43th CEEES Meeting

Minutes of R and ESS WG

Meeting location : Baden-Würtenberg Representation to EU, Brussels

Date : 17th February 2005

Attendees : see list hereafter

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1 - ADOPTION OF THE 39th CONGRESS R&ESS MEETING MINUTES

The minutes are adopted.

2 - AGENDA OF THE MEETING

See attachment one.

3 - Apologies FOR ABSENCES

No.

4 - INTRODUCTION OF NEW MEMBERS

No new member.

5- ESS ACTIVITY

It was agreed that there is a need for a basic terminology of terms relative to the tests , environmental engineering and reliability such as MTBF, MTTR, reliability test, accelerated test ….
It was proposed that all the members send a list of these terms , with the known definitions and corresponding source, to Marco , that will arrange a digest of all these inputs for next meeting.
Michel has proposed a list (see in attachment 1). This list has been examined during the meeting.

6- R ACTIVITY

6.1 Life cycles

It has been also decided in London to work of the product life cycles .
Extract from London meeting report : "

- *The expected life profile of a product in different sectors of activity *, which is an important issue to consider in product sustainability growth*
  - *Output : life cycle environmental profile characterisation : climatic related parameters such as number of cycles, temperature range , rate of change , humidity, pressure if relevant, chemical contaminents , etc.)*
    or mechanical related parameters such as PSD for vibration, SRS or time histories for shock, etc.
- *Operational use :*
  - *Dormant periods (storage)*
  - *Functional activation(ON/OF, junction temperature elevation, electrolytic phenomenon,etc.)*
- *Identify the expected processes or modes of failure*
- *Assess the life duration of different type of technologies*

**The sectors of acitivity covered by the current members are : mobile phones, telecommunication, automation/robotics, nuclear power plant, control of climatic chambers, electronics in automotive industry, missiles.*"

Henri is proposing as a beginning to consider the following documents in which there are elements on life cycle profile description:

- French CIN EG 1 " Taking into account the Environment through a product development (see an English version as attached document)
- An example of life cycle description (see a french version as attached document)

- Hank Caruso fundamental paper on LCEP , presented at IEST (distributed during the current meeting) .
- Henri has evocated the Strength / Stress approach ; the general appendix of GAM EG 13 is describing this approach in one appendix (see annex 14 of General Appendix of GAM EG 13 in French , attached to the meeting report , in French)

Henri has also introduced a document dedicated to program management structuration : *EN 9200* .
The work will be continued on the example of life cycle description on the mobile equipment dedicated to pollution measurement.

6.2 Different types of tests

6.2.1 List of withhold tests

Type of test	In charge of	
feasability , design aid	Colin	Done : see att.3
Development test	Michel	
Reliability growth test (RGT)	Bob	
Aggravated tests	Henri	Done : see att.4
Accelerated tests	Helge	
Qualification	Aad	
Reliability demonstration	Bob	
ESS including HASS	Bob for ESS (Henri for HASS)	
Acceptance test	Bengt	
Production reliability acceptance test (PRAT)	Bob	
Pre production (zero production)	Gunnar	
Life duration	Bob	
Verification (validation)	Bengt	

6.2.2 **Template to apply to each of these tests**

1	Test objective (purpose,definition…)
2	What is driving you for performing the test ?
3	Level of assembly of the product submitted to test
4	Number of items submitted to test
5	Type of product relevant to be submitted to the test (mass volume low price product ,..)
6	Test duration (days, weeks, months..)
7	Separate or combined environments
8	Product strength and environment stress variabilities are or aren't considered (in the process of deriving the test severity)
9	Does the test bring knowledge on reliability parameters ?
10	Does the test consume totally or partially the life potential ot the equipment submitted to test ?
11	main norms , standards, technical references relative to this type of tests

For next meeting : the proposed persons will try to apply the template to the corresponding test .

6.3 **Tour of table**

- Bengt : the Swedish ESS group is dormant . The companies haven't the time of sharing their knowledge.

- Colin : SEE is in active campaign to recruit technicians who want to involve in SEE. Work is done on contamination ; a document will be available in July.
- Marco :
    - Hope that a new established organization called TSP (Test Solution Providers = chamber suppliers, testing laboratories, crashing, mechanical stress testing,…) will bring a support to AITPA : a sign is expected during next summer.
- Helge :
    - Seminar presenting the results of a study on dependability management
    - Continuation of the study on reliability parameters : how to achieve them, …
- Michel Holy
    - Workshop on environmental specification for a new product , verification of what was specified,
    - Impact of leadless solders on manufacturing process and on reliability of the Swiss Industry : will bring the proceeding at next meeting in Paris.

- Henri
    - Aste has awaked the ESS WG ; more information will be given next meeting

List of virtual members

Current members + following list.

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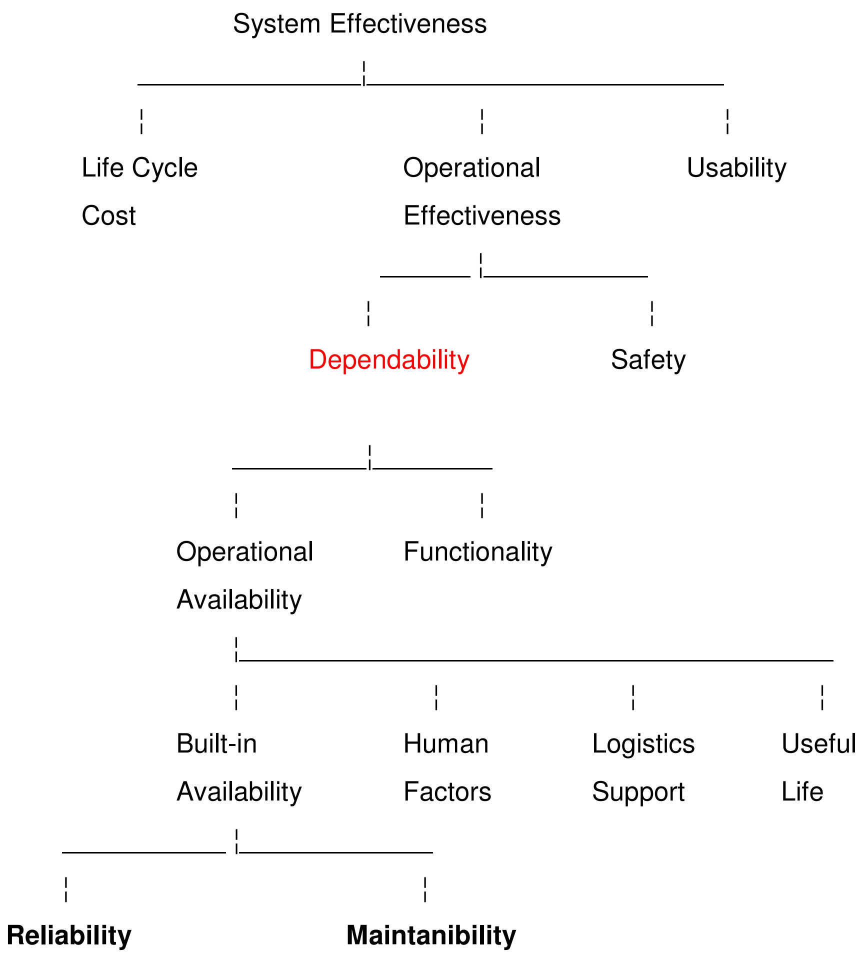
attachment 1

Definition(s) of Terms Dedicated to Availability, Reliability & Maintainability

1) Terminology-Structure



Environment Stress has direct influences on "Reliability" and "Maintainability"

2) Terms of Reliability and their abbreviations

- Reliability Function $\mathbf{R}_{(t)}$
- Failure Rate $\boldsymbol{\lambda}_{(t)}$
- Mean Time Between Failures **MTBF**
- Mean Time To Failures **MTTF**
- Mean Time To Mission - Failures $\mathbf{MTTF_M}$
- Lifetime $\mathbf{T_L}$
- Life Cycle **LC**
- Mission Profile **MP**
- Life Environmental Cycle Profile **LCEP**
- Durability
- Dependability

2.1) Relations between the terms of Reliability

$$\mathbf{MTTF} = \int_0^{\infty} R_{(t)} \cdot dt \qquad \textbf{(for Lifetime} = \infty\textbf{)}$$

for a finite Lifetime the upper limit of the integral is T_L

$$\lambda_{(t)} = d\,R_{(t)} \,/\, R_{(t)} \cdot dt$$

This equation shows that the reliability function $\mathbf{R_{(t)}}$ is completely defined by the failurerate $\boldsymbol{\lambda_{(t)}}$.
With $\mathbf{R_{(0)} = 1}$**,** the reliability function reads as follows:

$$R_{(t)} = e^{-\int_0^{t} \lambda_{(x)}\, dx}$$

For $\lambda_{(t)} = \lambda$ = constant it follows:

$$R_{(t)} = e^{-\lambda t} \text{ and in this case is } MTTF = \int_0^{\infty} e^{-\lambda(t)}\, dt = 1/\lambda$$

2.2) Terms related to Reliability

Reliability
- Analysis
- Blockdiagramm
- Requirements
- Verification
- Program
- Improvement
- Assurance of
- Evaluation
- Of mechanical Items

Failure
- Failure Analysis
  - FMEA (Failure Mode And Effects Analysis)
  - FMECA (Failure Mode, Effects and Criticality Analysis)
- Failure Cause
- Failure Mode
- Failure Symptom
- Failure Criticality
- Failure Effect
- Failure Detection
- Failure Localisation
- 8D process

Fault - Specification-fault
- Engineering-fault
- Manufacturing-fault
- Using-fault

Reliability Improvement during

Engineering - R-Verification
- R-Analysis
- R-Test
  - HASS (Highly Accelerated Stress Screening)
  - HALT (Highly Accelerated Life Testing)
- R-Demonstration

Manufacturing - ESS

- Qualifications-Tests

Product Use - Reliability Growth

3) Terms of Maintainability and their abbreviations

Is there any mathematical presentation of the following terms ?

- Maintenance
- Preventive Maintenance
  - Mean Time To Preventive Maintenance **MTTPM**
  - Time Between Preventive Maintenance **TBPM**
- Corrective Maintenance
  - Mean Time To Repair **MTTR**
  - Repair Rate μ

3.1) Relations between the terms of Maintainability

to be defined

3.2) Terms related to Maintainability

- Maintainability - Analysis
  - Requirements

- Verification
- Program
- Improvement
- Assurance of
- Evaluation

4) Definitions for Systems and/or Hardware

Functionality

[2] The capability of a product to provide the required function when it is used under specified conditions.

Operational Availability; Point Availability

[1] Probability that a product will perform its required function under given conditions at a stated instant of time.

Safety

[1] Ability of a product to cause neither injury to persons, nor significant material damage or other unacceptable consequences

Remark:

Safety is subdivided into accident prevention (the product is safe working while it is operating correctly) and technical safety (the product has to remain safe even if a failure occurs)

[3] State in which the risk of harm (to persons) or damage is limited to an acceptable level

Note 1: Safety is one of the aspects of Quality

Note 2: The above definition is valid for the purposes of quality standards. the term "safety" is defined differently in ISO/IEC Guide 2

Usability

[2] The capability of a product to be understood, learned, used and efficient for the user, when used under specified conditions.

Operational Effectiveness

Logistical Support

[1] All activities undertaken to provide effective and economical use of an product during ist operating phase.

Maintainability

[1] Probability that preventive maintenance or repair of an item will be performed within a stated time interval for given procedures and resources.

Remark:

A qualitative definition is:

Ability of a product to be retained in or restored to the ability to perform its required function in a given time interval under stated procedures and resources.

Maintainability is subdivided in serviceability (preventive maintenance) and reparability (corrective maintenance or repair)

Useful Life

[1] Total operating time of a product, ending for a nonrepairable product when the failure probability becomes too high or the product functionality is obsolete, and for a repairable product when the intensity of failures becomes unacceptable or when after a failure the product is considered to be no longer repairable.

Remark:

The term "Life Time" is only used for nonrepairable products. It is the time span between initial operation and failure of a nonrepairable item.

Reliability

[1] Probability that a product will perform is required function under given conditions for a stated time interval.

Remark:

This does not mean that redundant parts may not fail. Such parts can fail and be repaired.

Defect (only used for software**)**

[1] Nonfulfillment of an intended usage requirement or reasonable expectation, essentially present at t=0

Remark:

From a technical point of view, a defect is similar to a nonconformity, however not necessarily from a legal point of view. Defects do not need to influence the item's functionality. They are caused by flaws (errors, mistakes) during design, production, or installation. Unlike failures, which always appear in time (generally randomly distributed), defects are present at t=0. However, some defects can only be detected when the item is operating and are referred to as "dynamic defects". Similar to defects, with regard to the cause, are systematic failures; they are not necessarily present at t=0

[3] Nonfulfillment of an intended usage requirement or reasonable expectation, including one concerned with safety

Note: The expectation must be reasonable under the existing circumstances.

Defect- Immunity) (only used for software)

[2] The capability of the Software product to maintain a level of performance when used under specified conditions

Note:

Wear or ageing does not occur in software. Limitations in "reliability" are due to faults in requirements, design, and implementation. "Failures" due to these faults depend on the way the software product is used and the program options selected rather than on elapsed time.

Supportability, Maintainability (for software)

[2] The capability of the software product to be modified. Modifications may include corrections, improvements or adaptation of the software to change in environment, and requirements and functional specifications.

Security

[2] The capability of the Software product to protect information and data so that unauthorised person or systems cannot read or modify them and autorised persons or systems are not denied access to them.

Failure

[1] Termination of the ability of an item to perform a required function under specified conditions.

Durability

to be defind

Dependability

[1] Collective term used to describe the availability performance and its influencing factors, such as reliability performance, maintainability performance, and logistical support performance

[3] Collective term used to describe the availability performance and its influencing factors, such as reliability performance, maintainability performance, and logistical support performance

Note 1: Dependability is used only for general descriptions in non-qualitative terms

Note 2: Dependability is one of the time-related aspects of quality

Note 3: the definition of dependability and note 1 given above are taken from IEC 50(191), which also includes related terms and definitions.

Referenced Documents

[1] A. Birolini, Quality and Reliability of Technical Systems
Springer- Verlag

[2] ISO/IEC 9126-1, Software Engineering - Product Quality Part 1

[3] EN ISO 8402 Quality management and quality assurance - Vocabulary

1.0 What is a Feasibility Study?

A feasibility study is designed to provide an overview of the primary issues related to a technical and business idea. The purpose is to identify any "make or break" issues that would prevent the test from being successful. In other words, a feasibility study determines whether the technical issues make sense, as well as the business issues but I am concerned with technical issues here.

A thorough feasibility analysis provides a lot of information necessary for the technical plan. For example, a good market analysis is necessary in order to determine whether the project is feasibility. This information provides the basis for the market section of the business plan.

Because putting together a technical and business plan is a significant investment of time and money, you want to make sure that there are no major roadblocks facing you when the test plan is finalized and you make the investment in time and equipment. Identifying such roadblocks is the purpose of a feasibility study.

A feasibility study looks at three major areas:

1. Market issues (Not dealt with)
2. Organizational/technical issues
3. Financial issues (Not dealt with)

Again, this is meant to be a "first cut" look at these issues. For example, a feasibility study should not do in-depth long-term financial projections, but it should do a basic break-even analysis to see how much revenue would be necessary to meet your operating expenses.

The purpose of the business plan is to minimize the risk associated with a new business and maximizes the chances of success through research and maximizes the chances for success through research and planning.

(cf. University of California)

Technological Issues

The cost and availability of technology may be of critical importance to the feasibility of a project, or it may not be an issue at all.

For example, a service organization, such as a childcare centre, will have a few equipment and other technology- related issues to address. A manufacturing enterprise, on the other hand, may have a number of complex technology questions to analyze in order to determine whether or not the business is feasible.

Key questions to answer include:
a. What are the technology needs for the proposed business?
b. What other equipment does your proposed business need?
c. Where will you obtain this technology and equipment?
d. When can you get the necessary equipment?
How does your ability to obtain this technology and equipment affect your start-up timeline?
e. How much will the equipment and technology cost?
Keeping in mind that technology doesn't necessarily mean complex machinery; if your business simply needs a personal computer, printer, and fax machine, those are your technological needs.
However, making wise decisions on even simple purchases such as office machines may require some research. Obviously there are numerous types of personal computers on the market. You many want to check Consumer Reports for their recommendations, do some comparative shopping, and ask acquaintances about their experiences with different companies. Your cost estimates will get plugged into your financial projections.
Naturally, the more complex the technology you need, the more research that will be required to make good decisions about it. This is important and should not be looked at trivially.

Feasible:
“an examination of a situation to decide whether a suggested method, plan or piece of work is possible or reasonable”.

Feasibility: noun {U}
Whether something is feasible:
"People who consider only price, and not value, are the lawful prey of those who purvey shoddy goods" John Ruskin (1819 - 1900)

2.0 The Technical Issues to Look at During the Feasibility Study

In the commercial market we have to decide what we trying to achieve with a certain test. The main thrust is always the reliability of the product being manufactured.
The product life cycle begins at the component level and continues through assembly level; the life cycle includes exposure to the following environments

Assembly/process
Testing
Storage
Transportation
Operating
Servicing (preventive and corrective maintenance)

2.1.1 Assembly/Process

During processing and assembly of electronic assemblies, temperature excursions take place, e.g. soldering including reflow, cleaning or imposed thermal cycling tests. These temperature excursions can be damaging to some parts of the assembly and consume some part of the available life. This damage should be minimized by keeping the number of excursions to a minimum and the damage needs to be considered in the overall reliability estimates.

2.1.2 Testing

When devising the overall reliability test plan the frequency of applied test to the device and the fatigue that the testing induces into the product will be identified.

2.1.3 Storage

Storage tests will be defined by the product specification. The storage life of the product will be identified which may range from a few months to many years. A storage life cycle may include storage in a mobile unit to storage in a temperature-controlled warehouse.

2.1.4 Transportation

Transportation is not a single event that is simply defined. Each vehicle type may impose unique environmental loads. Each may also provide protection from certain environmental conditions. Duration and frequency of occurrence will influence how environmental effects are accumulated over time. The transportation configuration and degree of loading can also affect the loads imposed on the product.

2.1.5 Operating

It is assumed that the operational characteristics will not affect the reliability test as the unit is a low power device and operational tests.

2.1.6 Environmental Stress Screening (ESS)

ESS has the potential to identify latent defects that may cause early failures in a product. ESS needs to be specifically designed to accelerate the failure of 'weak' elements in the assembly. ESS does not add to the number of such failures but causes them to occur in a significantly shorter period of time.

Effective ESS programmes should be supported by well planned `Root Cause Analysis' (RCA) and corrective action resources. These enable timely corrective actions, elimination of latent defects and ultimate removal of the ESS process subject to continued monitoring and control of the manufacturing process.

3.0 Conclusion

All the above tests will be scrutinized during a feasibility study, equipment, infrastructure human resource and all the associated cost that go with these requirements.

This is the first part in looking at a reliability test programme.

Colin Weetch

1	Test objective (purpose,definition…)	Test where the applied constraints rose in a progressive way in very upper values in comparison to the qualification specified values and the essential objective of which being to investigate the limits of functioning and of destruction of the product in order to push them away, by suited actions, in the limits imposed by the state of the art of technology of its constituents.
2	What is driving you for performing the test?	- time to market of the product - safety consideration (avionics) - maintnability costs - technological limit: the limit of resistance imposed by the technology of a product or of a particular constituent, toward a given constraint (temperature, vibration, electric tension, etc.). This limit establishes so an unbridgeable barrier. Ex: melting point of a plastic building material, temperature the maximum of a functioning a semiconductor in the silicon, elastic limit of a building material, etc.
3	Level of assembly of the product submitted to test	At the lowest possible level of assembly
4	Number of items submitted to test	The statistical aspects in relation with the number of realized AGGRAVATED TESTS on a new product intervene to at least two levels: - The capacity of the AGGRAVATED TESTS to discover relevant causes of failing; - The obtaining the limits of functioning and / or of destruction and the associated variableness. With regard to the capacity of the AGGRAVATED TESTS to discover relevant causes of failing, two cases are be considered: - 1-st case: the relevant causes of failing presumed are of abstract nature and have for effect to

		reveal a problem on every copy subjected to attempt, since an applied constraint exceeds the specified value. It is translated generally by an incapacity of margins, typical case of the use of a badly calibrated constituent. In that case, the realized AGGRAVATED TESTS on a very limited sample of copies, even on the single copy, turns out effective to reveal the existence of the relevant cause of defect and power so to correct it. - 2-nd case: the relevant causes of failing presumed can affect a priori only a weak fraction of the complete population of the product (for example: less than 5 % of the population). In that case, it is not very probable that a limited number of AGGRAVATED TESTS allows to reveal this relevant cause. As example, the use of the model binomial indicate us that if one hopes to reveal an relevant cause of failing affecting only 5 % of the population with a probability of the success of 80 %, it would be necessary to subject about 30 copies to the test of AGGRAVATED TESTS. Such quantity is totally incompatible with the imperative manufacturers. Consequently, the AGGRAVATED TESTS realized in the phase of conception / development on an always very limited number of copies can not have a great efficiency toward the revealing of this type of defects. Only, aggravated ESS (HASS) in the phase of production will be susceptible to reveal, in addition to the manufacturing defects, these defects of the conception which would affect only a weak fraction of the products during their profile of life. With regard to the obtaining the limits of functioning and / or of destruction of the product, the major difficulty places itself in the statistical character

		associated to these sizes. So, the obtaining in a different way given value on the limit of functioning the single copy does not reveal inevitably the central value of the statistical distribution of this limit which could be associated to an important population of the tested product. In particular, this unit experimental value can be a value of tail of distribution, placed to the left or to the right of the distribution. It proves why it is hardly recommended, when it is compatible with the imperatives of development, to make the AGGRAVATED TESTS on several copies and not on the single unity. The number of available copies being always very limited in the phase of development; one can consider that a number of unities which are able to go from 3 to 5 establish an acceptable compromise.
5	Type of product relevant to be submitted to the test (mass volume low price product ,..)	**1. Factors bound in costs and in the strategic context** " Strategic aspects bound(connected) to the market (ex: any right for the error from the launch of the first copies on the market, maturity of the product from the starting, …) " The imperatives of reducing the costs of resumption of the defects of conception " The imperatives of reducing the times of

		development " The imperatives of reducing the durations of ESS " Also applicable in case of change of technologies if conditions of use are corresponding to a light environment " High mass production with weak environmental conditions " off the shelf equipment submitte to light environment in operation **2. bound(connected) Factors on the return to experience (REX)** " The insufficient operational reliability of similar products already developed and produced by the company (REX in operation) " Numerous problems generated in production on similar products of the previous generation (REX in production) **3. Factors bound to the uncertainties** " The use of technologies in very innovative character or of the new strategies of implanting of constituents " Use of new processes in production " The conditions of employment of the product not or little tried

		" Strong variableness of the profile of use of the product (ex: produced " general public ") " Strong variableness of the performances or of characteristics of the product in some constraints of environment or of use " Supply beside new suppliers " The use of constituents except specification (ex: the case of constituents " civilians " used in the military or spatial applications)
6	Test duration (days, weeks, months..)	" The duration of a aggravated tests campaign is very brief : of the order of 5 days on average
7	Separate or combined environments	Combined environments are not a condition but can be employed if necessary to disclose a failure. For example, we can gradually increase the vibration level for a given rate of temperature variation or by increasing gradually this rate for a given level of vibration.
8	Product strength and environment stress variabilities are or aren't considered (in the process of deriving the test severity)	no
9	Does the test bring knowledge on reliability parameters ?	no
10	Does the test consume totally or partially the life potential ot the equipment submitted to test ?	Yes , the product under test is normally destroyed
11	main norms , standards, technical references relative to this type of tests	no