Environmental Engineering Specification in Europe

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Biography
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Abstract
With respect to the political aim of creating a more open European defence procurement market the European Union has identified several target areas for action. One of the first and most important fields is the standardization in general and especially the procurement related standardization. In 2002 a committee had been established in the European standardization agency CEN to prepare a European Handbook of standards which are of relevance for the procurement process. This includes a compilation of all existing international and national standards in a specific area, the analysis of these standards whether some or most of them are technically equivalent, a selection of the most important ones and finally to give recommendations which standards should be promoted for future use.
One of the most important priority fields is environmental engineering. CEEES, the European counterpart of IEST, volunteered to provide the experts in this field and the CEN WS 10 EG 8 "Environmental Engineering" indeed has been composed mostly of CEEES experts. This group has screened through the standards and developed an in-depth-comparison of environmental program management and testing standards. The paper reflects the actual state of the work and the conclusions for international standardization in environmental engineering

Keywords
Environmental Engineering, Standardization, European Defense, Procurement, Testing Methodology, Test Tailoring, Military Hardware, Harmonization

Summary
Standards specifying products and tests which are essential for the procurement of defense related products in a single European defense market shall not hinder suppliers from different countries to deliver to armed forces in other European countries. Thereby also the civil standards of environmental engineering increasingly play an important role. The European Commission has mandated the European Standardization Organization CEN to screen and to compare the various existing national and international standards and to give recommendations for preferred application in future. An expert group mainly consisting of experts of the European umbrella organization of the societies for environmental engineering CEEES took over responsibility at the beginning of 2004 and is currently preparing the final report for June 2005. For the first time in the history of standardization of environmental engineering such a broadly comparing survey is elaborated which exceeds widely the sector of defense. In the following lecture the procedure and previously achieved results are described.

1. INTRODUCTION : EUROPEAN EFFORTS FOR A UNIFORM PROCUREMENT MARKET FOR DEFENSE PRODUCTS

In the course of the political efforts to increasingly see the European defense as a joint task and due to this to intensify the cooperation between the armed forces of the individual member states, the European Commission has just launched several initiatives. Thereby different obstacles have been identified that up to now complicate a common European defense. Also the sector of technology belongs to it, especially the selection and procurement of equipment for the armed forces. Within the framework of nationally well-established but different supply processes it was hardly possible in the past to speak of an open European armament market.
For reaching this target the harmonization of the supply process and especially of the standards and specifications which are applied during procurement is necessary. Three years ago the European Commission placed a mandate that means a working task with the European Standardization Organization CEN to compile and to compare the existing militarily relevant standards and to make suggestions for a harmonization. Thereby a hierarchy of the standards was fixed: International civil standards are prior to international military specifications at the same appropriateness and national civil respectively military standards are only to be used if the international documents are not sufficient in a specific case. In future such national standards are to be transferred into European or international standards.
This ambitious task has been distributed on different expert groups. First the representatives of the national ministries of defense collected the standards applied in their sectors and compiled them in a common data base. Then eight priority fields of action had been selected; one of them is the environmental engineering and testing of defense products. Each of the eight

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expert groups had the task to screen the corresponding relevant standards of this data collection, if necessary to complete the data base or to delete standards from it. Criterion for the selection process was the practical significance of a standard.

In the second step the standards were compared in order to elaborate possible overlaps or duplicates. Frequently the national standards are only translations of standards of the nations which are important for defense technology like USA, Great Britain, France, or Germany or their multilateral agreements like the Standardization Agreement (STANAG) of the NATO. Often also the technical content is textually adopted even if the text is not completely congruent. In the case of environmental engineering standards for instance you can often identify the US American Mil-Standard 810 as origin.
In the third step which is currently under progress the standards have to be compared in order to recommend which standards are to be applied preferably in the future or where additional European standardization demand is seen. Thereby the target has to be kept in view wherever possible to prefer the civil international standards instead of special military standards.

2. BACKGROUND : DEVELOPMENT OF THE WORKING TASK FOR THE DEFENSE-RELATED STANDARDIZATION

In November 2000 the General Directorate "Enterprises" (a General Directorate is similar to a ministry of the national governments) of the EU Commission discussed for the first time on a high-ranking level the targets of the corresponding political action plan on the occasion of the conference "European Defense Procurement in the 21st Century: Increase in the Efficiency and Improvement of the Competitiveness – the Role of Standardization".
Thereby it was declared that a reform of standardization is necessary to allow for a more rational, cheaper and more efficient European production capacity for armament goods. This standardization is closely connected with the civil standardization in Europe.
Whereas one previously assumed that the standardization for armament goods clearly differs from the civil standardization due to the special military requirements the latest developments show that more and more so-called "dual use"-products are purchased on the civil market (COTS – Commercially of the shelf) especially in the sector of premium products like for example the information technology. In various key sectors the application of civil standards will therefore become inevitable[2].
The representatives of CEN suggested in a resolution as consequence of this political target to install a new working group of the technical office of CEN, the BT/WG 125 that deals with the standardization of armament goods ("Standardization for Defense Procurement"). Besides the European standardization organizations CEN, CENELEC and ETSI and the national European standardization organizations, the national ministries of defense of the EU and EFTA countries as well as the NATO were invited for cooperation.
The resolution was accepted at the beginning of 2001 and the presidency was assigned to France. BT WG 125 established in the next step a platform for cooperation and installed for this purpose at the beginning of 2002 the CEN workshop CEN WS 10. Jean-Michel Bardot, EADS France, was appointed as chairman and a secretary office was installed at the French standardization organization AFNOR. The experts were appointed by the national ministries of defense, the national standardization organizations and the corresponding industrial associations.
According to the European defense policy the following targets of standardization have been pointed out :

- **Compatibility :** Products, processes and services have to be appropriate for the common application under special conditions and have to fulfill the relevant requirements without causing unacceptable reciprocities.
- **Replaceability :** The ability of a product, process or service to be used as substitute and to fulfill the same requirements.
- **Commonness :** The application of the same principles, the same procedure or the same equipment.

The advantages of standardization of defense-related equipment and behaviors are[3]:

- Improvement of the interoperability by standardized interfaces
- Reduction of the variety of supply articles by use of standardized components
- Common supply logistics
- Avoidance of parallel efforts for research, development and testing of defense material

The defense sector is increasingly interested to use commercially available products or components. Therefore an essential element of the composition of the future standardization work is to use the results of the civil standardization and thereby to widely pass on special military standardization activities.

[2] CEN BT N 6292 (Draft Resolution BT C198/2000), Release date: 2000-11-29
[3] T.Bahke: Standardisierung militärischer Ausrüstung – eine europäische Aufgabe. In: „Auf dem Weg zur europäischen Verteidigung“ Hg.: Karl von Wogau, Herder Verlag, Freiburg, 2003

CEN BT/WG 125 elaborated a work program in 2001 that among other things plans to issue till end of 2005 an internet based European handbook for standardization at the procurement in the defense sector by CEN WS 10. In 2002 WS 10 began its work which was supported and arranged from the beginning by the Western European armed forces group WEAG, thus by the ministries of defense of France, Great Britain, Sweden and Germany.

3. IMPORTANT FIELDS OF THE DEFENSE RELATED STANDARDIZATION

The first step was a compilation of the typical military procurement processes in the individual countries. Contributors to this report[4] were Norway, France, Sweden, Great Britain, Finland, Belgium, Spain, Italy, Germany as well as the NATO. In the second step these countries and the standardization department of the NATO communicated the list of defense related standards which had been summarized with title, number and sources in a data basis in form of charts. This so-called "Initial handbook" comprises more than 10 000 standards. In this complexity a standardization activity carried out by voluntary experts is of course no longer feasible. Therefore a partition into specific fields was considered knowing well that inevitably there will be overlaps.
First of all 16 priority fields of action were listed in the CEN workshop WS 10 following a suggestion of the national ministries of defense but then eight specific fields which have to be worked on were defined and corresponding expert groups (EG) had been installed:

EG 1: **NBC-indicators**
EG 2: **Energetic materials**
EG 3: **Propellants and lubricants**
EG 4: **Batteries**
EG 5: **Packaging**
EG 6: **Electrical and mechanical interfaces**
EG 7: **Electromagnetic environment**
EG 8: **Environmental engineering**

These newly appointed expert groups had been invited to foundation meetings to Brussels in January 2004 and first had the task to check their scope and to filter out from the complete data base those standards which could be effected by them. In the same time the working period of only one year was extremely short and it was meanwhile extended by half a year to summer 2005.

4. THE DEFENSE RELATED STANDARDIZATION IN ENVIRONMENTAL ENGINEERING

At the sector environmental engineering one suggested the cooperation of CEEES as European expert organization in this sector. With CEEES, in comparison to the other specific sectors, there has already been a European network of experts; lots of them could be convinced to participate. The working group "Environmental Engineering" did not begin at zero but could use existing expertise of specialists that on their part have lots of years of experience in the standardization of environmental testing.
With some of the other expert groups there are of course overlaps in environmental testing especially with Packaging, Energetic Materials and Electromagnetic Environment. These overlaps had been handled pragmatically by coordination between the chairmen of the expert groups.
Very quickly a common starting point and a common strategy were elaborated in EG 8 "Environmental Engineering". One concentrated on the most important standardization works - regarding the aspect of the practical significance - and on the common approach to consider the tailoring philosophy as a reasonable basis.
In no other specific sector there are also such strong reciprocities between civil and defense standardization as in the environmental engineering. This is mainly based on the fact that the environmental engineering has its origin in the military sector. Primarily in this sector the test labs began with the simulation of extreme environmental conditions in order to obtain reliable military equipment already more than half a century ago. Very much later, with the appearance of electronics, civil sectors like the electrotechnical industry, aircraft industry or automotive industry have dealt with environmental engineering and have used experiences from the defense sector. Indeed new requirements have developed from these application fields regarding the economically reasonable environmental engineering so that today a mutual fertilization of the standardization

[4] CEN Workshop 10 - Document N 035 c: Standardization for Defence Procurement – European Handbook, October 2003

activities can clearly be seen on the one hand due to the restricted budget in the defense sector and on the other hand due to the increasing application of dual use goods.
Various environmental testing specifications which are often included in the individual, product related performance standards caused difficulties at the beginning: For instance the product standard for a special type of munitions or a battery also comprises the required tests for environmental verification. Against this background one would have to be obliged to analyze thousand standards. Normally these testing regulations arise from the general environmental engineering regulations, very often by simple transcription.
Therefore the standards were grouped in so-called vertical and horizontal standards: Horizontal standards describe the procedure and the testing process in the environmental engineering independent from the testing object. Vertical standards are product specific standards which have a restricted scope only for the corresponding product. Typical representatives of the horizontal standardization are the Mil-Std 810 or the NATO STANAG´s. Finally there will be a recommended procedure that in future the vertical, product related standards should not define own environmental engineering tests but refer to the generic that means horizontal standards.
The work of EG 8 concentrated on these horizontal standards. Thereby the following works were identified as *especially relevant for the environmental engineering* :

International civil standards :	- Standard series **IEC 68 ff.**[5]
International defense standards :	- **NATO STANAG**[6] supplemented by the **AECTP**[7]**-series** - **Four-powers-agreement** to **ITOP**[8]
National defense standards :	- **Mil-Std 810** (USA) - **GAM EG 13** (France) - **Def Standard 0035** (UK)

All these standard series comprise more or less completely the whole sector of environmental engineering and are therefore suitable as basis documents. Whereas in the first years of environmental engineering after the Second World War mainly the American Mil-Std 810 played the most important role and was adopted in various countries partly without any changes, the English Def Std 0035 and the French GAM EG 13 have become in the meantime also well known and famous standardization works.
In Germany there are also some environmental engineering standards in the sector of the defense equipment standards (VG) and of the technical supply conditions (TL) but no coherent standardization works comparable to Mil-Std, Def-Stan or GAM.
With regard to the international consensus ability of documents the NATO documents and the ITOP´s are categorized as significant as they – in contrast to the national standards – have passed through an international coordination process. The same applies for the most important civil standardization series, the IEC 68 of the international electrotechnical commission.
From the point of view of the expert groups the following priorities for the assessment of the significance of the standards have been determined :

IEC 68 > NATO STANAG > national standards

The IEC 68-series is first choice for all civil products that contain electrotechnical or electronic components (and this is the majority of all technical products). Various goods of this type are also applied in defense products. Therefore the IEC-series can be regarded as basic standard for dual use products. Comparable to the IEC standards is the corresponding standard series of ETSI, an organization which deals with the standardization of telecommunication and information technology. As there are close interconnections and as normally the IEC documents are simply adopted for environmental engineering the ETSI series has not been regarded separately.
The IEC serial cannot fulfill in all points the specific military environmental requirements that appear at the defense application. Such special environmental conditions are for example vibrations and shocks which arise when operating guns (e. g. gunfire vibration). Therefore the civil IEC-series definitively has to be supplemented by such tests which reflect an original military requirement catalogue.
Here the corresponding documents of the NATO standardization agreement (STANAG, AECTP) are primarily classified as appropriate because they have been elaborated in a partly long coordination process between the NATO partners. Also the

[5] IEC: International Electrotechnical Commission; the series 68 with about 100 particular sheets deals with the environmental testing of electrochemical goods
[6] STANAG: Standardization Agreement of the NATO members; the STANAG 4370 is called,Environmental Testing' and consists of various particular sheets
[7] AECTP: Allied Environmental Conditions and Test Publications. They are detailed regulations assigned to the STANAG
[8] ITOP: International Test Operation Procedure. Specifications that are declared by the states USA, Great Britain, France and Germany and that are normally confidential

so-called ITOP´s that have been declared by several states at least are regarded as international approved documents. Especially at the ITOP´ s it is difficult as lots of them are still categorized as confidential and are not open to the public. Various states delegate their experts, who have worked on the national environmental engineering standards, to these working groups of NATO and the four powers, and are willing to defer the application of the mere national standards as long as the international standards fulfill the same purpose.
There is merely a certain distance between the civil standardization work at IEC and the defense standardization for environmental engineering which decreased in the past years and is still decreasing as the know how is accreting – often by the test labs and the test engineers that work for both customer groups.
The CEN WS 10 EG 8 group has assumed that generally there is no fundamental difference between the defense and the civil environmental engineering. Especially the Test Tailoring method firstly introduced in the Mil-Std 810 at the beginning of the 80´s merges the different users. The procedure is the same, the methodology of environmental engineering is firstly independent from specific environmental conditions and the assessment steps are also comparable. The differences mainly refer to the intensity of the environmental conditions and thereby to the testing severities.
Tailoring comprises the steps:

- Analysis of the expected life cycle of a product
- Identification of the environmental conditions in the particular life cycle phases
- Derivation of the simulation and testing conditions
- Assessment of the effects

A detailed description of the methodology of test tailoring is given in the Mil-Std as well as in the British Def-Stan and in the French GAM.
The actual test methods how for example a vibration test or a climate test has to be carried out can follow the same regulations in the civil and in the defense sector; differences merely result regarding intensity and duration of the test as well as regarding some special military related environmental conditions.

5. THE CATEGORIES OF ENVIRONMENTAL ENGINEERING

The environmental engineering usually comprises the complete field of environmental influences on a technical product. Thereby one can divide into groups certain stress situations and the corresponding stress parameters.
EG 8 has fixed the following categories :

- Management of environmental testing
- Temperature test
- Humidity test
- Contaminations
- Vibration
- Shock
- Other mechanical environmental conditions

Therein the following environmental testing procedures are compared in detail :

- Mechanical vibration
- Shocks
- Acoustic environmental conditions
- Temperature stresses (including temperature shock)
- Humidity
- Solar radiation
- Contamination (including salt dust, must, polluted atmospheres)
- Safety fall test
- Railroad shock
- Gunfire
- Under water explosion
- Steady acceleration
- Pyrotechnical shock

A detailed comparison for each procedure was elaborated, in which the characteristics of each standards were contrasted. Thereby the following aspects of each standard are regarded :

- Title and short description
- Scope and restrictions
- Target

- Advantages of the corresponding procedure
- Disadvantages of the corresponding procedure

The charts to the individual procedures are partly still in process; they are to be published in the final report. An example for the attribution of different environmental testing methods to the standards is given in the chart in the annex.

6. CONCLUSION AND SUMMARY

The CEN EG 8 had probably been the first international committee which deals intensely with the analysis and the comparison of environmental engineering standards, so that at the end one can expect a report whose significance outreaches widely the actual standardization task. The already existing working results that will be issued as report in 2005 anticipate this.

Military and civil environmental conditions do not differ basically in most cases but only in their intensity. Therefore the methodology of the procedure, the analysis of the life cycle, the performance of the testing processes and the assessment of the effects can be defined that way that they can be applied for both sectors. On the basis of Test Tailoring the specific stresses are then identified and enter in the determination of the testing severity.

Furthermore some special defense environmental conditions have to be considered which do not play any role in the civil application and have to be simulated in separate testing procedures. For example gunfire vibrations, pyrotechnical shock, under water explosions or constant high acceleration of a projectile belongs thereto. In addition special testing facilities and safety precautions are necessary that requires a special know how.

The detailed comparison that have been effected in EG 8 has improved the comprehension of the different standardization works and testing methods and allows a systematic procedure for the further development of the environmental engineering methodology. There are only few points where the standards differ significantly so that no basic dissent has to be stated between the different standardization philosophies. Today tailoring is the generally accepted procedure and therefore the separation between testing methods and testing severity. It is undisputed that for a real-world-simulation only the best available data have to be used. To achieve these data will quite often require own measuring exercises.

The standardization works differ regarding the sector that they cover: The description of the methodology is differently pronounced. For example, in the civil IEC 68 series the explanation of the Test Tailoring method is missing which is presented more or less in detail in the defense standards. There one can also find considerably more information on the program management of environmental tests in the development and supply chain of products. Additionally the military testing standards also include the so-called civil environmental conditions like for example the road or railroad transport during normal logistic operations.

How will the work progress? The extensive comparison of standards in environmental engineering will have on the one hand effects on the further European standardization work: Deficits have to be identified; additional standardization work has to be effected possibly at CEN. Thereby the principle has to be applied that international standards are prior to European standards. The only international collection of environmental engineering standards which has not been elaborated and issued in the defense sector is the series IEC 68. Actually only the interconnection with ISO is missing to cover also the products that are not characterized as electrotechnical. On the other hand there are still textual lacks with regard to the methods in the management of environmental test and of course it does not fulfill all requirements for the military sector.

Concerning their quality the NATO-STANAG is therefore classified higher by experts and serves as guide for an integrated environmental engineering methodology. As the NATO no longer demands the long lasting former confidentiality of this standardization series it can provide together with the IEC a basis for a universal European standardization works which is very beneficial for the civil as well as for the defense user. But one should avoid with regard to the single European internal market to reinvent everything. In the meantime the environmental testing methods have reached a high level of maturation and lots of critical issues of the past for example the unreasonable over-testing have been eliminated by the tailoring principle.

The (unnecessary) timidity of civil users towards the military standards can only be overcome if these ones are transferred to the civil responsibility and gain universal validity as CEN or ISO standards. In order to approach this vision one has to counteract more resolutely the competition of the particular institutions and various committees: ETSI, CENELEC and CEN rival on European level with ISO and IES as well as with the working groups of NATO and the other countries of the Four-Powers-agreement in the defense sector. Problems are not caused by the experts who often participate simultaneously in different committees but by the institutions which observe each other suspiciously with jealousy. Common European open armament procurement will hopefully support an improvement of the situation with some political pressure.

ANNEX

Matrix :
Environmental Test Methods versus Standards
(Equivalence sheet)

	NATO STANAG 4370 - AECTP (Method No)	IEC 60068 Part 2 (60068-2-xx)	UK Def Stan 00-35 Part 3 (Chapter/Test)	US Mil Std 810F (Test No)
HIGH TEMPERATURE (INCLUDING RADIATIVE HEATING)	302	2 3 30 38 41 51 56 61	3-01 / CL1 3-02 / CL2 3-06 / CL6 3-07 / CL7 3-11 / CL11	501
LOW TEMPERATURE	303	1 39 40 50	3-04 / CL4 3-05 / CL5 3-12 / CL12 3-13 / CL13	502
AIR-TO-AIR THERMAL SHOCK	304		3-14 / CL14	503
SOLAR RADIATION	305	5	3-03 / CL3	505
HUMID HEAT	306	66 67 78		507
IMMERSION	307		3-29 / CL29 4-05 / CN5	512
MOULD GROWTH	308	10	4-01 / CN1	508
SALT FOG	309	11 52	4-02 / CN2	509
RAIN AND WATERTIGHTNESS	310	18	3-27 / CL27 3-28 / CL28	506
ICING	311		3-10 / CL10 3-23 / CL23	
LOW PRESSURE (ALTITUDE)	312	13	3-21 / CL21 3-20 / CL20	500
SAND AND DUST	313	68	3-25 / CL25	510
CONTAMINATION BY FLUIDS	314	74	4-04 / CN4	504
FREEZE / THAW	315		3-24 / CL24	521
EXPLOSIVE ATMOSPHERE	316			511
TEMPERATURE, HUMIDITY, ALTITUDE	317			520
ACIDIC ATMOSPHERE	319	60	4-03 / CN3	518

VIBRATION	401	6 59 64	2-01 / M1 2-02 / M2	514
ACOUSTIC NOISE	402	65	2-08 / M8 2-09 / M9	515
CLASSICAL WAVEFORM SHOCK	403	27	2-03 / M3	516
CONSTANT ACCELERATION	404	7	2-13 / M13	513
GUNFIRE	405			519
LOOSE CARGO	406	55	2-11 / M11	514
MATERIEL TIEDOWN	407			
LARGE ASSEMBLY TRANSPORT	408		2-14 / M14	
MATERIEL LIFTING	409		2-15 / M15	
MATERIEL STACKING	410		2-16 / M16	
MATERIEL BENDING	411		2-17 / M17	
MATERIEL RACKING	412		2-18 / M18	
ACOUSTIC NOISE COMBINED WITH TEMPERATURE & VIBRATION	413		2-10 / M10	523
HANDLING	414	31 32	2-04 / M4 2-05 / M5	516
PYROSHOCK	415			517
RAIL IMPACT	416			516
SRS SHOCK	417	57	2-06 / M6	516
MOTION PLATFORM	418			
UNDEX ASSESSMENT AND TEST	419		2-07 / M7	
BUFFET VIBRATION	420			514
MULTI - EXCITER VIBRATION AND SHOCK TESTING	421			
BALLISTIC SHOCK	422			522
Non STANAG 4370 Tests				
KINETIC (AERODYNAMIC) HEATING			3-08 / CL8	
RAPID AND EXPLOSIVE DECOMPRESSION			3-09 / CL9	
AIR PRESSURE (ABOVE STANDARD ATMOSPHERIC)			3-15 / CL15	
HIGH WINDS			3-16 / CL16	
ELEVATED GROUND TEMPERATURE/ HUMIDITY DIURNAL CYCLES			3-17 / CL17	
DRIVING SNOW			3-18 / CL18	
EROSION AND STRUCTURAL DAMAGE IN FLIGHT BY RAIN, HAIL, DUST OR SAND			3-19 / CL19	
SNOW LOAD			3-22 / CL22	
MIST FOG AND LOW CLOUD			3-26 / CL26	
SEALING (PRESSURE DIFFERENTIAL)		17	3-30 / CL30	
CHANGE OF TEMPERATURE		14		
BUMP TEST		29	2-12 / M12	

BULLET ATTACK TEST FOR MUNITIONS			5-01 / FX1	
STANDARD LIQUID FUEL FIRE			5-02 / FX2	
SAFETY IMPACT TEST FOR MUNITIONS			5-03 / FX3	
SLOW HEATING TESTS FOR MUNITIONS			5-04 / FX4	
SYMPATHETIC REACTION			5-05 / FX5	