susceptibility, Antenna Port, Rejection of Undesired Signals, 30 Hz to 20 GHz	Mil Std 461
NCS05	Conducted Susceptibility, Antenna Port, Cross Modulation, 30 Hz to 20 GHz	Mil Std 461

NCS06	Conducted Susceptibility, Structure Current, 60 Hz to 100 kHz	Mil Std 461
NCS07	Conducted Susceptibility, Bulk Current Injection, 10 kHz to 200 MHz	Mil Std 461
NCS08	Conducted Susceptibility, Bulk Current Injection, Impulse Excitation	Mil Std 461
NCS09	Conducted Susceptibility, Damped Sinusoidal Transients, Cables and Power Leads, 10 kHz to 100 MHz	Mil Std 461
NCS10	Conducted Susceptibility, Imported Lightning Transient (Aircraft/Weapons)	Def Stan 59-411
NCS11	Conducted Susceptibility, Imported Low Frequency on Power Leads (Ships)	Def Stan 59-411
NCS12	Conducted Susceptibility, Electrostatic Discharge	Def Stan 59-411
NCS13	Conducted Susceptibility, Transient Power Leads	Mil Std 461
NRE01	Radiated Emissions, Magnetic Field, 30 Hz to 100 kHz	Mil Std 461
NRE02	Radiated Emissions, Electric Field, 10 kHz to 18 GHz	Mil Std 461
NRE03	Radiated Emissions, Antenna Spurious and Harmonic Outputs, 10 kHz to 40 GHz	Mil Std 461
NRS01	Radiated Susceptibility, Magnetic Field, 30 Hz to 100 kHz	Mil Std 461
NRS02	Radiated Susceptibility, Electric Field, 2 MHz to 40 GHz	Mil Std 461 / Def Stan 59-411
NRS03	Radiated Susceptibility, Transient Electromagnetic Field	Mil Std 461
NRS04	Radiated Susceptibility, Magnetic Field, (DC)	Def Stan 59-411

- About 70 percent of the requirements are based on and derived from MIL-STD-461
- About 30 percent of the requirements are based on and derived from Def-Stan 59-411





# Category 501 – Equipment and Subsystem Testing

- Requirement Matrix

Equipment and Subsystems installed in, on, or launched from the following Platforms	Requirement Applicability																								
	NCE01	NCE02	NCE03	NCE04	NCE05	NCS01	NCS02	NCS03	NCS04	NCS05	NCS06	NCS07	NCS08	NCS09	NCS10 *	NCS11 *	NCS12	NCS13	NRE01	NRE02	NRE03	NRS01	NRS02	NRS03	NRS04
Land	-	Y	P	Y	Y	Y	Y	P	P	P	-	Y	Y	Y	-	-	Y	-	Y	Y	P	Y	Y	P	-
Sea	P	Y	P	Y	Y	Y	Y	P	P	P	-	Y	P	Y	-	Y	P	-	Y	Y	P	Y	Y	P	Y
Submarines	Y	Y	P	Y	Y	Y	Y	P	P	P	P	Y	P	Y	-	Y	P	Y	Y	Y	P	Y	Y	P	Y
Air	Y	Y	P	Y	Y	Y	Y	P	P	P	-	Y	Y	Y	Y	-	Y	-	Y	Y	P	Y	Y	P	-
Space Systems, Including Launch Vehicles	-	Y	P	-	-	Y		P	P	P	-	Y	Y	Y	-	-	-	-	-	Y	P	-	Y	-	-

Key: Y Test is required for all equipment on this platform type.

P Test is partially applicable. Selection of the test should be based on knowledge of the installation and other co-located equipment's based on guidance for each test method given in **Clause 3.7**. These tests may also be specified / selected by the NAA.

\* NCS10 and NCS11 only applicable to GBR.

No entry in the table means the test is not applicable to equipment on/in that service/platform.



# Category 501 – Equipment and Subsystem Testing

- Requirement Matrix of AECTP-500 vs Requirement Matrix of MIL-STD-461G

CE106	CS101	CS103	CS104	CS105	CS109	CS114	CS115	CS116	CS118	RE101	RE102	RE103	RS101	RS103	RS105
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Equipment and Subsystems installed in, on, or launched from the following Platforms	Requirement Applicability																								
	NCE01	NCE02	NCE03	NCE04	NCE05	NCS01	NCS02	NCS03	NCS04	NCS05	NCS06	NCS07	NCS08	NCS09	NCS10 *	NCS11 *	NCS12	NCS13	NRE01	NRE02	NRE03	NRS01	NRS02	NRS03	NRS04
Land	-	Y	P	Y	Y	Y	Y	P	P	P	-	Y	Y	Y	-	-	Y	-	Y	Y	P	Y	Y	P	-
Sea	P	Y	P	Y	Y	Y	Y	P	P	P	-	Y	P	Y	-	Y	P	-	Y	Y	P	Y	Y	P	Y
Submarines	Y	Y	P	Y	Y	Y	Y	P	P	P	P	Y	P	Y	-	Y	P	Y	Y	Y	P	Y	Y	P	Y
Air	Y	Y	P	Y	Y	Y	Y	P	P	P	-	Y	Y	Y	Y	-	Y	-	Y	Y	P	Y	Y	P	-
Space Systems, Including Launch Vehicles	-	Y	P	-	-	Y		P	P	P	-	Y	Y	Y	-	-	-	-	-	Y	P	-	Y	-	-

Key: Y Test is required for all equipment on this platform type.  
 P Test is partially applicable. Selection of the test should be based on knowledge of the installation and other co-located equipment's based on guidance for each test method given in **Clause 3.7**. These tests may also be specified / selected by the NAA.

\* NCS10 and NCS11 only applicable to GBR.

No entry in the table means the test is not applicable to equipment on/in that service/platform.

Equipment and Subsystems Installed In, On, or Launched From the Following Platforms or Installations	Requirement Applicability																		
	CE101	CE102	CE106	CS101	CS103	CS104	CS105	CS109	CS114	CS115	CS116	CS117	CS118	RE101	RE102	RE103	RS101	RS103	RS105
Surface Ships	A	A	L	A	S	L	S	L	A	S	A	L	S	A	A	L	L	A	L
Submarines	A	A	L	A	S	L	S	L	A	S	L	S	S	A	A	L	L	A	L
Aircraft, Army, Including Flight Line	A	A	L	A	S	S	S		A	A	A	L	A	A	A	L	A	A	L
Aircraft, Navy	L	A	L	A	S	S	S		A	A	A	L	A	L	A	L	L	A	L
Aircraft, Air Force		A	L	A	S	S	S		A	A	A	L	A		A	L		A	
Space Systems, Including Launch Vehicles		A	L	A	S	S	S		A	A	A	L			A	L		A	
Ground, Army		A	L	A	S	S	S		A	A	A	S	A		A	L	L	A	
Ground, Navy		A	L	A	S	S	S		A	A	A	S	A		A	L	L	A	L
Ground, Air Force		A	L	A	S	S	S		A	A	A		A		A	L		A	

Legend:  
 A: Applicable  
 L: Limited as specified in the individual sections of this standard.  
 S: Procuring activity must specify in procurement documentation.





# Category 501 – Equipment and Subsystem Testing

- Equipment and subsystem testing according to AECTP-500 Category 501 is quite close to testing according to MIL-STD-461G.
- There are small differences in requirement applicability and in terms and definitions.
- If your equipment or subsystem fulfils MIL-STD-461G requirements, in most of the cases you can say that your equipment or subsystem fulfils AECTP-500 requirements.
- Even AECTP-500 has existed several years, still most of the military equipment and subsystems manufacturers specify their products according to MIL-STD-461G.





# **Category 507 – Land Platform and System Verification And Testing**

## **Example**

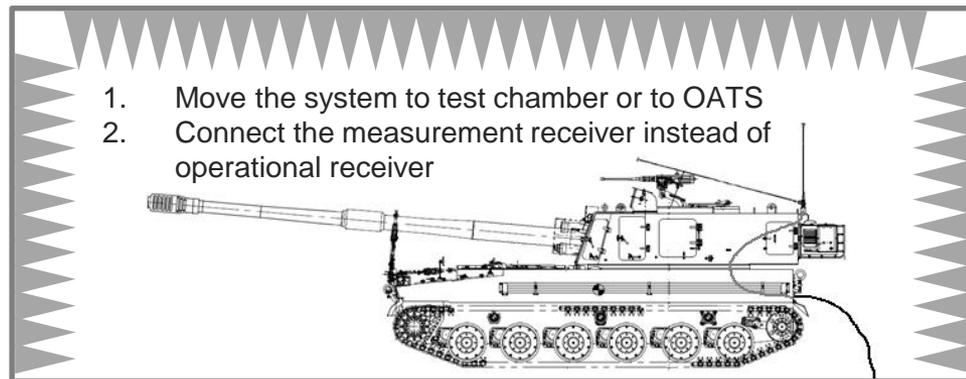
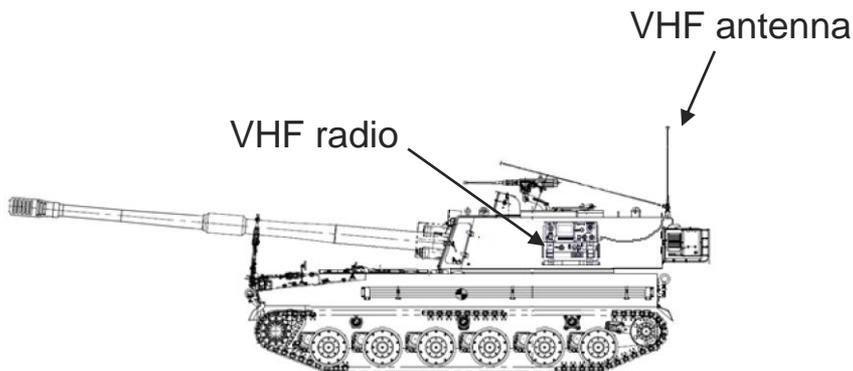
**NRE04S Disturbing Voltage Levels at Installed Antenna Ports, System**





# Category 507 – Land Platform and System Verification and Testing

- NRE04S Disturbing Voltage Levels at Installed Antenna Ports, System



1. Move the system to test chamber or to OATS
2. Connect the measurement receiver instead of operational receiver

EMI TEST RECEIVER



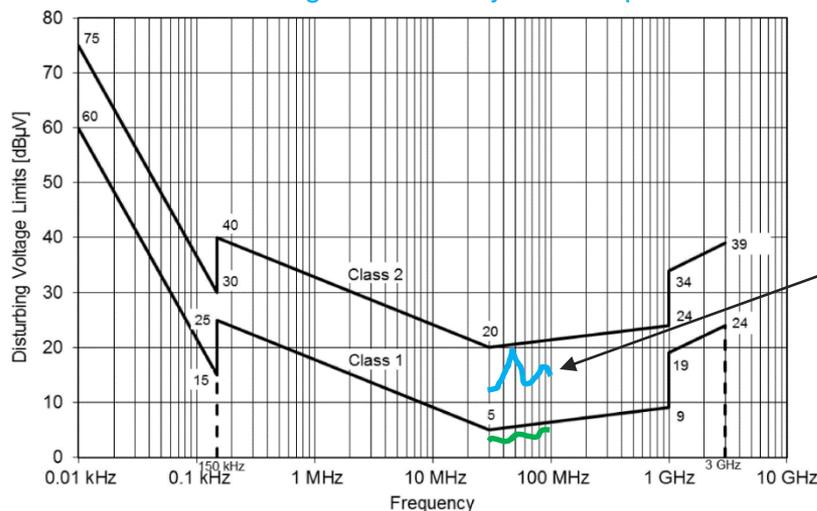
3. Set receiver settings according to standard

- Frequency span
- Peak detector
- RBW
- Measurement time

Frequency band	Measurement time
150 kHz – 30 MHz	1,5 s / MHz
30 MHz – 1 GHz	0,15 s / MHz
> 1 GHz	15 s / GHz

Frequency band	6 dB RBW
150 kHz – 30 MHz	10 kHz
30 MHz – 1 GHz	100 kHz
> 1 GHz	1 MHz

4. Measure ambient voltage level (system off)
5. Measure voltage level with system in operational mode



6. Compare results to standard requirements





# New STANAGs and new versions of AECTP-250 and 500

- The STANAG 4370 will be split to four different parts in the near future
  - STANAG 4370 - Environmental Testing covers AECTP-100 and 600
  - STANAG XXXX - Climatic Environmental Conditions and Test Methods covers AECTP-230 and 300
  - STANAG XXXX - Mechanical Environmental Conditions and Test Methods covers AECTP-240 and 400
  - STANAG XXXX - Electrical and Electromagnetic Environmental and Test Methods covers AECTP-250 and 500.
- Finland's ratification response for the above mentioned new STANAGs is currently in process and we will carefully go through the documents. It is very assumable that the response will include reservations and transition period is needed in the implementation.





# Effects of NATO membership on EMC requirements management in Finnish Defence Forces - Conclusions

- There is a "pressure" to ratify and implement the STANAG covering the AECTP-250 and AECTP-500 in Finland. This means that
    - In the future we are going to more and more refer to the AECTP standards in our system requirements
    - Finnish Defence Forces is going to be more active member in NATO E3 Action Team (E3AT) which is responsible for AECTP-250 and 500 development.
  - The defence market is now more open to Finnish industry as Finland is "full member" of NATO.
- Industry and test laboratories should familiarize themselves with AECTP-250 and 500 standards.





# List of Sources

1. NATO Standardization Documents Development Process (<https://www.dsp.dla.mil/Portals/26/Documents/Publications/Conferences/2018/2018%20International%20Standardization%20Workshop/20181031-Item1-NATOStandardizationProcess-IntlStdznWorkshop-NSO.pdf?ver=2018-11-06-151839-517>)
2. NATO terminology (<https://nso.nato.int/natoterm/Web.mvc>)
3. NATO STANDARD AECTP-250 Electrical and Electromagnetic Environmental Conditions, Edition C Version 1 December 2014
4. NATO STANDARD AECTP-500 Electromagnetic Environmental Effects Tests and Verification, Edition E Version 1 December 2016
5. J. P. Pulkkinen, “Statistical analysis of MIL-STD-461 emission test reports of commercial off-the-shelf products” in Proc. of the 2019 International Symposium on Electromagnetic Compatibility (EMC Europe 2019), Barcelona, Spain, September 2–6, 2019., pp. 410–415, 2019.
6. MIL-STD-461G, Department of Defense Interface Standard. Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, December 2015.



Thank you! Any questions?

