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Electronic components – Long-duration storage of electronic components – Guidance for implementation

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRONIC COMPONENTS –

Long-duration storage of electronic components – Guidance for implementation

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Draft PAS	**Report on voting**
47/1792/NP	47/1826/RVN

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned will transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of three years starting from 2005-09. The validity may be extended for a single three-year period, following which it shall be revised to become another type of normative document or shall be withdrawn.

INTRODUCTION

This PAS applies to the long-duration storage of electronic components.

Although it has always existed to some extent, obsolescence of electronic components and particularly of integrated circuits, has become increasingly intense over the last few years.

Indeed, with the existing technological boom, the commercial life of a component has become very short compared with the life of industrial equipment such as that encountered in the aeronautical field, the railway industry or the energy sector.

The many solutions enabling obsolescence to be resolved are now identified. However, selecting one of these solutions must be preceded by a case-by-case technical and economic feasibility study, depending on whether storage is envisaged for field service or production, for example:

– remedial storage as soon as components are no longer marketed;

– preventive storage anticipating declaration of obsolescence.

Taking into account the expected life of some installations, sometimes covering several decades, the qualification times, and the unavailability costs, which can also be very high, the solution to be adopted to resolve obsolescence must often be rapidly implemented. This is why the solution retained in most cases consists in systematically storing components which are in the process of becoming obsolescent.

The technical risks of this solution are, *a priori*, fairly low. However, it requires perfect mastery of the implemented process and especially of the storage environment, although this mastery becomes critical when it comes to long-term storage.

All handling, protection, storage and test operations must be performed according to the state of the art.

The application of the approach proposed in this document in no way guarantees that the stored components are in perfect operating condition at the end of this storage. It only comprises a means of minimizing potential and probable degradation factors.

ELECTRONIC COMPONENTS –

Long-duration storage of electronic components – Guidance for implementation

1 Scope

This Publicly Available Specification (PAS) is, first of all, a practical guide to methods of long-duration storage (more than five years) which summarizes the existing practices in the industry.

Unless otherwise specified, the approach, as well as the methods presented, apply to all families of electronic components, such as

- passive components, including quartz crystals, connectors and relays. However, components with "manufacturer's" specifications showing an expiry date or specific storage conditions are excluded from this document (for example, primary cells, storage cells, etc.);
- encapsulated or non-encapsulated active components of a silicon [Si] or gallium arsenide [GaAs] technology;
- micro-electronic assemblies.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-17:1994, *Basic environmental test procedures – Part 2: Tests – Test Q: Sealing*

IEC 60068-2-20:1979, *Environmental testing – Part 2: Tests – Test T: Soldering*

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 61340-5-1:1998, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

IEC 61340-5-2:1999, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide*

IEC 61945, *Integrated circuits – Manufacturing line approval – Methodology for technology and failure analysis*

IEC 62380: *Reliability data handbook – Universal model for reliability prediction of electronics components, PCBs and equipment*

EN 190 000:1995, *Generic specification – Integrated monolithic circuits*

3 Storage decision criteria

Any creation of an electronic component inventory should be carried out

- on the one hand, after having compared with the following additional solutions:
  - modification to the printed board by adding a "backpack" macro-component;

- development of a specific ASIC;
- production relaunched at a manufacturer specialized in the resumption of obsolete technological processes and components;
- complete revision of the board or the equipment;

- on the other hand, by taking into account the following aspects.

3.1 Advantages

3.1.1 Technical simplicity – Rapidity

When the various steps of the storage process are finalized and validated, the creation of a stock is a simpler, faster and technically less hazardous solution than developing or modifying electronic boards.

Storage can also be a temporary solution enabling equipment maintenance during modification or development of electronic boards.

3.1.2 Solution durability

Any equipment changes based on the use of new electronic components will be faced, eventually, with the obsolescence of these new components. Storage can resolve obsolescence problems until the end of the operating life of the equipment.

3.1.3 Preventive storage

Preventive storage (i.e., before the component becomes obsolete) presents several additional advantages compared with remedial storage (i.e., when the component has already become obsolete), for example, when

– the component price has not become prohibitive as in the case of specific obsolete components which have become very rare;

– the quality level is ensured if the component can be purchased direct from the manufacturer or approved distributor. When a component has been obsolete for a long time, it can only be found at specialists in purchasing, storage and resale of obsolete components ("brokers"). In this case, no component reliability guarantee will apply.

3.2 Hazards – Drawbacks

3.2.1 Generic aging hazard

Stock dimensioning is based on the assumption of a constant component failure rate. The problem of generic aging of the components ("bath-tub curve") cannot be easily taken into account and quantified. However, the existing electronic components seem to have extremely long lives provided that they are manufactured with all quality guarantees and that they are used in accordance with their specifications.

3.2.2 Poor stock dimensioning

The calculation of the volume of components to be stored may be based on feedback (operational failure rate) and/or on theoretical models (predictive failure rate). Calculation using feedback is only valid if the sample is big enough (significant population of components installed, operation for several years, high number of failures evidenced). Predictive calculations do not generally take into account the extrinsic parameters of the components (defects caused by printed-board handling and repair, systematic replacement of the components (including functional components) during repairs, improper use of the components, etc.). Therefore, the stock volume may be improperly assessed.

Underestimating the stock may lead to a lack of components to repair printed boards, which will ruin the stock strategy. Overestimating it will lead to the purchasing and conditioning of components which will not be used, including to significant additional costs.

3.2.3 Incorrect control of reliability during storage

Storage conditions shall be precisely defined and controlled, in order to guarantee the reliability of the components stored (see Clause 5). In addition, it is important to check the quality of the components to be stored (see Clause 4). This may lead to the setting-up of fairly heavy and costly infrastructure and procedures.

Checking component quality may be an efficient means of reducing the risk of improper reliability control during storage. This can be done either by performing periodic sampling in order to carry out tests on the components (see Clause 6) or by checking that the components taken from the stock and used on the electronic boards operate correctly (provided that the consumption of the components in stock is sufficiently regular).

3.2.4 Freezing equipment functionalities

Storing components to ensure equipment maintenance over a long time implies that the equipment functionalities be frozen. A long-duration storage solution is therefore not very compatible with the desire to upgrade equipment and functionalities.

3.3 Storage cost

In order to assess the cost of a storage solution, various items should be taken into account, such as:

– component purchasing;
– validation/test of purchased component batches;
– conditioning and de-conditioning;
– stock management;
– maintenance of installations dedicated to storage by means of manufacturing tests and/or repair;
– staff ensuring storage, maintenance operations, etc.;
– financial cost of tied-up stocks.

3.4 Decision criteria

The following criteria should be taken into account:

– planned storage time;
– stock dimensioning;
– dimensioning reliability index;
– life of test means;
– life of manufacturing means and/or printed boards;
– competence traceability and related documentation;
– industrial consequences of under-dimensioning or a component failure at the end of storage;
– confidence level in the knowledge of potential component failure mechanisms;
– cost compared with other solutions.

4 Purchasing – Procurement

4.1 List of components

A detailed list of the components used shall be established. It should include the designations, specifications, manufacturers and the corresponding trade references.

This list shall be related with the various lists of electronic boards (by means of either a procurement code, or a generic designation).

The purpose of this list is to

– define all components of a market or a series of equipment;
– allow component approval at the beginning of their design stage;
– allow field service procurement

An example of this list is given in Annex A.

This list shall, as far as possible, mention the probable life of each component over a 10-year period.

4.2 Quantity of components to be stored

There are two types of requirements:

- production stock;
- field service stock.

Special attention shall be paid to

– specific components;
– single-source components;
– components becoming obsolete before the end of production.

Care will also be taken to make sure that the stored quantities take into account parts used for tests considered as destructive.

4.2.1 Production stock

This stock shall guarantee productions in progress and future productions (to relaunch the market).

4.2.2 Field service stock

This stock shall enable components to be kept operational during the whole life of the equipment and systems (for example, 25, 30, even 40 years for military, railroad or nuclear power plant equipment).

A stock of the various component types shall be made up from the parts lists, the bills of material and feedback (observed failure rate).

ASSESSMENT EXAMPLE: These batches of parts, calculated according to the following formula, should not be less than 3 % of the total number of components installed (the higher of the two values) on the relevant equipment:

$$N_o = N \times h \times \lambda \times A$$