Expert Group 08
Environmental Testing

Final Report

Brussels, 1st of December 2022

Recommendations on best practice standards for Environmental Testing

Record of changes

Date	Issue	Changes
2010/03/01	V1	First Final Report after CEN WS10
2015	V2	Update for EDSTAR
2022/12/01	V3	Update for EDSTAR

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Content

1 Introduction

Initially, the European Commission requested the European Committee for Standardisation (CEN) to establish the "Workshop 10" (CEN/WS10) for improving the efficiency and enhance the competitiveness of European Defence Industry. As a result, the European Handbook for Defence Procurement (EHDP) was developed by Experts Groups and reported to CEN Workshop 10. This former document was a guide designed as a tool for anyone involved in the European defence procurement contractual negotiations. The primary target audiences for the Handbook were:

- The staff in the ministries of defence who are producing procurement specifications and tenders' calls and invitations;
- The staff in defence companies who are responding to those requirements;
- The EHDP is designed by the CEN Workshop 10 to provide Defence Procurement Agencies and Defence;
- Industries with a preferential list of selected recommended standards qualified as best practices. Best practice's with purpose to be included in armament contracts together with concise recommendations for an optimum use of those standards in such a Defence Procurement context;
- Those types of resulting informative data could be used in the acquisition process by ministries of defence (MoD) and in the development process by Industry such that system will be built faster, better and cheaper.

The Handbook provided recommendations to develop good practices in the domain addressed by the Expert Group and to assist the final user in utilizing selected best practices standards in the best cost-effective way, aiming at:

- Increasing the controlled use of existing standardisation, a necessity to harmonise European practices used by defence procurement stakeholders;
- The objective to deploy a common approach through Nations Procurement agencies about an optimized utilization of standards: civil ones and military ones, the possible limitations of civilian standards with respect to military applications, etc.;
- To provide a useful guide to all stakeholders involved in defence procurement process;
- Description of how to implement standard s successfully in armament contracts;
- The overall result will be a better use of standards in armament contracts.

In 2012 the EHDP became the European Defence Standardisation Reference (EDSTAR) under responsibilities of the European Defence Agency (EDA). EDA manage the work of experts' groups selection in order to maintain the EDSTAR database updated and continuously make it as close as possible to the need of the users. The EDSTAR public website contain the entire document selected as European "best practices" recommendations. It is designed to provide to the final users the right information, allowing for timely and quickly acquiring the best control in writing procurement's clauses related to the European defence project.

Currently, based on the situation in 2022, EG 08 experts have reviewed the previously issued Final Report and list of "best practice" standards (BPS) for the EDSTAR Technical Domain "Environmental Testing" within the member states of the European Union. This document aims at providing recommendations on the best use selected BPS in armament contracts. The BPS here listed are

presented and commented as far as the reasons for its selection and the way of implementing them in contracts by a tailored approach.

2 References and Terminology

- IEV or International Electrotechnical Vocabulary is the standard IEC 60050. An online version is available at: https://www.electropedia.org/
- NATOTerm database: https://nso.nato.int/natoterm/Web.mvc

3 Scope

EDSTAR EG 08 has identified reference documents in the key area "**Environmental Testing**" used in the European defence sector. EDSTAR Environmental Testing domain scope comprises the selection process of horizontal standards, made considering 4 categories:

- Environmental Engineering Process
- Environmental Conditions
- Guidelines for Deriving Test Profiles
- Default or "Fall Back" Test Severities

The aim of Expert Group 08 is to identify and select "best practice" standards (BPS) in the EDSTAR Environmental Testing domain. Are excluded of EG 08 scope, standards and best practices in vertical environmental engineering developed for specific fields and technical domains, as they should be addressed in the concerned EDSTAR Expert Group or, are too specific in their application to be considered as horizontal. For example, specific ammunition testing is tackled by EDSTAR Expert Group 10 on Ammunition.

The subject of Electromagnetic Environment will not be dealt with, as this subject Is tackled by the EDSTAR Expert Group 07 on Electromagnetic Environment.

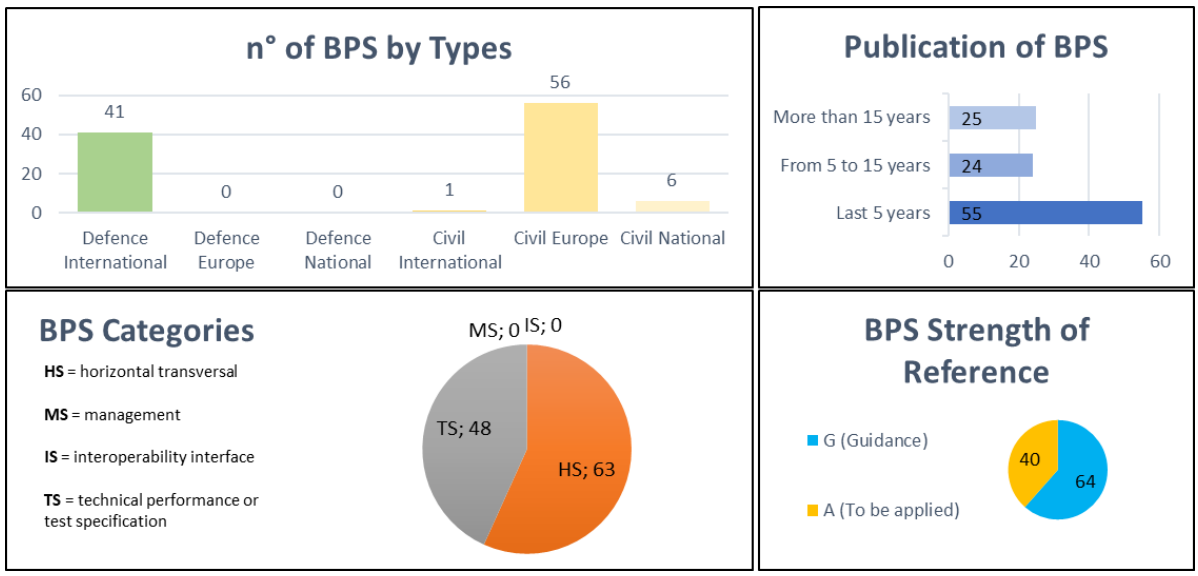
4 Rationale for selecting a standard/standards-like document as "Best Practice"

The work of this expert group followed the EDSTAR Expert Group Terms of Reference. Therefore the experts considered and reviewed the BPS based on the following steps:

- Identify all known standards that are of relevance for the given technical domain as the initial basic list for their selecting work;
- Benchmark the identified documents by applying the selection basic criteria mentioned under paragraph 3, comparing the identified standards with respect to their practical importance, including: technical excellence (stability and maturity), broadest audience, frequency of usage, availability, economic impact on European defence business, and influence on interoperability;
- The documents selection shall reflect the "state of the art" of knowledge and best practices in the service of European defence interests;
- Consider the documents of reference in defence (STANAG 4370) and civilian (EN IEC 60068) standardization;
- Select the BPS by consensus between the Experts Groups members;
- Include the rationale for the selection together with necessary advice for the application of the selected standard into the best practice's recommendations included in the reports by the expert group when delivering their final contributions;
- Propose way ahead for filling gaps identified during the expertise work.

5 Recommendations on application and tailoring of a standard

5.1 List of Best practices selected



5.2 Details about best practices standards selected

The selection of best practices standards has been made following the rationale depicted in sections 3 and 4 of this Report.

Previously in 2010, the consensus in this group was to make an exhaustive and representative analysis of the national practices and documents used throughout the industry and the military for Environmental Testing (for example: Def Stan 00-035 used in the UK, MIL-STD-810H used in the US).

For this current revision work, the choice was made across the references from both the military and civilian practices, with a choice of globally used references in Europe. They are declared here:

5.2.1 Environmental Guidelines for Defence Materiel (follows AECTP-100)

AECTP-100 contains the general introduction for the use of the complete series of AECTP-100 through 600. AECTP-100 also provides guidance on the management of the total environmental engineering task for materiel development projects.

The focus of this guidance is the environmental project tailoring process which can accommodate different methods of procurement and a range of test types including safety and reliability testing. The documentation that supports the management guidelines is also described.

Similarly, for the civilian standards EN IEC 60068-1 presents the guidance to use all the EN IEC 60068-2 test methods.

5.2.2 Environmental Conditions (follows AECTP-200 through 250)

AECTP-200 through 250, provide information and guidance on climatic, mechanical and electrical environments that materiel is exposed to during its life cycle. It describes conditions and data that have been compiled from established sources within NATO countries. Advice is given on the selection of suitable test methods used to derive test severities. Test procedures for the environments defined in AECTP-200 through 250 are presented in AECTP-300, AECTP-400 and AECTP-500.

5.2.3 Climatic Environmental Tests (follows AECTP 300)

AECTP-300 provides a series of climatic test methods for use during the design, development and qualification of materiel. The test methods are presented in a prescriptive style so that they can be readily invoked by the user. As far as has been possible the test methods included are those internationally agreed and published.

For each testing methodologies for each test, a table aligning references from the military and civilian standards are presented:

Specific Test	Defence document *(To be applied in procurement contracts)*	Civil document *(Used a civil guidance reference)*
Low Pressure (Altitude)	AECTP-300 Method 301: - Storage / Air Transportation - Operation / Air Carriage - Rapid Decompression - Explosive Decompression	EN 60068-2-13: Low air pressure
High Temperature	AECTP-300 Method 302: - High Temperature Storage or Transport - High Temperature Operation - High Temperature Tactical Standby to Operational	EN 60068-2-2: Dry Heat EN 60068-2-14: Change of temperature
Low Temperature	AECTP-300 Method 303: - Storage Test - Operational Test - Manipulation Test	EN 60068-2-1: Cold EN 60068-2-14: Change of temperature
Thermal Shock	AECTP-300 Method 304: - Shock from Constant Extreme Temperatures - Shock to/from Cyclic High Temperatures	EN 60068-2-14: Change of temperature
Solar Radiation	AECTP-300 Method 305 - Cycling (Thermal Effects) - Steady State (Actinic Effects)	EN 60068-2-5: - Simulated solar radiation at ground level - Guidance for solar radiation testing and weathering
Humid Heat	AECTP-300 Method 306 - Cycling - Steady State	EN 60068-2-30: Damp Heat, Cyclic (12h + 12h cycle) EN 60068-2-38 : Composite temperature / humidity cycle
Immersion	AECTP-300 Method 307 - Immersion - Fording	Sealing: EN 60068-2-17 Water: EN 60068-2-18
Mould Growth	AECTP-300 Method 308	Mould Growth: EN 60068-2-10
Salt Fog	AECTP-300 Method 309	Salt Mist: EN 60068-2-11 Salt Mist, Cyclic: EN 60068-2-52
Condensation and Drippproofness	AECTP-300 Method 310	EN 60068-2-18: Water
Rain and Water Tightness	AECTP-300 Method 310 - Rain and Blowing/Driving Rain - Exaggerated Rain - Drip	EN 60068-2-18: Water
Icing	AECTP-300 Method 311	
Sand and Dust	AECTP-300 Method 313 - Blowing Dust - Blowing Sand	EN 60068-2-68: Dust and Sand
Contamination by Fluids	AECTP-300 Method 314	EN 60068-2-74: Fluid contamination
Freeze Thaw	AECTP-300 Method 315 - Diurnal Cycling Effects - Cold-to-Warm Transfer - Rapid Temperature Change	
Explosive Atmosphere	AECTP-300 Method 316	

Temperature, Humidity Altitude	AECTP-300 Method 317 - Logistic Air Transport (stabilized conditions) - Tactical Air Carriage (cycling conditions)	EN 60068-2-39: Combined temperature or temperature and humidity with low air pressure EN 60068-2-40: Combined Cold / Low air pressure EN 60068-2-41: Combined Dry heat / Low air pressure
Acidic Atmosphere	AECTP-300 Method 319	EN 60068-2-60: Flowing mixed gas corrosion

5.2.4 Mechanical Environmental Test (follows AECTP-400)

AECTP-400 provides a series of mechanical test methods for use during the design, development and qualification of materiel. The test methods are presented in a prescriptive style so that they can be readily invoked by the user. As far as has been possible the test methods included are those internationally agreed and published.

For each testing methodologies for each test, a table aligning references from the military and civilian standards are presented:

Specific Test	Defence document *(To be applied in procurement contracts)*	Civil document *(Used a civil guidance reference)*
Vibration	AECTP-400 Method 401: Evaluate the effect of vibration environments that could arise during service life	EN 60068-2-6: Vibration (sinusoidal) EN 60068-2-57: Vibration - Time-history and sine-beat method EN 60068-2-64: Vibration, broadband random and guidance EN 60068-2-80 : Vibration - Mixed mode
Vibration *(Incl. combined with temperature and/or humidity)*	AECTP-400 Method 401	EN 60068-2-53: - Combined climatic (temperature/humidity) - Dynamic (vibration/shock)
Acoustic Noise	AECTP-400 Method 402: - Diffuse Field Acoustic Noise - Grazing Incidence Acoustic Noise - Cavity Resonance Acoustic Noise	
Acoustic Noise *(Incl. combined with temperature & vibration)*	AECTP-400 Method 413: - Precursor Test - Operational Test	EN 60068-2-65: Vibration - Acoustically induced method
Classical Waveform Shock	AECTP-400 Method 403 - Fragility Shock - Pendulum Impact	EN 60068-2-27: Shock
Shock Response Spectra	AECTP-400 Method 403	EN 60068-2-81
Handling and Drop	AECTP-400 Method 403: - Bench Handling - Catapult Launch/Arrested Landing - Crash Hazard Shock - Functional Shock - Transportation Shock - Transit Drop	EN 60068-2-31: Rough handling shocks, primarily for equipment-type specimens UN ST/SG/AC.10/1: Recommendations on the Transport of Dangerous Goods - Model Regulations
Constant Acceleration	AECTP-400 Method 404: - Centrifuge - Trolley (Sled)	EN 60068-2-7: Acceleration, steady state
Gunfire	AECTP-400 Method 405: - Direct Reproduction of Measured Data Materiel Response - Statistically Generated Repetitive Pulse - Repetitive Pulse SRS - High Level Random, SOR, NBROR Vibration	
Bounce / Loose Cargo	AECTP-400 Method 406: - Equipment slide	EN 60068-2-55: Loose cargo testing including bounce

	- Equipment roll	
Large Assembly Transport	AECTP-400 Method 408	
Pyroshock	AECTP-400 Method 415: - Near-Field with Actual Configuration - Near-Field with Simulated Configuration - Far-Field with Mechanical Test Device - Far-Field with Electrodynamic Exciter	
Rail Impact	AECTP-400 Method 416: - US Cushioned Coupler Car - European Railway - Laboratory Simulation	EN 60068-2-27: Shock
Motion Platform	AECTP-400 Method 418: - Aircraft Carrier - Frigate - Submarine	
Undex Test	AECTP-400 Method 419	
Aircraft Buffet Vibration	AECTP-400 Method 420	
Multi - Exciter Vibration & Shock	AECTP-400 Method 421: - Time Domain Reference Criteria - Frequency Domain Reference Criteria	
Ballistic Shock	AECTP-400 Method 422: - Ballistic Hull and Turret (BH&T) - Large Scale Ballistic Shock Simulator (LSBSS) - Light Weight Shock Machine (LWSM) - Medium Weight Shock Machine (MWSM) - Drop Table	
Time History Replication	AECTP-400 Method 423	EN 60068-2-57: Vibration - Time-history and sine-beat method
Materiel Bending	AECTP-400 Method 424	
Materiel Lifting	AECTP-400 Method 424	UN ST/SG/AC.10/1: Recommendations on the Transport of Dangerous Goods - Model Regulations
Materiel Racking	AECTP-400 Method 424	
Materiel Stacking	AECTP-400 Method 424	
Materiel Tiedown	AECTP-400 Method 424	

6 Missing/Gaps in the BPS and Future Evolutions

6.1 Evolutions in standardization

With raising concerns on climate change, temperature rising, new meteorological events, the standardized climate reference models for the tests are out-dated (models were defined in the 1990s). It could be relevant to review the models for the environmental testing to acknowledge such evolutions. This topic should be brought up in standardization in these fields.

6.2 Test severities from measured data

As stated in previous EG 08 Final Reports, there is still a concern on test severities from measured data in the current presented list of standards. STANAG 4370 being under review, the use of the French standards NF X50-144 (part 1 to 6) are crucial to ensure reliable European defence procurement contracts.

6.3 Evolutions on the STANAG 4370

The Life Cycle Management Group (LCMG WG6) in charge of STANAG 4370 evolution, has validated in October 2022 a main change in the organization of the current standard. The AECTP numbering will be kept, but the AECTP will be re-organized in 4 different STANAGs.

The current STANAG 4370 will stay in place with only AECTP-100, 200 and 600 as supporting standards. The new STANAG 4866 will be dedicated to climatic activity with AECTP 230 and 300. In a same way, the new STANAG 4867 will be created for mechanical testing (AECTP-240 and 400). Finally, the new STANAG 4868 will be dedicated to EEC domain, not covered in the scope of EG 08.

The table below shows the global re-organization of STANAG 4370 for EG08 scope:

Order	Current organization in 2022	New organization (expected in 2023)
1	STANAG 4370 AECTP 100 Ed. F	STANAG 4370 Ed. 8 AECTP 100 Ed. F Ver. 1
2	STANAG 4370 AECTP 200 Ed. E	STANAG 4370 Ed. 8 AECTP 200 Ed. E Ver. 1
3	STANAG 4370 AECTP 600 Ed. C	STANAG 4370 Ed. 8 AECTP 600 Ed. C Ver. 1
4	STANAG 4370 AECTP 230 Ed. B	STANAG 4866 Ed. 8 AECTP 230 Ed. B Ver. 1
5	STANAG 4370 AECTP 300 Ed. E	STANAG 4866 Ed. 8 AECTP 300 Ed. E Ver. 1
6	STANAG 4370 AECTP 240 Ed. B	STANAG 4867 Ed. 8 AECTP 240 Ed. B Ver. 1
7	STANAG 4370 AECTP 400 Ed. E	STANAG 4867 Ed. 8 AECTP 400 Ed. E Ver. 1

6.4 Detailed Analysis of the Test and Associated Standards

For the future work of revision in EDSTAR EG 08, it is recommended to perform a full review of the detailed analysis presented in the first Final Report annex. This valuable material can be of use for any environmental engineer for an overview of the work of standardization linked to defence procurement.

7 Conclusion

As a conclusion to this work, EG 08 strongly recommends standardization and defence procurement ecosystems to consider the challenges of climate change and its implications for environmental testing. The work of review and refinement undergone here to list the BPS on the Technical Domain "Environmental Testing" in Europe should be followed, with all expected changes in the industry. Many updates in the listed documents are expected in the short term and a review of this work should be done in not more than five years.

7.1 Annex A – List of referenced "Best Practice" standards associated to the technical domain Environmental Testing.