IEC TS 62565-1

Edition 1.0 2023-05

TECHNICAL SPECIFICATION

colour inside

Nanomanufacturing – Product specifications – Part 1: Basic concepts

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NANOMANUFACTURING – PRODUCT SPECIFICATIONS –

Part 1: Basic concepts

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IEC TS 62565-1 has been prepared by IEC technical committee 113: Nanotechnology for electrotechnical products and systems. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
113/697/DTS	113/723/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62565 series, published under the general title *Nanomanufacturing – Product specifications*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

The mission of IEC technical committee 113 (IEC TC 113) is to develop IEC publications based on quality management (QM) principles in order to facilitate the transition of nano-enabled products from development to mass production.

The standardization strategy of IEC TC 113 covers the entire value chain from the production of nanomaterials and their use as independent products (in other words, the product is the raw material) to their use as raw materials for integration into subassemblies or end-user products. Since IEC TC 113 is an electrotechnical committee, the focus of standardization is on electrotechnical products without excluding the applicability to non-electrotechnical products. The development of IEC Publications for reliability and durability assessment is also in the scope of IEC TC 113.

This part of IEC 62565 provides the basic concept and guidelines on how to write the various types of blank detail specification (BDS) and detail specification (DS) in a standardized and harmonized manner and describes the systematics behind these documents.

The systematics is based on the "three pillar concept" and provides:

– standards for the specification of nanomaterials and nano-enabled products (left pillar: IEC TS 62565-x-y);
– standards for the measurement of key control characteristics (KCCs) for nanomaterials and nano-enabled products (right pillar: IEC TS 62607-x-y);
– standards for quality and reliability assessment. These include test methods for reliability and durability, but also general standards based on existing International Standards for quality management systems (QMS) adapted to the specific needs of nanotechnology (centre pillar: IEC TS 62876-x-y).

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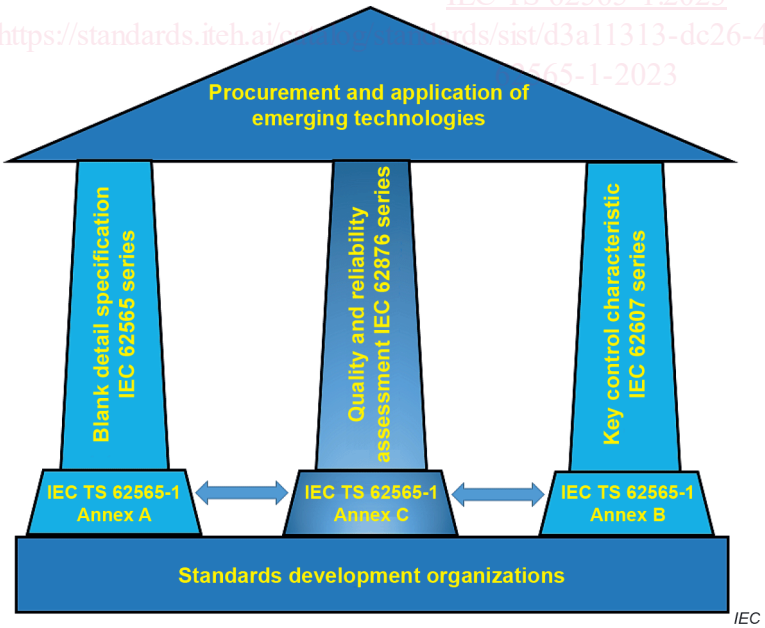

Blank detail specifications (BDSs) provide a list of all known product performance parameters, called key control characteristics (KCCs), of the nanomaterial or nano-subassembly which is part of the nano value chain.

Detail specifications (DSs) provide values and attributes (that had been left blank in BDS) for a specific application agreed between supplier and customer.

KCC measurement standards provide a detailed description how to measure a specific KCC and report the results. There can be several measurement methods for the same KCC, which can be selected based on the needs of the application.

Quality and reliability assessment standards describe the quality and reliability of nano-enabled products.

Figure 1 – Systematics of IEC TC 113 standards

In Figure 1, the logical connections in this comprehensive system of quality assurance for nanomaterials and nano-enabled products are visualized. Due to the interdependence of the three types of standards, it is important that standardization in IEC TC 113 covers all three columns in order to arrive at a consistent system of standards which can be operated in a "seamless" fashion.

This part of IEC 62565 provides the basic concept for the series of BDSs. Examples of other parts addressing specific technology areas are:

– IEC TS 62565-2-x: Carbon nanotube materials
– IEC TS 62565-3-x: Graphene-based materials
– IEC TS 62565-4-x: Luminescent nanomaterials
– IEC TS 62565-5-x: Nano-enabled energy storage materials

NOTE It is expected that additional BDS series will emerge as industrial uptakes of new materials or new applications occur.

An indispensable basis of the concept of BDS and DS are clear definitions of the product characteristics and detailed descriptions for measuring these characteristics. These characteristics are called key control characteristics (KCCs) because they represent key features of the products to be monitored in the framework of a quality management system. IEC 62607 consists of a series of KCC measurement Technical Specifications to be used for the BDS and DS:

– IEC TS 62607-2-x: KCCs for carbon nanotube materials
– IEC TS 62607-3-x: KCCs for luminescent nanomaterials
– IEC TS 62607-4-x: KCCs for nano-enabled electrical energy storage
– IEC TS 62607-5-x: KCCs for thin-film organic/nano electronic devices
– IEC TS 62607-6-x: KCCs for graphene-based material
– IEC TS 62607-7-x: KCCs for nano-enabled photovoltaics
– IEC TS 62607-8-x: KCCs for nano-enabled metal-oxide interfacial devices
– IEC TS 62607-9-x: KCCs for nano-scale stray magnetic field measurements

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Each part of the IEC 62607 series of measurement Technical Specifications describes exactly one method for measuring a particular KCC. Measurement standards outside the IEC 62607 series can be used in IEC 62565 BDSs and DSs if their applications are clear in the context of the specification.

In addition to the specification of the nanomaterial characteristics (IEC 62565 series) and the standardized procedures for the measurement of the characteristics (IEC 62607 series), two additional aspects of quality management are relevant for complete quality assurance:

The performance of materials and products at the time of manufacture is one thing, but the reliability is an additional relevant quality assurance metric. Two examples in the IEC 62876 series are given below.

- IEC TS 62876-2-1:2018, *Nanotechnology – Reliability assessment – Part 2-1: Nano-enabled photovoltaic devices – Stability test*
- IEC TS 62876-3-1:2022, *Nanomanufacturing – Reliability assessment – Part 3-1: Graphene-based material – Stability: Temperature and humidity test*

To ensure that the sourcing of the nanomaterials and the manufacturing process are consistently managed according to the prescriptions of ISO 9001:2015, the first steps have been taken in the development of an IEC standard for a quality management system in nanoelectronics.

The reliability standards and the quality management system standard are represented by the centre pillar in Figure 1.

More background information can be found in Annex C.

NANOMANUFACTURING – PRODUCT SPECIFICATIONS –

Part 1: Basic concepts

1 Scope

This part of IEC 62565, which is a Technical Specification, defines the system of blank detail specifications for nanomaterials and nano-assemblies as well as final nano-enabled products addressed in the nanomanufacturing value chain.

It defines the concepts of blank detail specification (BDS), detail specification (DS) and key control characteristic (KCC). Furthermore, it provides guidelines how to develop and use product specifications, particularly the IEC 62565 series, in the field of nanotechnology.

This document also provides guidelines regarding the certification and reliability aspects for products specified by a DS and associated KCCs.

NOTE 1 The IEC 62565 series uses an open generic structure that can be flexibly adapted to technical developments. The double indexing of the individual parts allows grouping into technology areas without restriction due to an overly strict hierarchical structure.

NOTE 2 Key elements of the IEC 62565 series are a consensus-based set of key control characteristics (KCCs) with clear definitions and standardized measurement procedures to measure them.

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2 Normative references

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There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
key control characteristic
KCC
product characteristic which can affect safety or compliance with regulations, fit, function, performance, quality, reliability or subsequent processing of the final product

Note 1 to entry: The measurement of a key control characteristic is described in a standardized measurement procedure with known accuracy and precision.

Note 2 to entry: It is possible to define more than one measurement method for a key control characteristic if the correlation of the results is well-defined and known (3.2).

3.2
blank detail specification
BDS
structured generic specification providing a comprehensive set of key control characteristics which are needed to describe a specific product without assigning specific values or attributes

Note 1 to entry: Examples of nano-enabled products are: nanocomposites and nano-subassemblies.

Note 2 to entry: Blank detail specifications are intended to be used by industrial users to prepare their detail specifications used in bilateral procurement contracts. A blank detail specification facilitates the comparison and benchmarking of different materials. Furthermore, a standardized format makes procurement more efficient and more error robust.

3.3
detail specification
DS
specification based on a blank detail specification with assigned values and attributes

Note 1 to entry: The characteristics listed in the detail specification are usually a subset of the key control characteristics listed in the relevant blank detail specification. The industrial partners define only those characteristics which are required for the intended application.

Note 2 to entry: Detail specifications are defined by the industrial partners. Standards development organizations will be involved only if there is a general need for a detail specification in an industrial sector.

Note 3 to entry: The industrial partners may define additional key control characteristics if they are not listed in the blank detail specification.

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3.4
good practice guide
GPG
informal document which is not necessarily peer reviewed but can be used as a working document to establish a measurement procedure

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Note 1 to entry: A GPG serves as the first document based on initial scientific research which is intended to be the first step toward future standardization.

3.5
standard maturity level
SML
measure for estimating the maturity of a measurement procedure based on the consensus achieved in the stakeholder community

Note 1 to entry: SML 1 – No documented measurement procedure available.

Note 2 to entry: SML 2 – Good practice guide publicly available based on a reasonable consensus achieved in the stakeholder community, e.g. an industrial or academic consortium.

Note 3 to entry: SML 3 – IEC or ISO standard or Technical Specification available which can be applied with modification and adaption to the intended application and use case of the blank detail specification scope.

Note 4 to entry: SML 4 – IEC or ISO standard or Technical Specification available for the exact intended application and use case of the blank detail specification.

3.6
procurement information
information other than key control characteristics needed for the procurement process

3.7
measurand
quantity intended to be measured

Note 1 to entry: If the quantity is a key control characteristic, the measurement is an essential part of the quality management system.

[SOURCE: ISO/IEC Guide 99:2007, 2.1, modified – Notes to entry and examples have been deleted and a new Note 1 to entry has been added.]

3.8
measurement
process of experimentally obtaining one or more values that can reasonably be attributed to a quantity

Note 1 to entry: If the quantity is a key control characteristic, the measurement is an essential part of the quality management system.

[SOURCE: ISO/IEC Guide 99:2007, 2.1, modified – In the definition, "quantity values" has been replaced by "values". Notes to entry have been deleted and a new Note 1 to entry has been added.]

3.9
measurement accuracy
closeness of agreement between a measured quantity value and a true quantity value of a measurand

Note 1 to entry: The concept ‘measurement accuracy’ is not a quantity and is not given a numerical quantity value. A measurement is said to be more accurate when it offers a smaller measurement error.

[SOURCE: ISO/IEC Guide 99:2007, 2.13, modified – Notes 2 and 3 to entry have been deleted.]

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3.10
measurement method
process of experimentally obtaining one or more values that can reasonably be attributed to a quantity

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Note 1 to entry: If the quantity is a key control characteristic, the measurement is an essential part of the quality management system.

3.11
measurement principle
phenomenon serving as a basis of a measurement

EXAMPLE 1 Thermoelectric effect applied to the measurement of temperature.

EXAMPLE 2 Energy absorption applied to the measurement of amount-of-substance concentration.

EXAMPLE 3 Hall effect applied to the measurement of magnetic flux density.

Note 1 to entry: The phenomenon can be of a physical, chemical, or biological nature.

[SOURCE: ISO/IEC Guide 99:2007, 2.4, modified – EXAMPLE 3 has been replaced.]

3.12
measurement procedure
detailed description of a measurement according to one or more measurement principles and to a given measurement method, based on a measurement model and including any calculation to obtain a measurement result

Note 1 to entry: A measurement procedure is usually documented in sufficient detail to enable an operator to perform a measurement.

Note 2 to entry: A measurement procedure can include a statement concerning a target measurement uncertainty.

Note 3 to entry: A measurement procedure is sometimes called a standard operating procedure, abbreviated SOP.

[SOURCE: ISO/IEC Guide 99:2007, 2.6]