A Review of DEF STAN 00-35 and IEC TC104 documents against other environmental standards

David Richards
Insys Ltd

Author Information

David Richards, Insys Ltd (formally Hunting Engineering), is the current Vice President of CEEES, Chairman of the CEEES Technical Advisory Board for Mechanical Environments and Chairman of the UK Society of Environmental Engineers. He works for a UK defence company as the Head of Structural Dynamics. Although a part of the Future Concepts Division he is involved with most INSYS projects as well as undertaking work directly for the UK MOD. David is chair of Working Group 15 of IEC TC 104. He is also a long standing member of the UK committee responsible for Def Stan 00-35 & implementing STANAG 4370. In that role he has generated sizable portions of Def Stan 00-35.

1. INTRODUCTION

A critical comparison of environmental standards, such as that undertaken by CEN Workshop˚10 Expert Group 8 (WS 10 EG 8), is a task very rarely undertaken at the level of a standards organisation. However, for those purchasing and developing equipment it is a frequent need to identify the most appropriate standard for a particular equipment/ application/ procurement stategy. Although the CEN WS 10 work was undertaken for Defence Procurement purposes it has value beyond that application as a some of the standards and issues addressed are common to many industries. This paper reviews a number of critical comparison of EG 8 which may have application to others.

The first half of this paper reviews the comparisons made by Expert Group 8 but concentrates on the procedures of IEC 60068 and IEC 60721 as well as Def Stan 00-35 are addressed. In the latter case reference is also made to GAM EG 13 as some useful comparison can be made between the documents. The US Mil Std 810F, STANAG 4370 and ITOP procedures are addressed for completeness but only briefly as they are discussed in other papers. The second half of this paper specifically reviews the outcome WS10 EG 8 work comparing how the various standards incorporate the Environmental Management Process.

2. REVIEW OF ENVIRONMENTAL STANDARDS

A total of six separate horizontal standards were identified as primary sources of environmental test procedures. This number included one added as a result of request made to WS10. Those six separate horizontal standards were;

International Commercial Standards IEC 60068 and IEC 60721
UK National Defence Standard Def Stan 00-35
French National Defence Standard GAM EG 13
US National Defence Standard Mil Std 810F
International NATO Defence Standard STANAG 4370and its AECTP s
Quadripartite Agreement ITOP (International Test Operating Procedure)

The Expert Group 8 comparisons were made using a total of ten criteria. Lacking any initial direction from WS 10, the expert group developed and tested these ten criteria. Whilst late in the process WS 10 did suggested a few vague criteria, these were already encompassed by those identified by Expert Group 8.

International Civil Standard EN / IEC 60068 & 60721

Standard 60068 is the IEC procedure for environmental testing which is also adopted by CEN and embedded into national standards by most European countries. IEC 60068 has an associated standard setting out environmental severities that standard is IEC 60721. IEC 60068 is designated by IEC as a horizontal standard and is intended for electro-technical products. Its procedures are adopted by a many vertical product standards either by direct reference or using a reformatted version of the text. This is particularly the case for the tests which are common used by COTS equipment.

Standard EN / IEC 60068 & 60721 is technically managed by IEC Technical Committee (TC) number 104. This technical committee was formed, in 1997, from the merger IEC TC 50 with IEC TC 75.

IEC TC 50 was Responsible for IEC 60068 (Environmental Test Procedures)
IEC TC 75 was Responsible for IEC 60721 (Environmental Conditions)
The merger of the two groups was intended to ensure alignment of information in IEC 60068 & IEC 60721. At the time of its formation TC 104 initiated work to identify differences in the two standards. This identified a significant number of differences between the test severities contained within the various procedures of 60068 and the environmental conditions set out in Part 2 and 3 of 60721. The outcome of this review was both a short term work programme to resolve the differences as well a long term work programme to verify the environmental conditions of 60721.

The outcome of the short term work programme was the issue of 60721 Part 4 which is in eight section. These were initially issued as Technical Reports but have recently been reissued as standards. Seven of the sections of 60721 Part 4 contain tables setting out the severities of the test procedures of 60068, the related environmental conditions of 60721 Part 3 as well as a recommendation of which of the two is the preferred severity.

This attempt to resolve the differences in test severities between 60068 and the environmental conditions of 60721 works only in that Part 4 of EN / IEC 60721 is a series pseudo test schedules suitable for a narrow range of electro-technical equipment. The severities of both documents are extremely simplistic, archaic and do support tailoring.

In the longer term programme TC 104 set up two working groups to review the environmental conditions of Part 2 and 3 of 60721. Working Groups 14 & 15 were set up to review the climatic and mechanical environments respectively. The terms of reference for these groups required them to assemble and review validated data with the intent of defining new environmental conditions. This work has now been running for some time and has made only limited progress. This is partly a consequence of the need for identifying a good range of validated data as well as a lack of resources.

Working Group 15, responsible for the mechanical aspects, has assembled three significant draft reports of validated data for transportation by Jet Aircraft, Road and Rail. Generally identifying good validated data is difficult. Lacking resources the two working groups have to rely on existing data acquired by companies and government agencies. Many companies are unwilling to contribute, partly because of concerns commercial confidentiality. However, frequently a more practical concern is that the data is incomplete and no necessarily fully documented. Working Group 15 has attempted to alleviate this by encompassing partly validated and unvalidated data. Nevertheless, hardly any of the countries active in TC˚104 have contributed data.

Attempts to identify the source data that were used as the basis for the existing environmental severities in Part 2 and 3 of 60721 has had little real success. No directly traceable path to the Part 2 and 3 severities has been identified although data some time reputed to be the basis has, in some cases, been found. In one of those, road transportation severities seem to have been set to encompass unvalidated measurements from a 1947 German truck driven over unknown road surfaces. Some of the severities in 60721, which are for commercial equipment, are greater notably than similar severities currently for defence equipment.

Generally the existing mechanical environmental severities of IEC 60721 Part 3 are extremely simplistic descriptions of actual environments. Actual environmental conditions do not sit particularly well into the existing Part 3 categories. The sub-division of environmental conditions is centred upon testing approaches as typically undertaken for smaller items 30 or 40 years ago. The sub-division approach does not map across to modern, cost effective testing facilities.

The main acknowledged advantage of the IEC 60068 group of test procedures is that they are consistently formatted with a clear distinction between guidance information and mandatory requirements. The procedures usually also contain guidance on how to undertake the test. The application of the test procedures are mostly firmly written and ensure repeatable results regardless of the tester, test facility or test equipment utilised. For this reason the test procedures are idea for setting as contractual requirements as well as use for COTS (Commercial Off the Shelf) and OEM items.

The main disadvantages of the 60068 test procedures, as indicated by CEN WS10 EG8, is that many of the test procedures are basic, quite old and frequently lack technical innovation. Moreover, they often do not utilise the latest and most cost effective facilities, techniques or methodologies. Although IEC adopt a maintenance procedure these can be slow and even then do not always bring a test procedure up to the same level of technical innovation as some of the defence standards. Recently a new mechanical test technique was published, after five years work, even though at the start of the work that technique was in common use and had been available in other standards for a decade. Some of the reason for the lack of technical innovation seems to be that the standard has only a limited scope of applicability, intended for only electro-technical items. The procedures of EN / IEC 60068 seem to be intended for equipment whose design, mass, cost and function are not critically affected by the environmental severities. That is for equipment or a market place which can withstand the degree of overtesting imposed by the adoption of the existing procedures.

In addition to the above, the test procedures of EN / IEC 60068 are not supported by a comprehensive environmental management strategy that would currently be considered credibly viable. The basic strategy is very dated and only integrates with many procurement strategies at the most basic level. That is one in which the purchaser takes all the risk and responsibility that the equipment will be suitable.

The EN / IEC 60068 standard are supported by IEC, with a formal secretariat (currently Sweden), a defined IEC committee which is in turn supported by national standards organisations. Both IEC and the national standards organisations make the documents publicly available but at a cost. The IEC and TC104 secretariat operate professionally and ensure discipline in the form of consistency of style and format. Indeed of the standards reviewed by CEN WS10 EG8, the management of EN / IEC 60068 was bar far the most professional. However, the generation and extensive commenting procedures can be slow and cumbersome.

National Defence Standards Def Stan 00-35 (UK) & GAM-EG-13 (France)

Def Stan 00-35 & GAM-EG-13 are respectively the United Kingdom and French national standards for environmental proving of defence equipment. The older tests of both have a clear historic root with older versions of EN / IEC 60068. Indeed interaction with the three test standards occurred in the late 1960 s. Both United Kingdom and French national test standards appear to still attempt to keep a reasonable degree of consistency with EN / IEC 60068. Indeed the UK Def Stan makes a statement in the scope of each procedures as to the commonality with EN / IEC 60068.

Both of these test standards adopt a clear distinction between guidance information and mandatory requirements. They are both firmly written but also supply additional test guidance information on both test conduct and severity derivation. The tests are written to facilitate consistency of testing and can be called in contractual requirements with confidence. The tests are frequently used for COTS equipment are included in a manner such that they are common to many vertical standards.

Although both Def Stan 00-35 & GAM-EG-13 have made some effort to achieve commonality with EN / IEC 60068, they have also incorporated additional, defence specific, procedures and include a number technically innovative enhancements to existing tests. Until recently both have attempted to encompass the use of up to date & cost effective facilities, techniques and methodologies. Both standards were considered and extensively utilised in the generation of STANAG 4370. Whilst, Def Stan 00-35 is still maintained and updated, GAM-EG-13 is no longer supported in favour of STANAG 4370. For contradictory reasons both approaches have been subject to some criticism and debate.

The view of the UK committee responsible for Def Stan 00-35 is that whilst it should implement STANAG 4370 as much as possible, the continued existence of Def Stan 00-35 allows a national base for establishing UK unique environmental conditions, setting UK unique reservations on test procedures as well as allowing for rapid the development of new procedures. Without the continued existence of Def Stan is it is considered that the technical competence of the support committee would dissipate.

As was the case in France for GAM-EG-13, the UK committee responsible for Def Stan 00-35 consists of representatives of both the UK MOD as well as the UK Defence Industry. As a consequence the group a much wider perspective than the NATO group responsible for STANAG 4370. The generic hierarchy of preferred standards within the UK (as published by D°Stan) is European civil standards, international civil standards and only then international defence standards. It is understood this is also the policy of the French MOD also.

Both Def Stan 00-35 & GAM-EG-13 are supported by viable environmental management strategies that is consistent with defence procurement approaches used in the two countries. Although the two strategies differ that is only because they address different aspects of the same issue. Representatives from both countries have long expressed the view that the management aspects of the two documents not only fit together but would be more useful if merged.

Def Stan 00-35 & GAM-EG-13 include credible and up to date test severities which are specific for defence usage. Both standards are compatible with the use of tailored severities and give significant advice on natural, induced and abnormal environmental severities. This advice is clearly separated from the test specifications and frequently includes background information on the mechanisms causing the environment.

Both Def Stan 00-35 & GAM-EG-13 are supported by standards organisations which make the documents publicly available at no real cost - the Def Stan can be downloaded from the DSTAN web site. The two defence standards organisations operate professionally and ensure discipline in the form of consistency of style and format.

From a Defence viewpoint both Def Stan 00-35 & GAM-EG-13 comprise a good practical compromise between consistency with commercial standards and technical innovation for use in testing sophisticated defence systems. The restriction on the European wide use of Def Stan 00-35 & GAM-EG-13 is that they have never been targeted outside the two originating countries.

National Defence Standard Mil Std 810 (US)

Unlike the procedures in Def Stan 00-35 & GAM-EG-13, the procedures within US National Defence Standard Mil Std 810 have never been notably consistent with other group of standards. Indeed the Mil Std 810 procedures have consistently adopted a number of different tolerances, procedure & approach to those of other standards. Originally the standard was well suited to testing of sub-assemblies and general defence equipment required to be used in a range of situations. However, this has changed over the various revisions, such that today it is more applicable to complete systems.

The lack of commonality with any international standard does not seem to have mattered historically in the US were the defence market is sufficiently large for manufacturers to develop components and sub-systems specifically for US military use. Today that is less so and has rarely been the case in Europe. The lack of commonality with any international & European standard would imply that the adoption of the Mil Std for European defence applications would potentially give US defence suppliers an undue advantage over European suppliers.

The main advantage of Mil Std is that historically the standard has included technically innovative approaches adopting up to date & cost effective facilities, techniques and methodologies. In the defence field the Mil Std has frequently been at the fore front of introducing new techniques and ideas. As a result the Mil Std has broadened its range of environmental conditions encompassed such that it now addresses most of the defence environments. However, some of these are not particularly well integrated and some new chapters relating entirely to the derivation of specific severities, with the procedures themselves not always that different from existing chapters. The enhancement of the standard has also resulted in further degradation of the distinction between test procedures and environmental conditions. This is considered by observers as another indication of the lack of control over the document.

International Defence Procedures ITOP s (US, UK, F, De)

The International Test Operations Procedures (ITOPs) are quadripartite agreements between the US , UK, France & Germany relating to the mutual acceptance of test and evaluation for the reciprocal procurement of defense equipment . The ITOP working groups are product related (munitions and tracked vehicles) and consequently the ITOPS should really be classed as vertical standards. Only a few ITOPS (around 10) relate to environmental testing and then they only encompass an inconsistent and narrow range of topics.

The level of detail contained in the ITOPS is intended for direct use in the test process. Restricting effort to four-nations is intended to provide for rapid development of procedures (the target is 2 years). The stated aim of the ITOP is that they should not duplicate other international documents, but are intended to replace national test procedures.

The ITOPS related to environmental testing appear to replicate existing STANAGS and in the majority of such cases the latest ITOP was issued AFTER the STANAG. This seems in conflict with the stated ITOP intent. Of more concern was that in several cases the ITOP and the STANAG differed or conflicted in important aspects. In some cases they also conflicted with existing national approaches.

The overlap and conflict with existing standards is of concern as it suggests inconsistency of policy within the four nations concerned. This is compounded further by the stated intent of the NSA (Nato Standards Agency) is to propose the ITOPS as STANAGs.

International Defence Procedure STANAG 4370 (NATO)

NATO STANAG 4370 contains a significant amount of identifiable content from the UK Def Stan 00-35, the French GAM EG 13 and the US Mil Std 810. As such it identifiably takes cognisance of a range of national standards.

The current version of STANAG 4370 seems far better written that the two previous versions. With that said it is doubtful whether either of those earlier versions would have passed muster, if managed by a professional national or international standards organisation. Having culled the various national standards the STANAG does include tests for virtually all defence environments likely to be encountered. In this regard the STANAG could be said to be much better than any one of its contributing parts.

STANAG 4370 is supported by a viable environmental management strategy which is broadly consistent with defence procurement approaches used in the US, UK and France (and in turn is probably consistent with that of most European countries). However, achieving that consistency was only possible after significant compromise and loss of detail.

Indeed it is likely that the current strategy is not sufficiently detailed to be practical. For European use a merger of the existing UK and French national strategies may be more applicable.

As a standard, STANAG 437, is not particularly well formatted with guidance relating to the test procedures not clearly separated from that relating to test severities. Mandatory requirements and guidance information are not clearly identified and quite a lot of text is repetitious or has no real value. In a number of areas confusion appears to exist whether the text was intended for the test specifier or the tester. Moreover, the mandatory requirements of the test procedure are frequently ambiguous and cannot be relied upon to produce a repeatable test or a result the test specifier can rely upon. For STANAG 4370 to be used as the common base for equipment specific vertical standards better control of style and format is clearly required.

The STANAG is controlled by the NATO CNAD (Conference of National Armament Directors) organisation. However, in practice that control seems almost entirely vested in the technical group. Little external control appears to occur and circulation for comment happens only at a very limited level and a common complaint is that it mostly excludes industry. Overall, the level of control indicated by the document is nothing like as rigorous as that used in the UK or French military standards and far less than for commercial standards. The availability of 4370 is, like most STANAGs, patchy but when found is usually freely available.

3. ENVIRONMENTAL MANAGEMENT

This section of the paper reviews the paper reviews how the environmental management process is incorporated into the various standards. The comparison of the standards is undertaken by consideration of four topics; the Environmental management methodology, environmental conditions, derivation of guidelines for deriving test profiles (tailoring) and fall back test severities.

The Environmental Management Methodology

Although the Environmental Engineering process is designated as Part 1 of UK Def Stan 00-35, it was included several years after many of the test procedures and environmental severities had been published. The current environmental engineering process in Def Stan 00-35 was written in the early 1990 s and is intended to align with the defence material design process used in the UK. The process sets out to demonstrate the equivalence in terms of documents and processes between the environmental engineering process and the design process. Part 1 sets out an overall idealised process which can be used under almost any procurement approach. It then indicates has this can be tailored into four different procurement strategies. These four strategies encompass the core approaches used for the vast majority of defence equipment procurement. Advice on the risks and responsibilities associated with each of these four strategies is set out. Although the standard explains the process by means of documentation, it concedes the titles of these documents may change from procurement to procurement and also environmental documentation may be incorporated into general design process documentation. Although Part 1 of Def Stan 00-35 sets out the management process it does not supply advice on how to implement strategies and programmes. That aspect is currently in preparation and is to incorporated into Def Stan 00-35 Part 2.

The French military standard CIN EG 01 sets out guidelines for accounting for the environment in military programmes. This document was issued relatively recently in 1999 and is founded on earlier work which set out the technical aspects of how to implement strategies and programmes. That is the order of the work was directly reversed from that adopted by the UK. As a consequence of this CIN EG 01 is far more extensive than the Def Stan and contains considerably more information on how to implement the process than does the UK document. In this regard the CIN EG 01 and the Def Stan appear to be aimed at different people.

Intrinsically the two processes contained in the two documents encompass different aspects of the environmental management process. The two are not actually incompatible, they are both based upon ensuring the defence system is able to operate in the service environment and go through the same five basic stages of establishing a requirement, formulating a strategy, defining the tasks and work programme, undertake the task and demonstrate compliance. The French military standard CIN EG01 implements a single process but does not explain how this can be used for different procurement strategies. Nevertheless the CIN EG 01 does have some features which are unique.

The US Mil Std 810F sets out an environmental management process that is based upon versions adopted in earlier version of the standard. The process is comprehensive but does not align with either the UK, French and likely European wide approaches. This seems to be because the Mil Std process is very much related to the US defence procurement. The Mil Std environmental management process is very much built around documentation which does not appear to be particularly flexible. Moreover, experience would suggest it is often not adopted by US defence equipment suppliers.

The environmental management process of STANAG 4370 AECTP 100 is intended as hybrid of US and European approaches. However, it effectively sets up yet another process which complies with none in national European use. It also does not appear to be particularly flexible and has not stood the test of real usage.

Neither the Mil Std process or the STANAG 4370 AECTP 100 process appear align with the procurement process that is adopted by many European countries. The adoption of the US based standard for European procurement would, it could be argued, put the European defence industry at a disadvantage. A similar argument could be made for the NATO standard which has also not stood the test of extensive usage. Although neither the UK DEF STAN 0035 part 1 or French CIN EG 01 have shortfalls, together, they are far and away better than the STANAG 4370 AECTP 100 process. Amalgamation of the French and UK environmental management processes is entirely viable as they cover similar ground but are aimed at different people. Amalgamation of the two processes would also allow integration with the European Defence procurement process.

Environmental Conditions

Since the early 1980 s it has become the norm to use environmental test severities based upon in-service conditions. When this approach was first initiated it necessitated many data collection exercise. However, since then it has become common to include environmental conditions in Environmental standards. Environmental conditions can be broadly divided into two groups, those which describe the natural environment and those which describe the conditions self induced by defence equipment. Descriptions of the world-wide natural environment should have a degree of commonality to all countries and equipment. Conversely, the induced environments are likely to be unique to a particular platform and consequently country and equipment specific. This notwithstanding some platforms are used by several countries and anyway similar platforms exhibit similarities. Moreover, common methods of transport of defence equipment is frequently a necessity.

Natural climatic conditions are described in a number of standards. These are generally reference documents indicating the extent and likelihood of world-wide natural conditions. Generally, the most commonly referenced values relate to the temperature and humidity conditions occurring world-wide. Also of common concern are the occurrence of sand & dust, salt atmosphere, rain, ice snow etc.

The UK Def Stan 00-35 Part 4 presents an extensive description of natural conditions based upon UK Meteorological Office records. Part 4 of Def Stan 00-35 is extensively based upon information the earlier Def Stan 07-55 and its use has a significant historical base in the UK. Generally, each section in Part 4 addresses a separate natural environment. Each section comprises two chapters the first presenting data from the Meteorological Office records and the second offering advice on how this can be used in defence equipment design. The temperature and humidity distribution maps included in Part 4 are essentially based on 1 in 1000 occurrence and have recently been updated (and will be published in version 4) by professional meteorological staff. The revision has utilised the forecasting meteorological office database which has considerably more measurements in terms of both location and samples than the historical bases used by some standards.

The actual meteorological data presented in UK Def Stan 00-35 Part 4 was also the base for the information contained in STANAG 2895. This STANAG is relatively well known as it is intended to be incorporated in STANAG 4370 AECTP 200. It is observed that STANAG 2895 has proven difficult to obtain in the past but now appears to be available from the NATO website. Although containing the same information as the UK Def Stan 00-35 Part 4 the STANAG is generally acknowledged (even ion the UK) as much easier to use and understand (hence the revision of the Def Stan).

GAM EG 13 environmental data and models also contains natural climatic information which is grouped in a similar manner. The data appears to be based upon French meteorological data, as a consequence, some differences are apparent but they are generally not that great. As was the case in the previous two cases, the extreme temperature and temperature/ humidity conditions are presented in map form. Unlike a lot of GAM EG 13, the climatic conditions are only available in French and this may have limited NATO adoption.

In the US natural climatic information is contained in Mil Std 310 (and previously 210). Again this is laid out in a similar manner to the other standards. In this case the data presented are mostly extreme conditions and do not appear to be based upon the same level of detailed information as the STANAG / Def Stan or GAM EG documents.

It would be reasonable to assume that natural climatic information is not limited to defence standards and that civil standards would present similar information. That is the case with IEC / EN 60721 Part 2 presenting information on the natural environment. However, the information is notably less extensive than that presented in the defence standards. Whilst, the extreme temperature and temperature/ humidity conditions are presented in map form, the criteria used to create these is unclear. The maps are quite different to those of the STANAG / Def Stan and appear to be based upon considerably courser information. The information in IEC / EN 60721 Part 2 was last reviewed over 15 years ago although currently a programme of revision is underway. That revision only has access to historical database information and operates without a budget. As consequence, it seems unlikely that the current revision will produce a result anything like as good as the defence standards.

Of the information on the natural climatic environment, that contained in STANAG 2895 (and shortly to be included in STANAG 4370 AECTP200) appears to be the most widely adopted both in NATO and Europe. It is based upon high resolution UK Meteorological information for world-wide conditions. The UK has updated their own document and hence the STANAG using funded meteorological expertise. It seems unlikely that any other defence or civil standard will approach the quality of the STANAG for sometime to come.

Information on induced environmental conditions is contained within a number of national and international standards. A large majority of this information on induced environmental conditions relates to mechanical conditions which are in turn relates to the particular platforms and methods of operation in use in individual countries. As a consequence commonality of induced environmental conditions is unlikely to be achieved by standards except at a generic level. Even when it is the case that the same platform and method of operation is used in several countries, the resultant description and derived test severity may vary. This is because different countries may adopt different methods and factors in the derivation of environmental descriptions and test severities. As the method of derivation can be significant that aspect is addressed separately in the next section. As a consequence of these issues the view of the Expert Group has been that direct comparison of severities would not be viable or meaningful, nor would any recommendation on induced environmental conditions. Nevertheless the following paragraphs are offered for general information.

Although IEC / EN 60721 Part 2 contains information on the natural environment no information is given at all on induced environmental conditions. IEC / EN 60721 Part 3 contains quantitative information on environmental conditions for a variety of conditions, no descriptive information is supplied. Moreover, the categories for which the quantitative information is supplied are broad, only vaguely defined and frequently considered out of date. The quantitative information itself is very coarsely specified and set out in the form of test severities rather than environmental descriptions. Overall IEC / EN 60721 Part 3 contains the sort of information that was common in the 1960 s and 70 s but which has not been used for anything but minor defence procurement since the 1980 s. Most vertical civil standards which use IEC / EN 60068 test procedures specify their own severities rather than adopt those of IEC / EN 60721 Part 3.

The US national standard Mil-Std 810F Part 2 contains more information on induced environmental conditions than did the earlier versions. However, most of the information is by way of illustration rather than a deliberate intent to specify environmental conditions. Mostly, Mil-Std 810F Part 2 contains fall back test severities which may be based upon actual in-service data. Not only is the method of transformation not generally specified, but different approaches are used for different environments. Some of the in-service environments are unique to US platforms and a few of the most severe cases represent platforms no longer in-service use.

The French national standard GAM-EG13 contains an annex for induced environmental data. This supplies sample information for a good range of platforms in common use by the French military for a range of in-service conditions. Similarly the UK Def Stan 00-35 Parts 5 and 6 contains information on induced environmental for mechanical and climatic conditions respectively. Again the standard contains a range of sample information for a good range of platforms in common use by the UK military for a range of in-service conditions.

The NATO standard STANAG 4370 AECTP 200 contains extensive information on induced environments. The base for the induced environments seems to be Part 5 and 6 of UK Def Stan 00-35. However, contributions from the French GAM and the US Mil Std can be identified. Overall AECTP 200 is strongly biased towards European information. Moreover, the AECTP 200 document appears to contain both the most recent and extensive information on environmental conditions. Any such information database is unlikely to be comprehensive and in this case notable absence of data exist from a number of major European countries who manufacture defence equipment.

Guidelines For Deriving Test Profiles (Tailoring).

The strategy of deriving test severities from In-service has lead to the need to supply guidance information on methods for the deriving test severities from measured In-service data. This information is mostly by way of guidelines as no single set of procedures has been found to be applicable in all circumstances. As no consensus exists as to appropriate methods it is unlikely that any real recommendation is possible. The following indicates the information available.

CIN EG 1 gives how to tailor disregarding the type of environment , but without presenting the details of operation when they are specific for a type of environment. GAM-EG13 contains a technical annex supplying extensive guidelines on the derivation of test severities for mechanical environments. This technical annex proposes a few generic method which can be consistently applied to the vast majority of in-service conditions. For those methods comprehensive guidelines are supplied which champion a number of novel methods. In this regard the French national standard GAM-EG13 has demonstrated significant technical innovation.

The UK defense standard Def Stan 00-35 presents extensive information on the conditions and mechanisms causing many induced environments. Understanding the conditions causing the environments is considered an essential precursor to the use of any test derivation process. The Def Stan also includes some guidelines on the derivation of test severities but these are neither comprehensive, modern or particularly innovative.

Mil Std 810F contains relatively few guidelines on the derivation of test severities and mostly these relate to specific test types. It does make reference to a fair number of reports. The guidelines that are contained in the Mil Std are mostly derived from those reports although the information is not always well or consistently extracted.

International Test Operating Procedure ITOP 1-1-050 is a Quadripartite agreement between US, UK, F & DE. This particular ITOP is entitled The development of Laboratory Vibration Test Schedules . It effectively presents the method used to derive the vehicle vibration test severities contained in Mil Std 810. It sets out the type of (US) test track used and results for a number of individual US vehicles. It also presents a lot of information on basic vibration & shock analysis. However, apart from the one method, it does not expand this basic textbook information to encompass any other test severity derivation methods. The vehicle test derivation method presented is one of two used in Mil Std 810 (the other is entirely different) and it is rarely used in Europe. In short the ITOP is little more than a supporting document for the Mil Std and is not consistent with European practice. Like many of the environmental ITOPS this has almost no discernible European content and relates entirely to US practice. As such it could be argued that it puts European defence system suppliers at a disadvantage.

Stanag 4370 AECTP 200 contains limited guidelines on the derivation of test severities. This is essentially a summary of guidelines presented in the French GAM, the UK Def Stan and supporting papers referenced in the in US Mil Std. For an overview of potential methods the STANAG is quite useful, although users who are attempting to implement these methods are unlikely to find the STANAG particularly helpful. Nevertheless as a starting point the STANAG is recommended.

Fall Back Test Severities.

Historically all environmental test procedures contained related test severities. However, over the last two decades these have been replaced by a strategy of deriving tests based upon intended In-service use. As a consequence the severities remaining attached to the test severities are intended only for use when no information is available or when the item may be used in many platforms (typically COTS and MOTS items). Mostly use of these fallback severities is intended to be limited to small items, subsystems or components. Many of the remaining test severities are relatively rudimentary and are frequently intended for use on the most basic test equipment.

The test procedures of Def-Stan 00-35 Part 3 mostly have fallback test severities appended. Some procedures also contain guidance on these severities. However, the majority of the guidance is in Parts 4, 5 and 6. The severities are mostly historical and have a long track record. With that said they have all been reviewed for applicability at reasonable intervals. The severities indicate backward compatibility has been considered. Whilst, the fallback severities have a degree of commonality with other specifications, overall they are not precisely equivalent with other standards.

The second part of GAM EG 13 addresses the fall back levels. They are split in 5 documents, in function of the sector which is concerned;

GAM EG 13 A for army
GAM EG 13 B for air force
GAM EG 13 C for navy
GAM EG 13 D for missiles
GAM EG 13 E for ground equipments.

The above fall back levels have not been updated from the original issue and are now superseded by STANAG 4370 AECTP200 except for air force (not including aero transport) where DO160 is recommended When STANAG 4370 AECTP200 are not covering the need , GAM EG 13 A, B, C and D are still applicable.

The test procedures of GAM-EG 13 also have fallback test severities appended. Again the severities are mostly historical and have a long track record. Until recently they were all reviewed for applicability at reasonable intervals. The severities indicate backward compatibility has been considered. Whilst, the fallback severities have a degree of commonality with other specifications, overall they are not precisely equivalent with other standards.

The test procedures of Mil-Std 810F again contain have test severities. Although a few of these have a long track record, others have changed markedly as the various revisions of 810. Backward compatibility does not seem to have been a strong driver in those that have changed. Whilst, the fallback severities have a degree of commonality with other specifications, overall they are not precisely equivalent with other standards.

A significant proportion of the test procedures of STANAG 4370, specifically the AECTP 300 and 400 series, relates to fallback severities. Indeed the amount of information frequently swamps that the procedure itself resulting in a marked loss of firmness of statement. Generally, the fallback severities are based upon the UK Defence standard, the French GAM and the US Mil Std. In some cases a single fallback severity recommendation results. However, in other a compromise approach of presenting several options is adopted. Although it is intended that the STANAG fallback severities will be broadly implemented, at the moment, it is difficult to identify which severities are used in different countries. It has been argued that in combining the various national requirements, a test schedule more extensive can result than is required by a national defence procurement authority. In this regard the STANAG fallback severities may be resulting in more expensive programmes than is necessary.

International Test Operating Procedures (ITOP s) 1-2-601 & 5-2-506 present fallback shock severities for missiles and vibration severities for wheeled & tracked vehicles as well as a single helicopter. All of these are based upon US fallback test severities and were derived using a US procedure not usually used (or considered adequate) in Europe. The severities are at odds with the European national standards as well as the STANAG.

As already indicated IEC / EN 60721 Part 3 contains quantitative information on environmental conditions for a variety of conditions. However, a review around 8 years ago indicated a significant number of discrepancies between this document and the test severities set out in the various test procedures of IEC / EN 60068. To resolve these inconsistencies, IEC / EN 60721 Part 4 was generated to recommend a resolution for each Part 3 category. IEC / EN 60721 Part 4 is set out as a series of test schedules for some notional electro-mechanical equipment. As was the case for Part 3 the environmental categories for which test severities are supplied, the categories used are very broad and frequently considered out of line with current commercial (and military) practice. The actual test severities are very rudimentary, out of date and appears to make undefined sweeping assumptions about life cycle (in-service) usage. IEC / EN 60721 Part 4 is based very much on the test definitions of the type common in the 1960 s and 70 s, an approach which is no longer used for defence procurement for two decades.

4. CONCLUSIONS

The comparisons undertaken by CEN Workshop°10 Expert Group 8 have indicated that all the five commonly used vertical environmental testing standards used for defence equipment have both strengths and weaknesses. It probably comes a no surprise to many users of these different standards that no single standard appears to be ideal for all applications. The final report of Expert Group 8 contains a considerable amount of collated information and comparisons. It is believed that the information presented will be of value to user faced with the need to identify suitable standards for particular equipment development or procurement tasks.

As a final point it is worth observing that with the trend towards international standards it is important that national working groups are not disbanded and the expertise dissipated. Experience indicates that it is from, small active groups working together on a regular basis towards a goal, that new technically inovative concepts are likely to emerge.