Research on the Standard System of Avionics Component Management Plan

Shuiquan Pang[1,a], Fangfang Song[1,b*], Zhifeng Lei[1], Xinhong Wei[1], Jun Luo[1] and Zhizhe Wang[1]

sq_pang@126.com[a], songff@ceprei.com[b*]

China Electronic Product Reliability and Environmental Testing Research Institute, Guangzhou, Guangdong, People's Republic of China, 511370[1]

Abstract: The difficulty in understanding the IEC/TS 62239 series of standard documents is an important reason for the inefficient preparation of the electronic component management plan (ECMP). This paper interprets the technical requirements of the IEC/TS 62239 series of standard files and builds the ECMP standard system framework to help those unfamiliar with the IEC/TS 62239 series standards to quickly understand the process of preparing the ECMP. Application analysis shows that different institutions may have different ECMP management requirements, but all management requirements are within the interpretation range of this article. Therefore, managers can choose from them quickly according to their needs. If there are further study needs, one can also find documents according to the ECMP standard system framework of this paper, thereby reducing the cost of ECMP development.

Keywords: ECMP, standard system, avionics, process management, management plan

1 INTRODUCTION

With the development of the aviation industry, the aviation field has put forward increasing requirements for the quality and reliability of avionics electronic components, and the requirements for the standards related to the management of avionics components have become more and more urgent. In order to guarantee to customers that all of the electronic components in the equipment of the plan owner are selected and applied in controlled processes compatible with the end application, Boeing first proposed the electronic component management plan (ECMP) in the 1990s according to the internal management document D6-55583, and established an avionics component management system with 25 major aircraft and aviation product manufacturing companies such as Honeywell, Airbus and British Airways [6, 10]. Hereafter, ECMP is used as the basis for the operation of avionics manufacturers. In 2001, the international electrotechnical commission (IEC) specially established the avionics process management technical committee (TC 107), and issued IEC/PAS 62239: Process management for avionics – management plan. The management plan was adopted by IEC and issued in the form of technical specification (TS) in 2008. Subsequently, it was supplemented and updated in 2012, 2015, 2017, and 2018 [4, 7].

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IEC/TS 62239 applies to avionics components users, including aviation equipment manufactures, subcontractors, and maintenance factories [5]. The specification specifies the basic requirements for the preparation of ECMP, that is, the maker of the management plan shall ensure to the end user and the management organization that the selection and application process of all electronic components used in the equipment is controllable, and consistent with the final application, and meets the technical requirements specified in the technical specification [3]. The specification describes the objectives and technical points to be achieved, but does not restrict specific work items, data and reports. Therefore, the plan maker can select corresponding standards and specifications according to the objectives described in the technical specification, and record the most effective process (Wang 2021, Zheng 2020). However, the IEC/TS 62239 documents have about 150 pages and involve more than 160 standards [1-2]. The lack of sufficient understanding of them is one of the important reasons for the high cost of ECMP development. Therefore, it is essential to quickly understand the technical requirements of IEC/TS 62239 and the composition of the ECMP standard system for the efficient formulation of ECMP.

This paper outlines the technical requirements of IEC/TS 62239 to help those unfamiliar with IEC/TS 62239 series standards understand the process of ECMP development. Subsequently, in order to show the scope and composition of the information contained in IEC/TS 62239 in a structured way, the ECMP standard system framework is constructed based on the referenced standard documents of IEC/TS 62239, thereby providing clues for users to understand and apply the IEC/TS 62239 documents, and reducing the cost of ECMP development.

2 ECMP TECHNICAL REQUIREMENTS INTERPRETATION

IEC/TS 62239 requires the person in charge of the plan to form an ECMP procedure document that can be used by the planned holder. As shown in figure 1, the procedure document should cover eight aspects of technical content: component selection, component application, component qualification, continuous component quality assurance, component dependability, component compatibility with the equipment manufacturing process, component data, and configuration control. According to the procedure or production line requirements, if the reason is reasonable, the person in charge of the plan can add or delete clauses, but the revised clauses need to be reviewed. The technical elements are summarized as follows:

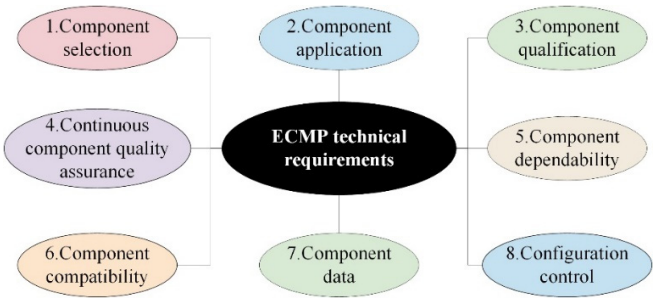

Figure 1. ECMP technical requirements.

2.1 Component selection

The ECMP procedure document shall include the selection principles and preferred catalog of components that meet the requirements of this specification and meet the specific use conditions. The application environment, acquisition availability, and risk of stopping production of the selected components shall be specified. At the same time, specific quality identification tests for components with additional requirements, such as screening, uprating, and additional parameter requirements, shall be conducted. In addition, the type of selected components and their product manuals, application instructions, packaging forms, reliability data, production process data, manufacturer data, and specifications should be fully confirmed during the selection process of components and ensure that the components meet the final use requirements.

2.2 Component application

The ECMP procedure document shall fully consider various application design elements, including electromagnetic compatibility, derating and stress analysis, thermal analysis, mechanical analysis, testability, maintainability, aviation irradiation, lead-free treatment, anti-counterfeiting, humidity, corrosion, etc. Not all elements may be related to the specific application of the components. However, procedure documents applicable to most products should be formed to ensure that the selected components can meet the use requirements in the whole production, storage, and service life cycle. In order to ensure the rationality of the equipment design, a formal design review shall be conducted.

2.3 Component qualification

Component identification is divided into manufacturer/distributor/subcontractor quality identification and product quality identification. The former requires verification of the quality evaluation and management system of component manufacturing and distribution organizations, as well as procurement of components from component manufacturers and distributors with corresponding qualifications. The latter requires that the rationality, qualification, and reliability of the selected components be verified, and the methods to achieve the application quality and reliability be recorded in writing, including the quality appraisal plan, test process, sampling, and acceptance standards of each product.

2.4 Continuous component quality assurance

The ECMP procedure document shall ensure that the quality and performance of all components used in the whole production cycle are stable before the delivery of the equipment and ensure the consistency of the quality between batches of the same components, as well as that the delivered products meet the requirements of the delivered equipment.

2.5 Component dependability

Within the warranty period/maintenance period and/or service life of the equipment agreed with the user, as long as the user uses the components within the agreed environmental limits, the ECMP procedure document shall ensure the reliability, availability, maintainability, risk and out-of-grade response measures of the components. For integrated circuits used in aviation equipment, it is necessary to design their wear life for aviation applications.

2.6 Component compatibility with the equipment manufacturing process

The ECMP procedure document shall confirm that the components are always compatible with the equipment manufacturing process and will not affect the quality and reliability during the transportation, delivery, storage, equipment manufacturing, assembly, transportation, handover, storage, testing, repair, rework, and other processes of components. If there is an impact, it should be detailed how to identify, record, and control the impact of the above processes on components.

2.7 Component data

The person in charge of the plan shall own and complete the data system to collect all relevant data from component manufacturers, equipment design manufacturers and users, and store, keep and analyze the data according to the customer or regulatory requirements. The procedure document shall ensure that the data manual, technical and application notes, use conditions, identification and quality supervision data, packaging data, reliability data, availability information, storage conditions, assembly data and other additional information of any component can be obtained.

2.8 Configuration control

The procedure documents shall ensure that the equipment configuration management is consistent with the actual use of components. At a minimum, each component shall include a list of controlled components and records traceable to the original manufacturer of components. If there is no complete traceability record, it shall be verified whether the components comply with the detailed specifications of the original manufacturer and the quality and reliability level.

3 ECMP STANDARD SYSTEM FRAMEWORK CONSTRUCTION

IEC/TS 62239 puts forward basic requirements for the preparation of ECMP to avionics equipment manufacturers, subcontractors, maintenance plants, and other users of aerospace components to ensure the quality and reliability of avionics components. According to the relevant requirements of IEC/TS 62239 and the referenced standard documents, the ECMP contains more than 160 standard items, including management standards, technical standards, and product standards. By analyzing the types and scope of application of relevant standard documents, and referring to the framework of the European ECSS aerospace standard system, the ECMP standard system framework can be constructed, as shown in Figure 2.

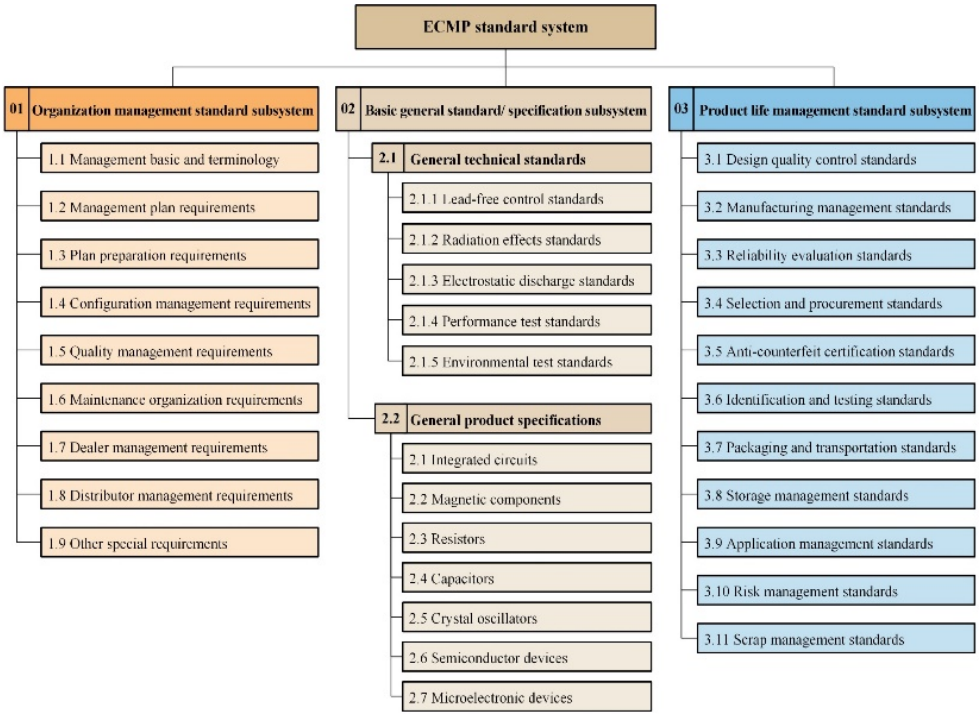

Figure 2. Framework of the ECMP standard system.

The framework adopts a top-down hierarchical structure, which is composed of 3 subsystems and 32 categories. From the structure perspective, the ECMP standard system is composed of three layers. The first layer classifies the relevant standards and specifies the relationship between the subsystems. This layer is mainly composed of three subsystems, including the organization management standard subsystem, the basic general standards/specifications subsystem, and the product life management standard subsystem. Among them, the organization management standard subsystem puts forward management and configuration requirements for avionics components-related organizations. The basic general standards/specifications subsystem provides the general verification technical standards and specifications of products to ensure the quality and reliability of avionics components. The product life management subsystem provides management methods for relevant links in the product life cycle. The second and third layers build subsystem modules according to ECMP standards, and each module contains corresponding management and technical standards. The composition of ECMP architecture will be introduced below.

3.1 Organization management standard subsystem

The ECMP organization management standard subsystem has more than 20 standards, mainly including management basis and terminology, management plan requirements, plan preparation requirements, configuration management requirements, quality management requirements, maintenance organization requirements, dealer requirements, distributor requirements, and other special requirements. Its main purpose is to provide organizational management methods and procedures for aviation equipment manufacturers, distributors,

maintenance vendors, and other aviation electronic component users to help them improve the quality of aviation electronic products and lay a good foundation for promoting sustainable development.

3.2 Basic general standard/specification subsystem

The ECMP basic general standards/specifications subsystem has more than 100 standards, which can be divided into general technical standards and general product specifications. The former mainly includes lead-free control standards, radiation effects standards, electrostatic discharge standards, performance test standards, and environmental test standards, which provide technical methods for the corresponding test and identification of avionics components. The latter is the general specification for avionics components, including integrated circuits, magnetic components, resistors, capacitors, crystal oscillators, connectors, semiconductor devices, and microelectronic devices, which provide effective technical support for ensuring the quality of avionics components.

3.3 Product life management standard subsystem

The ECMP product life management standard subsystem has more than 40 standards, including design quality control standards, manufacturing management standards, reliability evaluation standards, selection and procurement standards, anti-counterfeit certification standards, identification and testing standards, packaging and transportation standards, storage management standards, application management standards, risk management standards, and scrap management standards, which are mainly used to ensure the process management of the product life cycle, and provide technical support for further improvement and improvement of product management.

4 APPLICATION ANALYSIS

Table 1 analyses the application of the ECMP in commercial off-the-shelf (COTS) components by the Federal Aviation Administration (FAA), the European Aviation Safety Agency (EASA) and the Radio Technical Commission for Aeronautics (RTCA). It can be concluded that the requirements of these mainstream agencies for COTS components management have the following characteristics:

1) These institutions believe that it is necessary to carry out COTS components management, but there are inconsistent opinions on the coverage of COTS component management.

2) These institutions consider that the component compatibility with the equipment manufacturing process is not the focus of attention.

3) The FAA has not put forward the requirements of the component selection, while both EASA and RTCA made suggestions on component selection.

4) The RTCA believes that the component dependability is credible, and the configuration control is not necessary. However, the FAA and EASA are exactly opposite.

Table 1. Application of the ECMP on COTS components

Technical requirements	FAA	EASA	RTCA
Component selection	−	√	√
Component application	√	√	√
Component qualification	√	√	√
Continuous component quality assurance	√	√	√
Component dependability	-	-	√
Component compatibility with the equipment manufacturing process	-	-	-
Component data	√	√	√
Configuration control	√	√	-

From the above analysis, it can be seen that the management requirements for different institutions on ECMP applications may be different. Nevertheless, all management application requirements are within the scope of this paper. Therefore, managers can choose from them quickly according to their own needs. If there are further study needs, managers can also find corresponding specification documents according to the standard system framework of this paper, so as to reduce the cost of ECMP development.

5 CONCLUSIONS

By researching the scope and composition of information contained in the ECMP standard system, this paper outlines the technical requirements of IEC/TS 62239, and constructs the framework of the ECMP standard system according to the relevant standard documents, which helps those who are not familiar with IEC/TS 62239 series of standards to understand the technical elements and scope of ECMP development quickly. For those unfamiliar with IEC/TS 62239, this article can serve as a useful entry point to quickly understand the technical points of ECMP and its standard architecture. Although it is impossible to provide every detail of IEC/TS 62239 within the scope of this article, it is hoped that this article can help the responsible person to fully understand the composition of ECMP and reduce the cost of ECMP development.

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