MINUTES CEEES TAB R&ESS WIEN 4 oct 2011

1 ADOPTION OF THE 55th TAB R&ESS MEETING MINUTES

The minutes were adopted.

2 APOLOGIES FOR ABSENCES

Harry Roossien was apologized.

3 INTRODUCTION OF (NEW) MEMBERS

There were no new members in this TAB's meeting

. It was suggested during the 54th meeting in Mechelen to make an overview of core members and virtual members, where it was referred to the set-up some years ago. Below the proposed list.

Core Members (Wien meeting)		**Virtual Members**
Henri Grzeskowiak (ASTE)	present	Michel Holy
Colin Weetch (SEE)	not present	Sami Millyniemi
Helge Palmen (KOTEL)	present	Antii Turtola (VTT/KOTEL)
Harry Roossien (PLOT)	apologized	Klaus Kangas (KOTEL)
Boudewijn Jacobs (PLOT)	not present	Roman Betschen (SSEE)
Werner Wittberger (SSEE)	present	Hubert Dollenmeier (SSEE)

Contact data of core members

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4 REPORT

The agenda of the meeting constitutes 4 documents as RP (Review Proposal) to review.

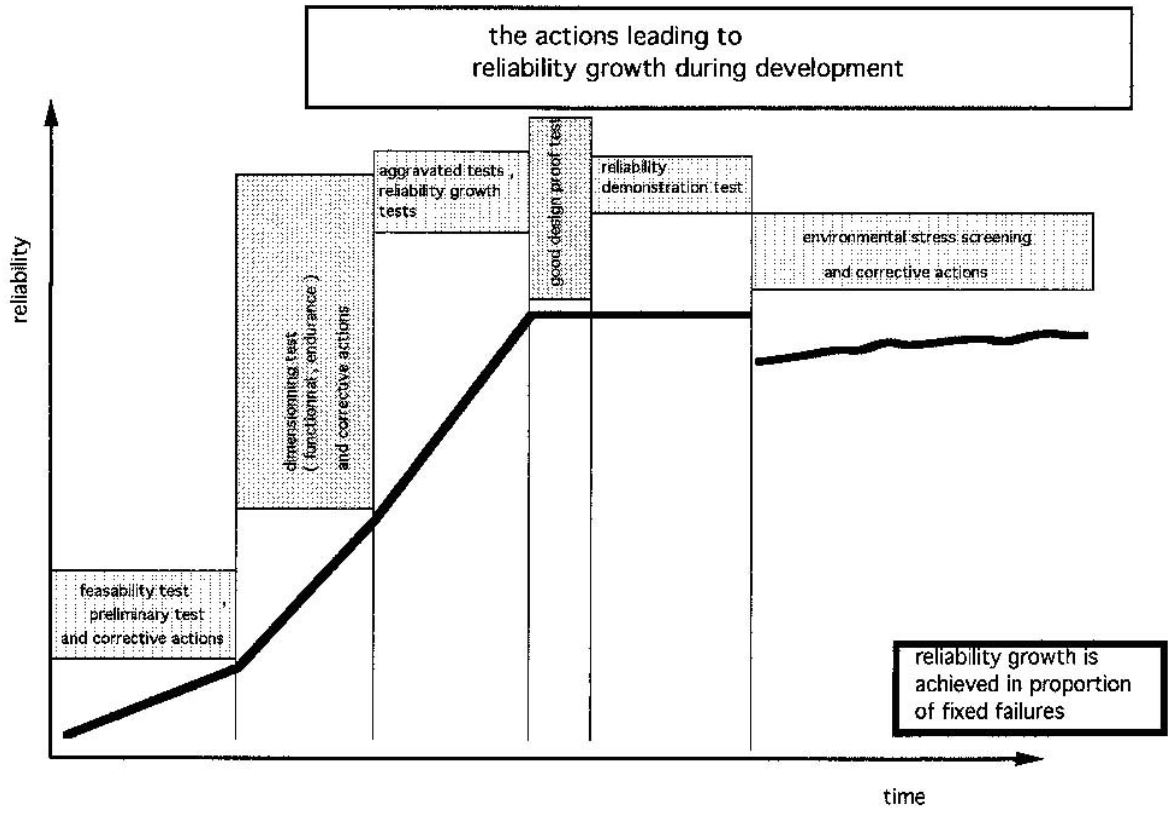
4.1 Review of CEEES Publication n° 9.

This publication was already reviewed in the 54th meeting in Interlaken and today's TAB has focused how to implement the recommendations. Further notes recall (in blue character) the different questions which have been arisen.

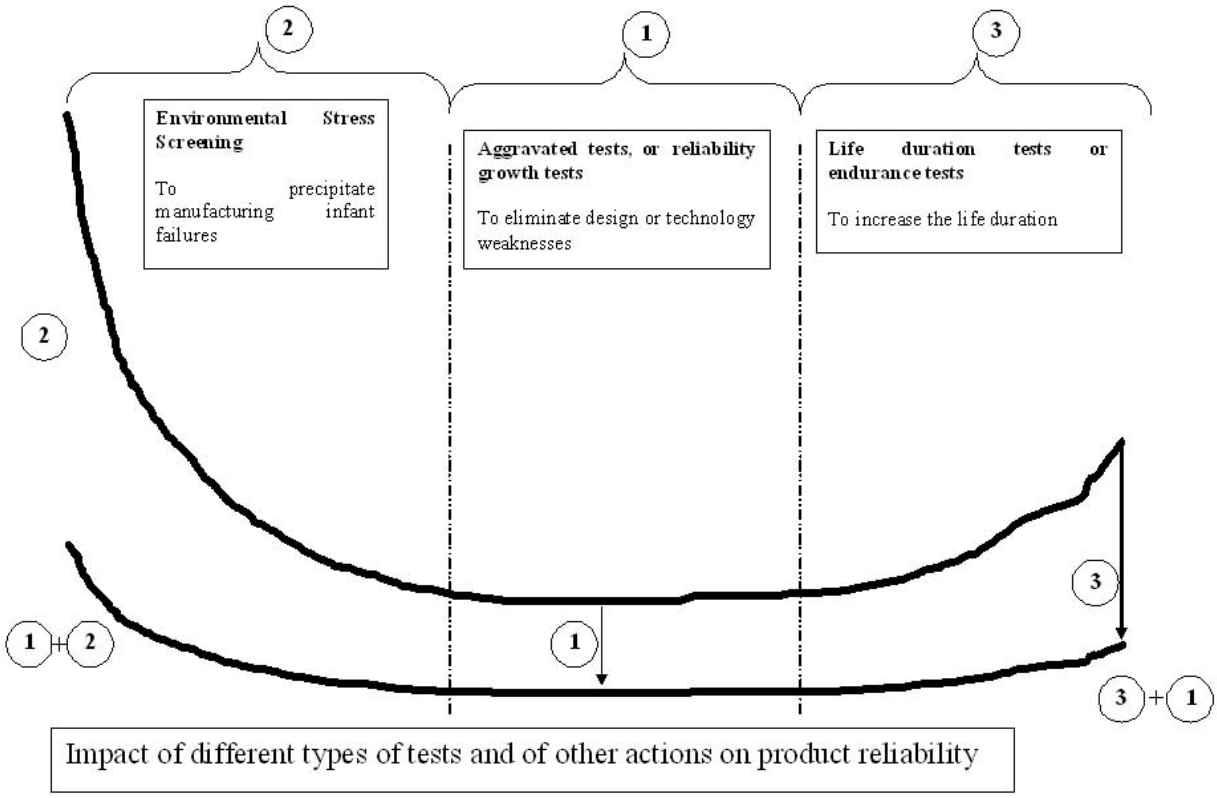
New pictures suggested (from Henri, in Helge's notes) were studied, but no decisions were made. The proposer of those pictures must be present to fully understand the message of those pictures. Some terms were incorrect. Those should be checked and used consistently during improvement of the publication.

The picture "Actions leading to reliability growth during development" shows that shift to production will lower reliability level. The reason to this should be explained in the publication. The development phases should also be indicated in the picture. The picture includes only tests, but should other issues also be explained? This might require another graph or a table showing for example the use of FMEA, RCA, design rules (and use of derating), DfR (design for reliability) methods etc.

Emphasis was on the word 'might'. The TAB agreed that an explanation need to be given and made an action point for that. Helge is most aware of the Interlaken inputs and the expert background and took the action to come up with a proposal for explanation. (AR 1)



Henri explains why "*the shift to production will lower reliability level*" : at the beginning of production of a new equipment, the production processes (and often some limited aspects of the design) are still under maturation. That is clearly disclosed by the rate of ESS precipitation, generally much higher at the beginning of production of a new equipment. Several months can be required for reaching the maturation.



Impact of different types of tests and of other actions on product reliability

A discussion during the Wien meeting pointed out that some of the members of the R&ESS TAB are attached to the community of Reliability expertise and others to the community of Environmental Engineering Expertise.
The content of the CEEES Publication n° 9 was more intended to the second one type of experts. Henri has proposed (AR 10) to introduce some inputs in order to open the Publication n° 9 to the first type of expertise, but only with the idea to give an overview of the different techniques used by Reliability Experts to the intention of the Environmental Engineering Expertise

> *Too simple assumptions about failure rate behavior in time (infant mortality - constant failure rate or exponential distribution – wear-out period and mechanisms) may be risky in estimating guarantee issues, lifetime etc. Reliable results require quite a large number of test samples as well as long test times. The failure modes and mechanisms found in accelerated testing should be the same as in the field data.*
> Input from Werner was that often exponential models are used, but that other models are of interest too. The TAB discussed about the different reliability models (as well because of inputs in other documents). The PLOT Reliability workgroup had different presentation on reliability models under chair of Boudewijn. He focused on statistical analysis as key issue too. Therefore Boudewijn is asked to make an explanation on the models. (AR 2)

This action (AR 2) is still to be realized.

> *About MTBF calculations based on HALT results: Klaus Kangas recommends to see for example "A method of estimating product field failure rate from results of HALT data", http://www.ewh.ieee.org/soc/cpmt/tc7/ast2008/Bio_Harry_McLean.pdf. Some case examples exist, but does the nature of the HALT approach really allow this?*
> There are doubts within the TAB about the validity of MTBF calculations, especially on the new test techniques like HALT. Werner and his staff members use MIL 217F MTBF calculations, and pinpointed towards full system level. Relationships towards field information

are for older systems possible, but often overhauled by new technology. Werner is asked by the TAB to bring the MTBF calculations into perspective and do a proposal to add in the publication. For example: 'although the relationships between MTBF and field data are sparse, if you like to do calculations you can refer to ……' (AR 3)

As references is the pdf from Harry McLean found to be insufficient. A better reference is the book by K.K. Bothe, World Class Reliability. Another good reference from practical site is from Isabelle Vervenne, who gave some presentations on HALT and MTBF this year within PLOT. Therefore Boudewijn will ask her. (AR 4)

This info will be added to the references list by Werner. (AR 5)

The meeting also thought that something should be mentioned about the reliability of software. The test methods covered in the publication do not include testing or evaluation of software, which should be mentioned. Also it could be added that methods to evaluate maturity of software exist, but the actual reliability of software is difficult to estimate. About terms in general: check for correct English terms and search for example in Wikipedia, http://www.weibull.com/hotwire/issue21/hottopics21.htm, etc.

The importance of software is increasing rapidly, not only the application software, but as well test software. This software as such can constitute a fail mode. With increasing monitoring for new test techniques, as in HALT and HA-ESS, this topic is missing in the document. Therefore the TAB decided to honor this argument and come with a proposal chapter for 'software'. Perhaps on page 10 'Validaton of function'. Harry is asked to come up with a proposal where and what to address. (AR 6)

More notes by Klaus Kangas:

About MTBF calculations based on HALT results: Klaus Kangas (Interlaken) recommends seeing for example "A method of estimating product field failure rate from results of HALT data", http://www.ewh.ieee.org/soc/cpmt/tc7/ast2008/Bio_Harry_McLean.pdf. Some case examples exist, but does the nature of the HALT approach really allow this?
There are doubts within the TAB about the validity of MTBF calculations, especially on the new test techniques like HALT. Werner and his staff members use MIL STD 217FN2 [2] for MTBF calculations, and pinpoint towards full system level.
Relationships towards field information are for older systems possible, but often overhauled by new technology. Werner is asked by the TAB to bring the MTBF calculations into perspective and do a proposal to add in the publication. For example: "although the relationships between MTBF and field data are sparse, if you like to do calculations you can refer to…" (AR 3)

Failure rate estimates based on MIL-HDBK-217 F Notice 2, could be made, based on the guidance in ANSI/VITA 51.1 (2008). This is not a revision of the handbook, but a standardization of the inputs to the MIL-HDBK-217F Notice 2 calculations to give more consistent results. There exists also updates on prediction models, for example IEC technical report IEC TR 62380: 2004 on the subject and an updated model / handbook by the RIAC, "The RIAC Handbook of 217 Plus Reliability Prediction Models" (2006).
Since MTBF is mentioned in different perspectives and was discussed in broad sense in this TAB again. There are different ways to calculate the MTBF (MIL, Milstress, Relpred, Telcordia, Vidas), it might be of interest to add a separate chapter 'MTBF' or 'Product Life Time Calculation'.

Systems in use (by Werner):

Customer feedback by means of occurrence reports contain field data which are valid for the precise mission the equipment under test is experiencing with its users.
If the feedback information is sufficient, the analysis of the data can be structured into showstoppers (mission failures), major and minor problems. The ratio between total operating time and total numbers of failures shows the Mean Time to Failure (MTTF). For constant failure rates this is referred to as the Mean Time between Failures (MTBF) [1].

Feedback from customers is always late and therefore can only be used for deployed systems to discover developing problems if MTTF – figures versus time change too quickly. Very often one discovers different behaviour in maintenance (due to cost reduction plans).

- Klaus KANGAS declares in an email :

- at the moment, you can add me to the group who think that HALT cannot be used to estimate field MTBF failure, BUT I think that HALT is a very good way to find out weak points from the product to make the product more robust and possibly in this way to give more lifetime
- I think it will be hard to understand if failure modes that occur in HALT (soft and hard) could ever occur in a real field case, especially if manufacturer doesn't know very well how and where the product is used. Another case that makes this hard is if you test the whole product in HALT chamber: finding the root cause of a complex product could be very hard, when speed of stresses is this high. Then HALT for a subassembly is a wise thing to do, but you will not get interface etc. whole product failure modes that could occur only when all parts are attached to each other. To make it even harder, let's consider that the whole product has a complex SW, and maybe throw in some components with chemical liquid material....
- It is important to consider the statistical points of view, confidence bounds and to have enough test samples to have reliable failure rate and prober failure distribution used. Can we really trust to say (only based to HALT results) that in the field e.g. 95% of tested products will survive 3years (without failure) when confidence (lower) level is 90%, when product is used according x specification, and in this case not having any months lasting lifetime tests with lesser stresses values than in HALT...? . There is also a space limit in HALT chamber, so would mean quite many HALT tests for bigger products to have enough statistical data.
- Testing in HALT chamber is not cheap. Also to find & understand the root causes and physics of failure takes time and money (well ok also costs to analyze normal lifetime test data...)

Henri has responded that :

The probability density function of a Weibull random variable *x* is:

$$f(x;\lambda,k) = \begin{cases} \frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1} e^{-(x/\lambda)^k} & x \geq 0, \\ 0 & x < 0, \end{cases}$$

where $k > 0$ is the *shape parameter* and $\lambda > 0$ is the *scale parameter* of the distribution. Its complementary cumulative distribution function is a stretched exponential function. The Weibull distribution is related to a number of other probability distributions; in particular, it interpolates between the exponential distribution ($k = 1$) and the Rayleigh distribution ($k = 2$).

The hidden assumption in the article of Harry Mc Lean intitled “From HALT Results to an Accurate Field MTBF Estimate " is that the shape parameter is constant whatever the stress level applied to the unit under test (see the article attached there - this article doesn't give the folowed methodology in detail and the associated assumptions) .
Demonstration of that assumption supposes long duration tests which is the contrary of the seeken objective (i.e. shorten the test duration).

This assumption can be verified in particular for a failure mode following the exponential distribution where k=1 ; some authors consider that for a complex system constituted of many different sub assemblies the trend of the system associated distribution is exponential one. But it could not be generalized . Otherwise, the accelerated tests would have been replaced by Highly Accelerated Tests …which is not the case.

Henri has grapped on Google books some pages of Mac Lean book (see attached in the attached documents)) : it seems that this issue is not at all addressed in it, that is not a surprise.

In other words:

- with accelerated tests we are in the known world (in a limited domain of stress amplitudes : the model of acceleration is known, the associated parameters are known, the invariance of the shape parameter is supposed);
- in the case of aggravated tests (so called Highly Accelerated Tests) , we are in an unknown world, but still assume that the correction of the identified defects ,even in the case they are not relevant to increase the margins will not degrade the product;

And about when is a product mature? =>This is challenging – not necessarily clear even at end-of-life… Problems may rise due to problems in hw – sw joint operation. Suppliers or subcontractors may make changes without announcement and infant mortality issues may be repeated.

This is more part of product quality assurance/control. Integration of HALT in production lines (HASS), requalifications or market reviews, but as well incoming inspections can reduce the risk of infant mortalities. Harry will propose some text to add this perspective. (AR 7)

Response of Henri : a mature product is a product characterized by a completeness of industrialization (production line operational, testing tools available and industrial having achieved a good level of FPY (first pass yield) and having disclosed in operational conditions a reliability close to its inherent reliability . The inherent reliability is a measure of the overall “robustness” of a system or piece of equipment. It provides an upper limit to the reliability and availability that can be achieved. In other words, no matter how much inspection or maintenance you perform, you will never exceed the inherent reliability. It corresponds to the current state of the art.

It was unclear if the document is fully checked on the English language (Red. Harry: in the GA Dave addressed that the text and storyboard was fine today, but when we make additions, we have to be critical towards this.)

Comparison of Estimation Techniques (Werner Wittberger) :

D.J. Wilkins uses HALT / HAST in early project phases to discover problems where their elimination is cost effective, because only a few demonstration models, prototypes are involved. See also [1].

Harry McLean uses HALT over the entire product life. In his presentation he addresses the correlation between field and HALT stresses. Hopefully his advice as to which acceleration model to use for the estimation of the Product’s Field Failure Rate (linear, exponential or quadratic) is given to the readers of his book.

Harry McLean’s proposal of “A Method of Estimation Product Field Failure Rates from HALT/HALT Plus TM” is therefore very welcome.

The method uses 3 different acceleration models and asks for an exact definition of the HALT process according to his book: HALT, HASS and HASA Explained [4].

Gürmen Kahramanoğlu presented in 39 slides his idea of a Field Return Rate Estimation Process which compromises the size and complexity of the equipment under observation, results of Life Data Analysis based on various models and last but not least the maturity level.

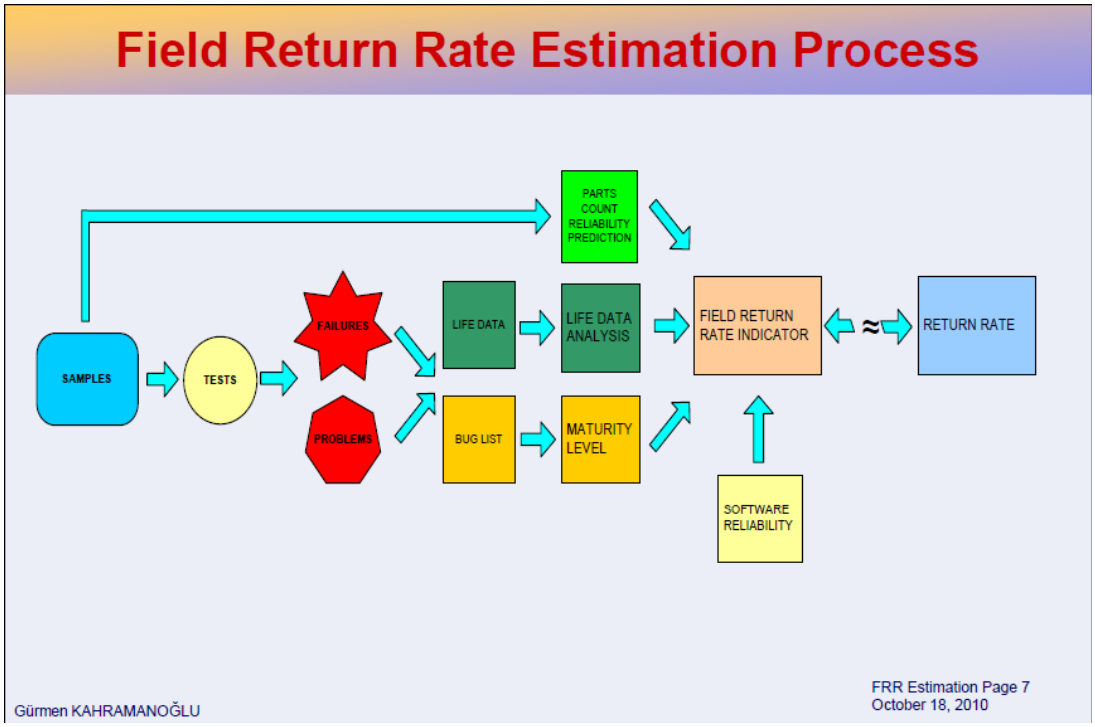
Given the impact and amount of changes on the 2009 version of this document it is proposed to make a 2012 version of the publication.

Gürmen Kahramanoğlu from VESTEL ELECTRONICS points out in a paper presented in October 2010 under IEEE/ASTR/CPMT that the main stress factors are: temperature, humidity, voltage, temperature cycling and vibration. In addition to component failure rate and

failure rates arising from accelerated testing, he creates a failure rate which is calculated from "Maturity Level" of the product and contains:

- Electro Static Discharge
- Voltage Variation, Interruptions, Dips
- Lightning Surge
- Inrush Current while Turning on
- Loose Plug
- Opening the Product at Low Temperature

The usage of the Arrhenius Model, Corrosion-Voltage Model, Modified Coffin-Manson Method and the Basquin-Model are explained in detail.



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The TAB members including Henri agree to prepare a 2012 edition of the publication.

Proposed by Werner proposal for an add-on to Publication N°9 :

Producers need a tool to estimate the Field Return Rate in time to decide if the maturity of their new component, device or system is in line with the requirements. They need to know the return rate of their product including both the infant mortality and the constant failure rate phases.

More than one tool promises to give the right results. Even for in-house equipment with small changes of temperature and humidity, a number of parameters have to be considered involving not only the equipment to be delivered but also the environment of use.

- Electro Static Discharge
- Voltage Variation, Interruptions, Dips
- Lightning Surge
- Inrush Current while Turning on
- Loose Plug
- Opening the Product at Low Temperature

The estimation process according to [5] is in favour because it addresses all the known parameters whereas [3] is fixed to three different acceleration models only and does not address parameters which are not included within HALT.

The validity of the accelerated test should be confirmed by checking if the shape parameter "m" of the Weibull distribution remains unchanged by the accelerated stress [TOSHIBA, 7].

References (AR 5 Werner)

[1] -Reliability- for a Mature Product from the Beginning of Useful life
The Different Type of Tests and Their Impact on Product Reliability
CEEES Technical Advisory Board Reliability & ESS Publication N° 9 -2009- ISSN 1104-6341
[2] MIL-HDBK 217 F, Reliability Prediction of Electronic Equipment 12/1991 (notice 1, 1992-07-10, notice 2, 1995-04-28)
[3] http://www.ewh.ieee.org/soc/cpmt/tc7/ast2008/Bio Harry McLean.pdf
[4] HALT, HASS, and HASA EXPLAINED Accelerated Reliability Techniques Revised Edition 2009, Harry McLean, and ISBN 978-0873897662
[5] Field Return Rate Estimation Process, October 18, 2010, Gürmen Kahramanoğlu , http://www.ieee-astr.org/kahramanoglu_ASTR2010.pdf
[6] http://www.weibull.com/hotwire/issue21/hottopics21.htm, Dennis J.Wilkins, Issue 21, November 2002
[7] http://www.semicon.toshiba.co.jp/eng/product/reliability/device/testing , http://www.semicon.toshiba.co.jp/eng/product/reliability/device/estimation ,
[8] World Class Reliability, K.K. Bothe
[9] Isabelle Vervenne, presentations on HALT and MTBF, (AR 4 Boudewijn)

4.2 ASTE document on HA-ESS

Reminder of the Mechelen report :

SSEE is working on an updated version of their ESS book. Within this book HA-ESS might be addressed as well. This information can be aligned with the ASTE document, but therefore the consequences should be reviewed. It could be two separate documents, but then the information could be inconsequent and not of benefit for the readers and TAB.
Next to technical, the commercial interests are part of this document, a strategic discussion between SSEE and CEEES need to take place, Werner is best to take this action point and start with sending out the contents list of the current SSEE ESS book. (AR 8)
Henri/Werner will organize a strategic meeting with Henri Grzeskowiak, Werner Wittberger, Marco Huber and Thomas Reichert. (AR 9)

Nothing new has been discussed on that topic at the Wien meeting.

Reminder of comments received from Harry :

After first review following issues could help to bring the document from national to european level:
- add explanations and clarifications
  . on distributions/shift
  . on type of failmodes (not unrealistic failmodes)
  . on thermal cycling gradient
  . on precipitation and detection testing vs on/off andstep back.
- add or combine with other practices
  . add statistics (Weibull)
  . add relations to confidence level and test coverage
  . add other standards, to make it an overall document

Since we could do this in the existing document and make it even better, there is a need to have the document, preferably in word-format.
If I receive the document from ASTE: Environmental Stress Screening for Electronic Equipment using Highly Accelerated Tests guide, DEV HA ESS R25 2006, it will be used only

for the above reasons. It will be used for review and update, not be used for commercial reasons.

4.3 & 4.4 Environmental Engineering documents

Reminder of the Mechelen report :

There was no input and review is postponed till next meeting. There is an action for all core-members to look through the documents and present next time what they think need to be done.
(Red. Harry: in the GA it was emphasized that the quality of these document need to be assured and that peers review would be necessary. It might be that not all models are correct or in right perspective (Dave)).

Nothing new has been discussed on that topic at the Wien meeting. No remark has been provided either by Thomas Reichert representing the climatic TAB nor by David Richards representing the mechanical TAB.

5 ACTION LIST

Ref.	Resp.	Action
AR 1	Helge	Make proposal for explanation of other issues in the graphs 'reliability growth'
AR 2	Boudewijn	Put 'too simple assumptions' into perspective and make short explanation on the models
AR 3	Werner	Make proposal to add text to the publication which brings MTBF into the right perspective
AR 4	Boudewijn	Ask Isabelle Vervenne for latest information/references and give that info to Werner
AR 5	Werner	Add the references for MTBF (K.K. Bothe and Isabelle Vervenne/input Boudewijn)
AR 6	Harry	Come up with proposal for software reliability, where and what to add in the publication
AR 7	Harry	Add text to 'assure' product maturity in production and field
AR 8	Werner	Sent out contents current ESS book
AR 9	Werner/Henri	Have discussion between SSEE and CEEES about ASTE document
AR10	Henri	Introduce an overview of the tools used by the Reliability Experts