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Space systems — Programme management — Management of product characteristics

Systèmes spatiaux — Management de programme — Management des caractéristiques des produits

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Foreword

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This document was prepared by ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

During the development of space products, it is important to identify critical and major characteristics, and to annotate them in drawings and technical specifications. In design, proper product characteristic classification helps to improve the design quality. In production, proper product characteristic classification helps manufacturing activities successfully implement design requirements, and also helps producers control the characteristics which are critical to keeping the stability and traceability of product quality. In inspection, characteristic classification facilitates effective allocation of inspection effort. Meanwhile, it ensures realization of critical and major characteristics, quality of end product and the preset mission by performing management requirements through all of the development stages.

This document mainly defines the critical, major and minor characteristics of space products, describes the whole management process of product characteristics and specifies related management requirements.

This document focuses on management requirements for identification and control of space product characteristics, especially for critical and major characteristics, which are closely connected with end product quality and mission success, and enhances cost-effective applications in the life cycle of a space product.

In addition, this document will help to clarify and enhance current practices to improve quality assurance, and promote international cooperation.

Space systems — Programme management — Management of product characteristics

1 Scope

This document defines management requirements of product characteristics, including their classification, in order to highlight those areas of the product to which specific attention, control or inspections are applied.

This document is applicable to direct implementation of space product characteristic management, especially for mechanical parts and fluidic equipment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 27025, *Space systems — Programme management — Quality assurance requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9000 and ISO 10795 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
critical characteristic
kind of characteristic whose fault would cause failure of the whole system or major subsystem to perform a required mission or create serious harm to the safety of humans

3.2
end product
product in the assembled and completed state at which acceptance will take place

3.3
inspection unit
unit on which characteristic inspection is performed

3.4
major characteristic
kind of characteristic whose fault would cause the end product fails to perform a required mission

Note 1 to entry: It would not cause failure of the whole system or major subsystems which perform a required mission.

3.5
minor characteristic
kind of characteristic significant to product quality, but whose fault could not affect realization of mission performance of product

3.6
product characteristic
distinguishing feature of a product

Note 1 to entry: Product characteristics can be classified variously, including physical, sensory, functional and so on. In this document, according to the severity of consequences caused by characteristic faults and non-conformance with design requirements, product characteristics are mainly divided into three categories: critical, major and minor.

4 General requirements

4.1 In support of product quality and mission functions, management of product characteristic shall be implemented. As part of management process of product characteristics, the suppliers shall identify and classify product characteristics which shall conform to the requirements submitted by their customer, and implement control measures according to classification in order to highlight those areas of the product to which specific attention, control or inspections shall be applied.

4.2 The suppliers shall especially identify critical and major product characteristics during design phase, focus on their control during the process generating critical and major characteristics, and inspect their conformance with the design requirements.

4.3 According to the severity of the consequences caused by failure and non-conformance with the design requirements, product characteristics are classified into critical characteristics, major characteristics and minor characteristics. The suppliers shall strengthen control of critical and major characteristics with proper measures during the production and inspection process.

4.4 Product designers are mainly responsible of product characteristic identification and classification, and product assurance and process personnel participate. Processes, manufacturing, inspection and other factors shall be taken into consideration during product characteristic identification and classification. The analysis procedure and results of identification and classification shall be documented and reviewed. If necessary, the customer shall take part in the review.

4.5 Identification and classification of product characteristics are implemented over the project phases. The suppliers shall begin to identify and classify product characteristics during the preliminary definition phase in which results of product characteristics analysis including product characteristic category and their control measures shall be preliminarily defined. The suppliers shall continue to make further identification of critical and major characteristics referring to product design and verification, and to update the results of classification during the detail definition phase in which characteristic categories are determined finally.

4.6 Product characteristic management should be supervised by the department with responsibility for quality assurance/configuration and data management.

5 Management process

Management of product characteristic generally includes product characteristic identification and classification, management implementation and management close-out. Figure 1 gives the management process of product characteristics.

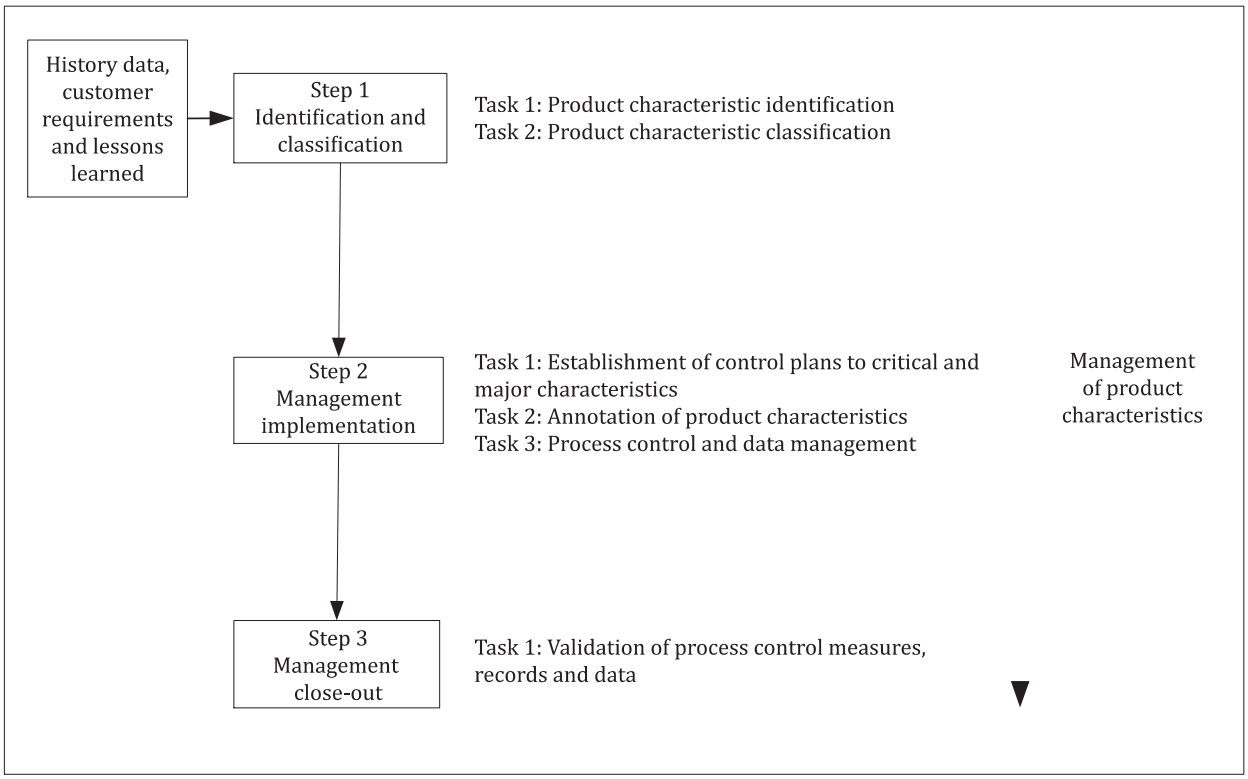

Figure 1 — Management process of product characteristics

6 Identification and classification

6.1 General

Product characteristics identification and classification is a part of design activity. Integrated engineering, dependability, quality assurance disciplines, product characteristics identification and classification is a complicated process with the effort of comprehensive analysis. Engineering experience is needed in accomplishment of identifying and classifying product characteristics.

History data, lessons learned and customer requirements which contain technical requirements, acceptance requirements and project management requirements are the inputs of product characteristics identification and classification. Identified critical, major and minor characteristics are the outputs of product characteristics identification and classification.

6.2 Product characteristic identification

6.2.1 General

Product characteristics identification which includes activities of requirements analysis, design analysis and selection of units of inspection is the basis for product characteristics classification. Through product characteristic identification, the characteristics related to product quality and acceptance of product can be identified, and levels of inspection can be determined.

6.2.2 Requirements analysis

Requirements analysis is a systematic procedure for determining the demands made on product by its intended mission. Requirements analysis shall be performed by the analysis of mission functions of

hardware elements, duration of required performance, environmental limits of the mission, availability of maintenance and effects of failures on the mission. Contents of each analysis are generally as follows.

a) Functions analysis: all functions of the product shall perform during its mission.

b) Duration of performance analysis: the duration of performance required of each function.

When the performance times are random variables, their maximum values should be used.

c) Environmental limits analysis: environmental extremes applicable to the mission.

d) Availability of maintenance analysis: if the product can be maintained in use, consider what maintenance is feasible in the worst case of conditions.

e) Effects of failures analysis: whether partial or complete failure of product can be accepted, and the effects of failure to the mission.

6.2.3 Design analysis

Design analysis is a procedure for identifying and understanding in detail the means by which a product is able to respond to the requirements of its mission. Complete design analysis is required for a new design. Design analysis of existing design is to evaluate history data of similar items. Design analysis is to analyse the design features of hardware elements relative to the requirements of coordination, life, interchangeability, function and safety, and to study material properties, fabrication, assembly and testing processes, tolerances, design life, failure modes, effects of failure on performance and safety. Contents of design analysis are generally as follows:

a) material properties which are significant in determining the quality;

b) means of the item to be processed, fabricated, assembled and tested;

c) interface;

d) interchangeability;

e) design life and characteristics determining the life;

f) product failure modes and failure effects;

g) safety hazard to humans caused by failure; and

h) ways of handling, shipping and storing the product.

6.2.4 Selection of units of inspection

Selection of inspection units shall also take possibility and economical efficiency of inspection into consideration. A product should generally be selected as an inspection unit if it meets one of the following criteria:

a) the end product;

b) the spare part which is needed for maintaining or repairing the end product;

c) the product which is required to be interchangeable for use and safety;

d) the product which is required to be very safe and reliable in using;

e) the product whose characteristics can be determined only in actual service condition (e.g. the product which must be tested destructively); and

f) the product which cannot be inspected, repaired or replaced after installation or whose inspection, repair or replacement costs too much.

NOTE Generally, it is more effective to find the defective product at lower assembly level, and quality control effect is maximized. However, it is more economic to inspect at higher assembly level.

6.3 Product characteristics classification

Based on the results of product characteristics identification, classification is implemented with mainly assessing the seriousness of the relevant defects of the product contributing to the mission. The results of classification are critical, major and minor. Categories shall properly reflect the seriousness of the product defects. It shall not be over-classified or under-classified.

Take solar array drive assembly (SADA) as an example.

Based on the effort of technical requirement analysis, design analysis and selection of inspection unit, examples of SADA's critical, major and minor characteristics are in Table 1.

Table 1 — Examples of SADA's critical, major and minor characteristics

Characteristic	Classification	Reason description
Power transmission and driving functions	critical	If any of these two characteristics is lost, abnormity and malfunction of satellite would happen because of energy lost.
Supporting and load bearing of major structural components	major	It influences load-carrying capability and operation stability of SADA. It may cause SADA to fail to perform required mission, but this may not cause the consequence as serious as critical characteristics.
Weight	minor	It may not affect the realization of mission performance of SADA.

7 Management implementation

7.1 Establishment of control plans to critical and major characteristics

After classification of product characteristics, proper control plans to critical and major characteristics are required and documented to assure these characteristics are effectively controlled during development and ongoing production. As a minimum, a control plan shall contain the following:

a) product name (name of system, subsystem or equipment);

b) characteristic and its classification code;

c) inspection unit;

d) inspection methods;

e) control measures adopted;

f) criteria for judgment of conformity with requirements;

g) time of completion of implementing control measures; and

h) resource support.

7.2 Annotation

7.2.1 General

7.2.1.1 After final determination of product characteristic classification, critical, major and minor characteristics shall be marked on the drawings or technical specifications with proper codes in order to be transitioned from design to production. Production and inspection departments know what to specially focus on, control and inspect through those annotated documents.

7.2.1.2 All of the documents related with the processes of generating critical and major product characteristics shall be marked.

7.2.2 Product characteristic classification codes

7.2.2.1 After the product characteristic categories are determined, the characteristics shall be annotated with proper codes, which generally consist of category code letter and sequence number. Besides, supplementary symbols should be added when necessary.

7.2.2.2 Category code should be marked with capital letters.

EXAMPLE

Critical characteristics: C

Major characteristics: M

Minor characteristics: No letter

7.2.2.3 The characteristics classified should be numbered serially on each drawing and technical specification. Sequence number should be serially placed after the category code letter with an Arabic number.

EXAMPLE

Critical characteristics: C1~C99

Major characteristics: M101~M199

7.2.2.4 Supplementary symbol should be annotated after the sequence number with alphabet in order to designate requirements indicated.

EXAMPLE

A — Part whose characteristic classification is defined as critical or major characteristic when purchased as individual product changes into minor characteristic after assembled.

B — Requirement for check before assembly.

C — The technique parameters can be taken as acceptance basis.

D — Requirement for special test or check.

NOTE When there is D marked in the characteristic classification code, a special explanation on the inspection or test method, condition and requirement are provided.

7.2.2.5 The code structure of product characteristic is shown in Figure2.

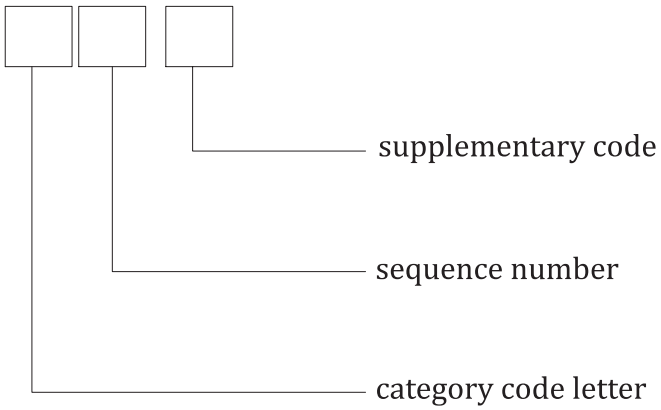

Figure 2 — Code structure of product characteristic

EXAMPLE When the surface roughness 3,2 μm is considered as the first critical characteristic of a part, and it has to be checked before assembly. It shows as 3,2 μm (C1B).

7.2.3 Annotation principles

7.2.3.1 Annotation in drawings should follow the principles below.

a) When some dimension tolerance is classified as a critical or major characteristic, the category code should be marked behind the dimension value with parentheses.

b) When some geometrical tolerance is classified as a critical or major characteristic, the category code should be marked behind the geometrical tolerance frame with parentheses.

c) When a technical requirement is classified as a critical or major characteristic, the category code should be marked before the technical requirement with parentheses.

d) When the product material is classified as a critical or major characteristic, the category code should be marked in the material column of the drawing. A supplementary symbol may be added when necessary.

e) For those drawings of inspection units with critical or major characteristics, the label of “Critical” or “Major” should be marked in the blank corner top-right of the main title bar. For those assembly drawings of inspection units with critical or major characteristics, the characteristic code should be marked in the frame left of the assembly list. If this inspection unit contains both critical and major characteristics, it shall be treated as a critical characteristic.

7.2.3.2 When the product technical specification has the description of critical or major characteristics, the category code shall be marked behind the description with parentheses. Besides, the category code shall be also marked clearly on the specification cover. If this specification contains both critical and major characteristics, it shall be treated as with critical characteristic.

7.2.3.3 For examples of the category codes of critical or major characteristics in drawings or technical specifications, see Annex A.

7.3 Process control and data management

7.3.1 The supplier production department shall perform process-related analysis including process realization, process stability, process inspection analysis and so on, after the documents with category codes are transitioned from the design department. Based on the above analysis, the production department shall identify significant procedures or indexes where special control shall be imposed,

determine the control methods or measures (such as operators, equipment tools and process methods) and mark “Critical” or “Major” in the process documents.

7.3.2 The personnel who perform the processes generating critical and major characteristics shall be trained and certificated or can demonstrate their proficiency through their regular activities.

7.3.3 Materials, equipment, computer systems, software and procedures involved in the process of generating critical and major product characteristics shall be stable, validated and monitored.

7.3.4 100% check shall be performed to critical and major characteristics. If necessary, key inspection points and mandatory inspection points shall be selected. The requirements for key inspection points and mandatory inspection points shall follow ISO 27025.

7.3.5 Before inspection of critical and major characteristics, the supplier quality assurance department shall organize design and production department to analyse and determine the inspection points, methods, procedures, tools, acceptable criteria, record, environment conditions and so on, which are the basis to inspect critical and major characteristics.

7.3.6 The original product data during the process generating critical and major characteristics shall be kept completely and traceable.

7.3.7 Information of abnormal variation and other quality problems shall be reported to quality management department in time.

7.3.8 The inspection results of critical and major characteristics shall be quantitative, completed and traceable.

7.3.9 Deviation and waiver of the critical and major characteristics are not allowed in general. But, if they must be done, they shall be approved by higher authority.

7.3.10 Design and production documents related to critical and major characteristics shall be considered as configuration baseline and shall be maintained stably. Their changes shall be controlled strictly. If necessary, it shall be approved by higher authority. If the categories of product characteristics change, the category codes of products in drawings and technical specifications shall be amended correspondingly.

8 Management close-out

8.1 The suppliers shall monitor and assess the product characteristics and associated control measures for status.

8.2 The suppliers shall implement corrective actions when non-conformances occur during the process of generating critical and major characteristics.

8.3 The suppliers shall analyse the quality records and other objective evidence and validate conformance of process control.

8.4 The suppliers shall retain data package associated with product characteristics and ensure that the data package are completed, specified and readily accessible and retrievable wherever they are needed.

Annex A
(informative)

Examples of product characteristics annotation

A.1 Annotation on drawing

A.1.1 Annotation of measurement tolerance

When some measurement tolerance is classified as a critical or major characteristic, the characteristic classification code is marked behind the measurement value with parentheses. If the upper and lower variations of tolerance are defined with different characteristic categories, the upper variation of tolerance is marked with "+", and the lower variation of tolerance is marked with "-".

EXAMPLE 1

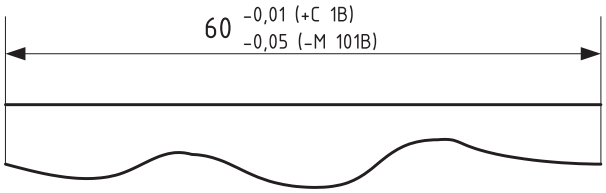

Figure A.1 — Maximum value critical characteristic and minimum value major characteristic

Figure A.1 shows maximum value as a critical characteristic, the minimum value as a major characteristic and all of them shall be checked before assembly.

EXAMPLE 2

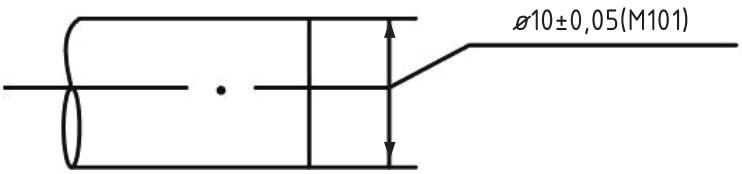

Figure A.2 — Maximum value and minimum value major characteristics

Figure A.2 shows both the maximum value and minimum value are major characteristics.

EXAMPLE 3

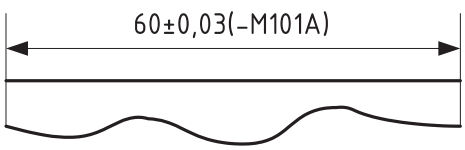

Figure A.3 — Minimum value as major characteristic when product purchased individually

Figure A.3 shows the minimum value as major characteristic when the product is purchased as an individual product. It becomes a minor characteristic after assembly.

A.1.2 Annotation of shape/position tolerance

When some shape/position tolerance is classified as a critical or major characteristic, the characteristic classification code is marked behind the shape/position tolerance frame with parentheses.

EXAMPLE 1

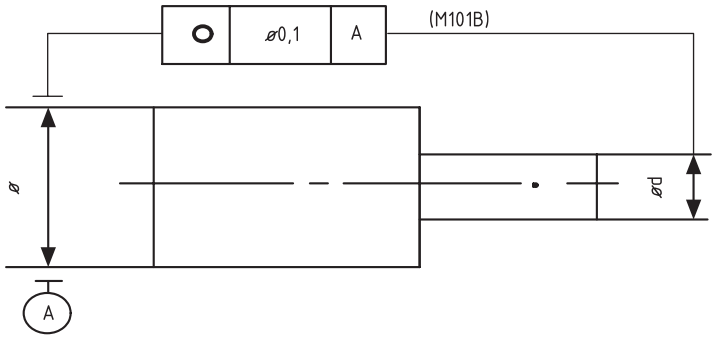

Figure A.4 — Requirement of coaxial as a major characteristic

Figure A.4 shows the requirement of coaxial as a major characteristic, and it shall be checked before assembly.

EXAMPLE 2

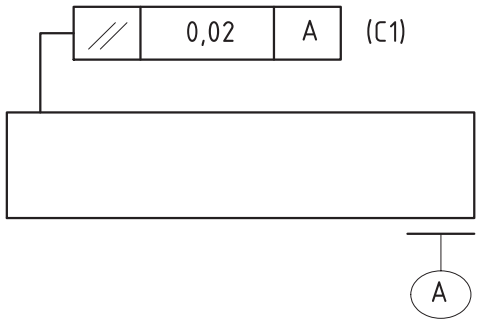

Figure A.5 — Requirement of parallel as a critical characteristic

Figure A.5 shows the requirement of parallel as a critical characteristic.

A.1.3 Annotation of technical requirement characteristics on drawing

When some technical requirement is classified as a critical or major characteristic, the characteristic classification code is marked before the technical requirement with parentheses.

EXAMPLE 1

(M101B) 1. No scratch, crack or chasm shall be on the surface of the part by visual inspection.

It means this requirement is a major characteristic and is required to be checked before assembly.

EXAMPLE 2

(M102C) 2. Heat treatment HRC=32~36.

It means the rigidity is a major characteristic and the technique parameters can be taken on an acceptance basis.

A.1.4 Annotation of material characteristics

When the material of a part is classified as a critical characteristic or a major characteristic, the category code letter and sequence number are marked in the material column of the part drawing. Material characteristic supplement code is added when necessary.

The material characteristic supplement code is shown in lowercase, and marked as subscript.

a — material component

b — material specification

c — material characteristic

d — material surface quality

EXAMPLE 1

$$\text{Rod steel}\ \frac{25}{45}\ (\text{M101})$$

This means “Rod steel” is a major characteristic.

EXAMPLE 2

Fluoro rubber 26-41 (M101_{c})

This means the characteristic of fluoro rubber is a major characteristic.

A.2 Annotation on content of design document

When the product technical requirement has the item description of critical or major characteristics, characteristic classification code shall be marked behind the item with parentheses.

EXAMPLE “Working hour without failure”: The working hour without failure shall be no less than 20 000 h (C1D) in a specified environment.

This means the 20 000-h working hour is defined as a critical characteristic and shall be checked by using a special check method.

A.3 Label on chart of design document

When the product list contains critical products (with critical characteristics) and important products (with major characteristics), their characteristic classification codes are marked in the frame 8 mm right to the list, as shown in Figure A.6.

"

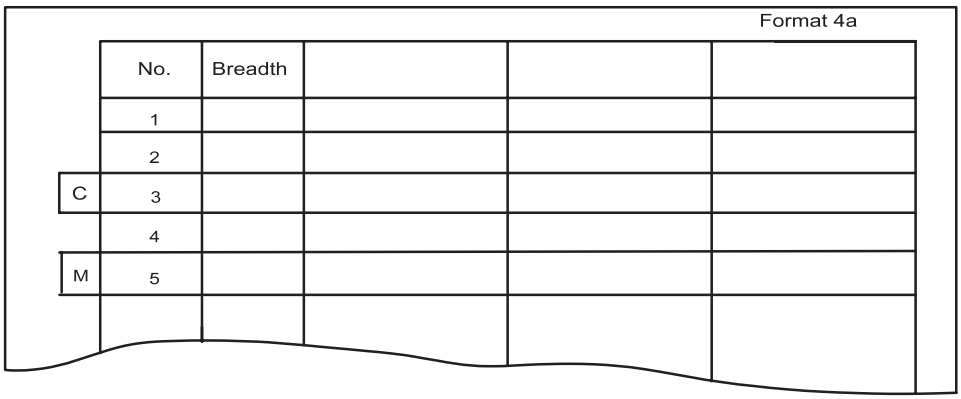

Figure A.6 — Marking characteristic classification codes

Bibliography

[1] ISO 9000, *Quality management systems — Fundamentals and vocabulary*

[2] ISO 10795, *Space systems — Programme management and quality — Vocabulary*

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