Short History of IEC TC56 from 1965 to 2017

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I. The Beginning of TC56

IEC is the oldest international standardisation organisation, established in 1906.

It standardises everything electrical. ISO is from 1947 and standardises everything else.

In 1962 Germany proposed an IEC committee on reliability. In 1965 Germany, Sweden and Denmark started negotiations to establish what became IEC TC56. From Sweden, it was Olle Björklund from the Swedish military telecommunication laboratory (FTL). From Denmark, it was the director of ElektronikCentralen (now DELTA institute) Tage Rasmussen (former Risö Nuclear research institute), Haunstrup-Clemmensen from Danish Telecom (KTAS) and Professor Hald, statistician from Copenhagen University. The committee was formally established at the IEC plenary meeting in 1966, and the committee began its work, and published its first standard IEC 300-1 in 1967. Olle Björklund was convener of WG3 until 1991 and Haunstrup Clemmensen participated in TC56 until 1997.

The name of the committee was initially "Reliability of electronic components and equipment". In 1980, this was changed to "Reliability and maintainability" and in 1988, to "Dependability". IEC TC56 expanded the scope of the work by including new aspects of reliability. In 1970, Maintainability, in 1982 Software reliability, Managerial aspects of reliability and "guide to inclusion of reliability clauses into specifications for components and parts." In 1984, Availability, in 1985 Field data and Design review, in 1987, Life Cycle Costs (LCC), in 1988, Human reliability and in 1989, Risk analysis and Ease of Use.

II. From Reliability to Dependability

In the US, the military standards were dominating the field until they in the 1990's were no longer supported by the military and no longer could be required in government contracts. Also, NATO military standards were dominating, especially on the component area.

In the 1950's the abbreviation RAM for Reliability, Availability and Maintainability became common, and in 1954 the RAMS conferences started in the USA. TC56 discussed to use the term "the RAM committee", but his was rejected since only reliability specialists would recognise the abbreviation. Further TC56 also had added maintenance support to the work program. Therefore, it was decided to use a not often used English term "Dependability" as a so called "umbrella term" like "Quality". An "Umbrella term" covers a number of different aspects, some of which is quantifiable, end some are not. The "umbrella term" itself is not quantifiable. This also allowed in English and in other languages to distinguish between reliability as a measure and the wider aspects of reliability, now called "dependability".

There was a long discussion about the definition of the term "dependability". One issue was if "dependability" is a property of a product (called an item in IEC terminology). The present definition of "dependability (of an item): to perform as and when required" defines it as a property of an item. This creates a problem with the term "maintenance support" which is not a property of an item, but rather the conditions under which it is used. An alternative proposal is that "dependability is the summary of activities, like analysis, tests etc. that give the manufacturer, customer or user confidence that the product will perform as required after it is taken into use."

III. Organisation of TC56

A. *Chairmen*

- Jacques Eldin, France 1965 – 1973
- Guy Peyrache, France 1974 - 1981
- Arnould d`Harcourt, France 1981- 1991
- Claude Benski, France 1991- 1997
- Jeff Alstead, UK 1997 - 2008
- Valter Loll, Denmark 2008 - 2017
- Tom Van Hardeveld, Canada 2017 -

B. *Secretaries / Secretariat*

- E.G.D. Patterson, USA 1965 - 1973
- Richard Jacobs, USA 1974 - 1982
- Kjell Strandberg, Sweden 1983 - 1991
- ??????, UK 1991 - 1993
- Jane Moss, UK 1993 - 1997
- Mick Maghar, UK 1997 -

C. *Assistant secretaries*

- Richard Jacobs, USA 1969 - 1973
- J. Edelman, USA 1974 - 1982
- Bengt-Olof Malmberg, Sweden 1983 - 1991
- Function deleted from 1991

D. Working groups and conveners

TC56 had in 1990 the following 12 working groups:

- WG1 Terms and definitions (Colin Desborough, UK)
- WG2 Data collection (Flavio Riciniello, Italy)
- WG3 Equipment reliability verification (Valter Loll, Denmark)
- WG4 Verification and evaluation methods (Statistics) (Jan Rise, Sweden)
- WG5 Formal design review (Richard Jacobs, USA)
- WG6 Maintainability (Helmuth Gross, Germany)
- WG7 Component reliability (Gerhard Meyer, Germany)
- WG8 Reliability and maintainability management (Göran Holmberg, Sweden)
- WG9 Analysis techniques for system reliability (M. Villemeur, France)
- WG10 Software aspects (Dave Kiang, Canada)
- WG11 Human aspects of reliability (R. Pope, UK)
- WG12 Risk analysis (Jan Krasnodepski, Canada)

In 2001 Mr. Alstead reduced the number of working groups to 4. The present conveners (2017) are :

- WG1 Definitions (Mohinder Grover, Canada)
- WG2 Methods (Jeff Jones, UK)
- WG3 Management and large systems (Jean Cross, Australia)
- WG4 Software (Yoshiki Kinoshita, Japan)
- Further the following advisory groups were added:
- SAG (Strategic Advisory Group, Tom Van Hardeveld, Canada)
- LAG (Legal Advisory Group, Dai Davis, UK)
- CAG (Communications Advisory Group, Joffrey Smitham, UK)

The Strategic Advisory Group (SAG) advises the chairman, coordinates the work between the WG's and prepares decision proposals for the plenary meetings. This saves time during the plenary meetings.

The LAG is a unique group, only found in TC56. It consists of international lawyers that look at how the TC56 standards would be interpreted in different courts around the world. The LAG gives advice to the chairman, the WG conveners and the project leaders.

The Communications Advisory Group is an advisory group that work on promoting the knowledge and use of TC56 standards around the world. They work with books, presentations, papers, conferences and through the TC56 homepage. The CAG usually holds a seminar in each country where there is a TC56 meeting. It is extremely important to increase the knowledge about standardisations and standards (especially TC56 standards) around the world. It is planned to increase the activities of the CAG in the future.

IV. Work Program of TC56

During the first 25 years TC56 produced 35 standards. In 1988 at the plenary meeting in Tokyo, a new structure of TC56 standards was decided, the so-called toolbox concept. The idea was that a number of guide standards would advise non-experts and guide them to the relevant standards to perform a given task. Each guide would therefore point to a number of tool standards, that contained the actual methods. Experts could however go directly to the appropriate tool standard. At the same time an ambitious program of 45 standards was passed. The last standard of those planned was finished in 2007. At that time IEC had changed its emphasis to self-contained standards, to avoid that a customer had to buy one standard to find out which standard(s) to buy to perform a given task.

IEC as well as ISO have a number of technical committees (TC's). Most of them cover products (product committees) like automotive, railways, oil and gas, IT, machines etc. But some committees in IEC as well as ISO produces standards that cover several (or all) product areas. These standards are called horizontal standards (generic standards). The product standards are called vertical standards. Well known horizontal standards are ISO 9000 for quality, ISO 55000 Asset Management and ISO 10012 Measurement technique. Of course, TC56 has always produced horizontal (generic) standards covering all product types. The vertical committees produce product standards, where they for dependability requirements should refer to TC56 standards, adding, modifying or exempting requirements as needed by their specific products.

In 1988, TC56 was requested to make generic (horizontal) standards that covers also non-electrical products. A coordination committee JCG QDS (Joint Coordination Group-Quality, Dependability and Statistics) was set up between ISO JTC 176 (ISO 9000), TC56 (Dependability) and ISO TC 69 (Statistics). The coordination group was later dissolved.

The work of TC56 was a great success. From 1988 to 1989, the number of documents on the FDIS stage increased from 4 to 13, and continued to grow the following years. At that time, an approved FDIS document would be edited by an editing committee consisting of the project leader, the secretary and the chairman. This process would take up to 3 days. Kjell Strandberg as secretary and Bengt-Olof Malmberg as assistant secretary, both working for Ericsson were very busy at their daily work, so the publishing of the FDIS documents was much delayed. The publication at that time was made by book printing (on paper). At the plenary meeting in Vienna 1991 the US headed an action against these delays. The plenary lasted into 1:30 in the morning and Kjell Strandberg resigned in anger. Claude Benski from France then took over as chairman and BSI in the UK took over as secretariat. With a professional full time secretary, the accumulated pile of FDIS documents were published much faster.

Unfortunately Claude Benski had been seriously ill, and the vaccinations he had to take before traveling to India tragically caused his death in 1997.

V. TC56 AND EUROPEAN NORMS

In 1961, the European Union set up the CEN standardisation committee as a European parallel to ISO and in 1973 CENELEC as a European parallel to IEC. In 1988 ETSI followed for the telecommunication standardisation, as a European parallel to IEC. These standardisation organisations make European Standards, named European Norms (EN). These norms were important for implementing the European CE-marking scheme to create an open market, where only one approval was needed in order to sell a product in the whole of Europe and the associated EFTA countries (e.g. Norway). The difference from IEC and ISO is that the European Commission orders some standards made and pays participants for the work.

The standardisation work procedure is similar to IEC and ISO with the difference that, for the European standards, large countries have more votes than the small countries. In IEC and ISO, each country has one vote. Another difference is that for international standards (IEC and ISO) the countries that voted "yes" to a standard are required to implement it as national standard. But there are no consequences if they do not. Countries that voted "no" are not required to implement the standard as national standard. For European norms (EN) the rule is that all European countries must implement an EN as their national standard even if they voted "no". If they do not do it, they will have a court case at the European Court. When a country implements an EN as a national standard, conflicting national standards must be withdrawn. In practice, an EN is implemented as a national standard by double labelling it. For example, in Denmark the EN would be labelled DS/EN followed by the number of the EN (DS means Danish Standard). The title will normally be translated, but in many cases the whole text of the standard is not translated. Similarly, an IEC standard can be implemented as DS/IEC followed by the IEC number or DS/ISO followed by the ISO number.

Since CEN, CENELEC and ETSI did not want to duplicate the work already done by IEC and ISO, these international standards could become EN through the parallel vote process. The procedure is that when the final draft (FDIS) is sent for out for vote in the whole world the countries in Europe at the same time vote using their weighted vote system i.e. the large countries have more votes than the small countries. The criteria for passing the vote is the same 2/3 of the passed votes with the whole world counting one vote per country, and for Europe counting with the weighted votes. If the FDIS is passed also in Europe using the European voting system, the FDIS will be an EN besides being a IEC or ISO standard.

One of the main purposes for setting up CEN, CENELEC and ETSI was to make standards that could be used in the approval process for products in order to apply the CE-mark to the product. It is important to note that the CE mark is a free trade mark. This means that no European country can demand more tests and approvals if the product bear a CE-mark. But the CE mark does not cover quality or reliability, but only safety to persons, property and environment. Therefore, safety was a very important issue for the CE-marking scheme.

For that reason, TC56 standards could not be sent to parallel vote for many years since they were seen as safety standards. But an agreement was made that TC56 would not make safety standards, and after that TC56 standards were sent for parallel vote, where so far all were passed and became EN. It should be noted, however, that TC56 writes standards on methods used for safety and risk analysis like, for example, FMEA (IEC 60812), FTA (IEC 61025), HAZOP (IEC 61882) and IEC/ISO 31010 Risk analysis methods.

An EN does not automatically qualify for use in the CE marking scheme. Before it can be used for CE-marking the EN has to be harmonized, a process that normally takes approximately 6 months. But in 2017 there is a huge backlog of about 600 standards that have to be harmonized. The European Commission is therefore trying to simplify the process and speed it up.

Basically standards are for guidance, i.e. compliance with the requirements in a standard is voluntary, unless the standard is called out in a contract, in the quality management system of the company / organisation, or listed by the manufacturer for compliance with a CE-mark.

Standards can be used for certification e.g. ISO 9001 and ISO 55001, if a standardisation body offer such certification. If a company / organisation chooses to be certified, compliance with the standard that the certification is based on is of course required. But more standards may be used to comply with specific clauses in the certification standard. For example for the life time of a product (ISO 9001 Clause 8.5.5) IEC 61649 Weibull analysis may be used. For determining if an asset is improving or deteriorating over time (ISO 55001 requirement) IEC 61710 Power law may be used. TC56 therefore supply tools that may be used to comply with specific requirements (clauses) of certification standards like for example ISO 9001 and ISO 55001. However it must be emphasised that the company / organisation are free to use other methods that they choose themselves, if they in that way can show sufficient compliance with the certification or CE-marking requirements. But since it is easier to use and more readily accepted by certification bodies and authorities most companies / organisations prefer to refer to international standards and harmonized standards.

VI. EXPANSION OF TC56 STANDARDS

TC56 already in 1982 started to make standards on software dependability. The story is that the software product committee protested against TC56 making standards on software. The convener of WG10 (now WG4), Dave Kiang met with the chairman of the software committee. His first words were: "What does TC56 know about software?" – "Nothing", Dave Kiang answered" and then said "What do you know about reliability?". After that they began to talk, and TC56 did make a number of software reliability standards.

Over the years TC56 has widened its scope based on the request in 1988. The standards are truly generic covering not only electrical products (see for example the new version of IEC 60812 FMEA). But the TC56 standards now also cover services like IEC 60300-3-12 Integrated Logistic Support and IEC 60300-3-14 Maintenance and maintenance support.

The development of TC56 can be illustrated by the figure below.

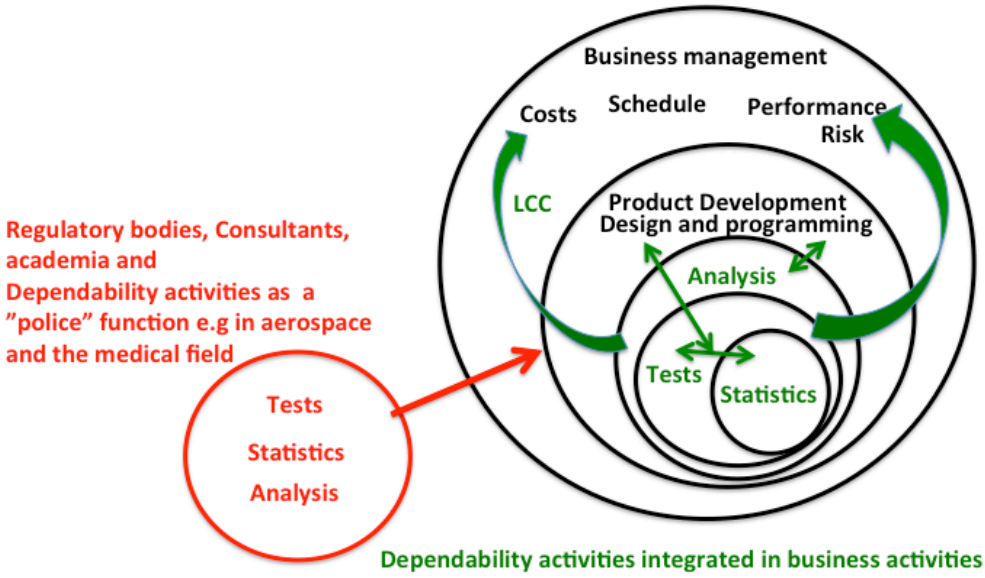

Figure 1

TC56 started with test and statistics. Later some analytical activities like prediction (IEC 61709), FMEA (IEC 60812) and tests (IEC 60300-3-5 and IEC 62506) were added. At that time reliability (RAM) activities were primarily performed by specialists outside the product development and manufacturing process. The quality and reliability function was deliberately kept separated from the persons performing the work, so it was often seen as a "police" function. This was especially prevalent in the aerospace and medical field. Further regulatory bodies took this approach. This is also the perspective of the consultants and academia. It is illustrated by the red circle.

Later it was realized that reliability (RAMS) could not be tested into the product through the so-called Test Analysis and Fix (TAAF) method. Therefore, TC56 started to make standards to support design activities like IEC 61160 Design Review, IEC60812 FMEA, IEC61025 FTA, IEC 61078 Reliability Block Diagrams and IEC 60706-2 Maintainability studies and requirements during the design and development phase.

Later procedure standards were made to support the design activities like for example IEC 60300-1 Dependability management systems, IEC 60300-3-3 Life Cycle Costs (LCC), IEC 62402 Obsolescence management, IEC 60300-3-15 Engineering of system dependability and IEC 60300-3-16 Guide for the specification of maintenance support services.

Finally, TC56 has addressed the dependability aspects of business management, giving standards to support the activities concerning costs (IEC 60300-3-3 Life Cycle Costs (LCC)), performance (IEC 60300-3-4 Guide to specification of dependability requirements) and risk assessment techniques (IEC/ISO 31010).

Of the 58 current TC56 standards, 5% give definitions, 34% are management standards and guides, 34% are test and statistical standards and 27% are analytical standards (review, FMEA, FTA, BRD etc.).

In recent years Dave Kiang and Tom Van Hardeveld have argued for widening the concept of dependability from the narrow Reliability, Availability and Maintenance (RAM) to include more aspects of a product performance such as maintenance, integrity, durability, disposability, security, survivability, environmental sustainability, serviceability, vulnerability, retainability, accessibility, safety and capability. This has caused a heated discussion in TC56 especially since new members are joining the work as the old members retire. The new members question the basic assumptions of TC56. This is a good and necessary discussion, but unfortunately the new members do not know the 58 existing standards or their history.

A special new aspect of dependability is asset management (ISO 55000). It was realized that the modern society is critically dependent on a number of large systems such as the power grid, water supply, sewer and flood control, gas and oil supply, telecommunication, railways, air traffic, roads and bridges. This infrastructure is in many western countries very old and breaking down. It is very hard to find funding to maintain it, not mentioning renewing it. For non-western countries the problem is that the infrastructure is not well developed and not well functioning. The existing ISO 9001 system address products and services, and is not suitable to address those problems. Therefore, ISO has developed the ISO 55000 Asset Management series of standards that give requirements and guidance on managing assets like these large systems. Like ISO 9001 it is possible to be certified according to ISO 55001. More than 10 Australian companies and organisations are already certified according to ISO 55001.

The role of TC56 in this is that TC56 provides the tools needed to fulfil the requirements of ISO 55001, for example, IEC 60050-692 Electric Power Systems, dependability and quality of service, IEC 60300-3-3 Life Cycle Costs (LCC), IEC 60300-3-12 Integrated Logistic Support (ILS), IEC/ISO 31010 Risk assessment techniques, IEC 60812 FMEA, IEC 61025 FTA,

IEC 61078 Reliability Block Diagrams, IEC 61649 Weibull analysis, IEC 62502 Event tree analysis, IEC 60300-3-2 Collection of dependability data from the field, IEC 61710 Power Law model, IEC 61070 Steady State Availability, IEC 61014 Reliability Growth, IEC 60706-5 Testability and diagnostic testing, IEC 60300-3-11 Reliability centred maintenance, IEC 61882 HAZOP studies, IEC 61907 Communication network engineering and IEC 62508 Human aspects.

It was noted that all large systems are today controlled by software. Since most of these systems are somehow connected to the internet, they are vulnerable against attack through the internet (malware). For example, the power distribution system today uses intelligent power meters at the consumers premises. These meters can be read remotely, and it is possible to change the price of electricity hour by hour, day and night. This allows the consumer to shift the consumption to the time when the price of electricity is low, for example, using washing machines and dishwashers and charging the electric car by night. At the same time the consumer can sell electric power from wind turbines and solar cells at the actual price. But the consumer will probably control the wind turbines and the solar cells by a PC, which is also connected to the internet. Since the power meters are connected to the distributor of electric power that also are connected to the power stations and the international power networks, it is possible for a foreign nation or a terrorist to infiltrate the power distribution network and in theory close down the electricity supply of a big city. When a hurricane hit Houston the city was without power for 2 days – 55 persons died. In the hurricane Katrina, 1833 persons died.

Therefore, TC56 has started work on a standard IEC 62853 Open system dependability that addresses those large open systems. This work is very important.

VII. The Future

The future will give large challenges but also possibilities for TC56. The concept of the circular economy and sustainability creates a demand for tools for designing, analysing, testing, monitoring, maintaining and withdrawing such systems. In the summer of 2017, the European Commission has started work to increase the lifetime and maintainability (repairability) of products. This program will require a number of the existing standards of TC56 as well as new standards. The ISO 9001 has in its previous editions limited its scope to quality of the product during the warranty period. But the 2015 edition of ISO 9001 in Clause 8.5.5 Post-delivery activities requires the supplier that:

"In determining the extent of post-delivery activities that are required, the organisation shall consider: a)….b) the potential undesired consequences associated with its products and services c) the **nature, use and intended lifetime** of its products and services d… e) customer feedback NOTE: Post-delivery activities can include actions under warranty provisions, contractual obligations such as **maintenance services**, and supplementary services such as **recycling and final disposal**."

TC56 has the tools needed to monitor the reliability, the life time, maintenance and final disposal in order to fulfil these requirements of IEC 9001.

TC56 has been early in implementing new ideas. For example, TC56 issued certificates of appreciation to members that had done a significant work for TC56. A few years later, IEC implemented their 1906 Award. TC56 also 3 years ago reduced the time in office for WG conveners to 3 years with possible re-election. The reason for this was to make room for the next generation of leaders in TC56. A few years later, IEC implemented the same rule for the whole of IEC.

In 2017, TC56 has 23 countries as full members (P-members) and a number of countries as observers (O-members). TC56 has 192 experts and maintains 58 standards, each of which has to be checked and if needed updated at least every 5 years. TC56 has published 15 standards the last 5 years and now has 9 active projects. Sales figures for TC56 standards are not among the highest in TC56 but certainly above average.

Since 1988 meetings have been held in 18 different countries around the world. Every year two meetings are held, a spring meeting and a plenary meeting in the fall. To coordinate with other standardisation committees of IEC, ISO and other standardisation bodies, TC56 maintains liaison with 27 other standardisation committees. In 2017 the representative from IEC Central Office stated that TC56 is a very well run committee. The future bodes well for further developments and improvements in the valuable contribution that dependability standards are making in an ever-changing technological and societal environment.