INTERNATIONAL STANDARD

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Second edition
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Industrial automation systems and integration — Product data representation and exchange —

Part 235: Application protocol: Engineering properties and materials information

Systèmes d'automatisation industrielle et intégration — Représentation et échange de données de produits —

Partie 235: Protocole d'application: Propriétés d'ingénierie et informations sur les matériaux

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration,* Subcommittee SC 4, *Industrial data.*

This second edition cancels and replaces the first edition (ISO 10303-235:2009), which has been technically revised. It also incorporates the Technical Corrigendum ISO 10303-235:2009/Cor 1:2011.

The changes made in this edition are documented in Annex J.

ISO 10303 is organized as a series parts, each published separately. Each part of ISO 10303 is a member of one of the following series: descriptive methods, implementation methods, conformance testing methodology and framework, integrated generic resources, integrated application resources, application protocols, abstract test suites, application interpreted constructs and application modules. This document is a member of the application protocols series.

A list of the parts of ISO 10303 is located at: https://standards.iso.org/iso/10303/tech/step_titles.htm.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product data. The objective is to provide a neutral mechanism capable of describing product data throughout the life cycle of a product and independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving.

This document defines the context, scope and information requirements for properties of products that can be used for product design and design validation and other purposes, the testing, measurement and approval processes used to determine those properties and specifies the integrated resources necessary to satisfy these requirements.

Clause 1 defines the scope and summarises the functionality and data covered by this document. Clause 3 lists the words defined in this document and gives pointers to words defined elsewhere. An application activity model that is the basis for the definition of the scope is provided in Annex F. The information requirements for the application are specified in Clause 4, using terminology appropriate to the application. A graphical representation of the information requirements, referred to as the application reference model (ARM), is given in Annex G.

Resource constructs from the Integrated Generic Resource Model are interpreted to meet the information requirements of this application and produce the application interpreted model (AIM). This interpretation, given in 5.1, shows the correspondence between the information requirements and the AIM. The short listing of the AIM specifies the interface to the integrated resources and is given in 5.2. Note that the definitions and EXPRESS provided in the integrated resources for constructs used in the AIM can include items in select lists and subtypes that are not imported into the AIM. The expanded listing given in Annex A contains the complete EXPRESS schema for the AIM without annotation. A graphical representation of the AIM is given in Annex H. Additional requirements for specific implementation methods are given in Annex C.

Engineering properties, which include materials properties, are not fundamental constants derived from physical or chemical laws. The understanding of an engineering property of a product is dependent on the process used to measure the property value and the value is dependent on the conditions used in that process.

If properties that are based on fundamental physical or chemical behaviour, such as latent heat or melting temperature, are measured by different methods, then the results obtained are usually sufficiently similar to be regarded as a single value. A method used for measuring an engineering property attempts to simulate the behaviour of a product in an engineering situation in the real world. Each aspect of behaviour, for example the hardness of a product, can be simulated by several different methods. The methods are usually designed to be convenient to use and to provide a consistent result from repeated measurements. However, the difference between physical or chemical properties of a substance and the engineering properties of a product is that if different methods are used to measure an engineering property, then different results are obtained. For example, the measurement of the elongation property attempts to provide a numerical value to represent the engineering concept of plastic ductility by stretching a specially shaped sample of a product by applying a uniaxial tensile load. The value of the elongation property is determined as a percentage of the original length of a portion of a sample piece of the product. Comparisons between values of the elongation property for different products are therefore only possible if the fixed length was the same for each case. It is therefore necessary to state this length explicitly for all values of the elongation property.

An engineering property is therefore the result from operating a specific test method in a specific manner and it is necessary to associate the value of an engineering property with the conditions in which it is valid, in order for the meaning of the value to be explicitly determined. This additional

information is called the data environment in ISO 10303-45. An alternative term that is often used is metadata - i.e. data about data.

In most communications of engineering data, the relationship of a property value to its data environment or metadata is often an implicit assumption and it might not be explicitly associated with the value. The purpose of this document is to provide the means to associate a property value explicitly to the conditions in which it was measured, and thus provide an audit trail to the origins of data values that can be used in product design.

In order to measure the properties of a product, it is sometimes possible to test the whole product but usually this is not possible and a sample of a product has be taken to represent the bulk of the product. The procedure for taking this sample can be specified in a regulatory document, such as a quality manual, or in a standard. The operation of the testing apparatus and the measurement procedure can require that the item that is tested has a specific shape and dimensions, and it will be necessary to create this from the product sample by some manufacturing process. The result of this process can be called a test piece. The specific shape and dimensions of test pieces can also be defined in standards or other regulatory documents. The measurement of the engineering property is then carried out on the test piece by means of some measuring apparatus or testing machine, whose operation might need to be controlled to be within specified limits. Manufactured products can be assemblies or single products, but they are rarely homogeneous or isotropic in their properties, so it is necessary to know the relationships between the test piece, the sample and the original product if the results of the measurement need to be related to the original product.

Data produced by a testing or measurement process is rarely used in its original form. It is necessary to first evaluate data values by some process in order to determine if the conditions prescribed for a particular test method have been met. For many properties, such as fracture toughness as an example, the validity of a test result can only be determined by an evaluation process after all the measurements have been completed and that process is specified in the standard that describes how to make the measurement. Individual results are rarely used as single values, but can be combined or processed in some way to provide a collective result that is indicative of the results of a series of measurements. It is necessary to identify the most likely value of the collection and to provide the uncertainty associated with this value.

The validity of a test result can be established by an approval procedure which results in the issue of a certificate. The certificate affirms that the original product from which the sample was taken conforms to a particular requirement or specification, and that the tests used to determine this were carried out in an approved manner. The data obtained from a valid test can also be subject to a further approval procedure that confirms the suitability of property values for the design of a functional product. This procedure will use criteria for the approval based on the requirements that the product needs to satisfy. The approval process and the criteria can be established and administered by an independent regulatory body or authority.

Test data values are not used for design because they often represent a condition of failure of the test piece. Design values are derived from the test data to represent a condition in which it is safe to use the product, and it is also advisable to record explicitly the procedures by which a design value is derived. Further testing can be required to measure the design values.

The number of different engineering properties and test methods is too large for every property and test method to be included in this document. There are also differences in test methods, and therefore differences in the engineering meaning of the properties, between different national engineering systems. Provision has therefore been made for the names of test methods and their association with particular properties to be defined in computer-processable dictionaries conforming to ISO 13584 Parts Libraries, or defined in a referenced document. An entry in such a dictionary can be referenced from the information model in this document in order to make use of a particular property name associated with a particular measurement method.

The benefit of this approach is that, with appropriate dictionaries to define test methods and their relevant property names, this document can be used for the representation of any engineering property measured by any method, provided that those methods and properties are defined in a computer processable dictionary. The application of this document therefore extends to other engineering domains and is not restricted to materials. Other applications could include the results of measurements of environmental data, for example.

Figure 1 shows a high level view of the concept of this document. Figure 2 shows the high-level view of a process. Further information on the application of product data technology to materials information, as examples of engineering properties can be found in Reference [1] in the Bibliography.

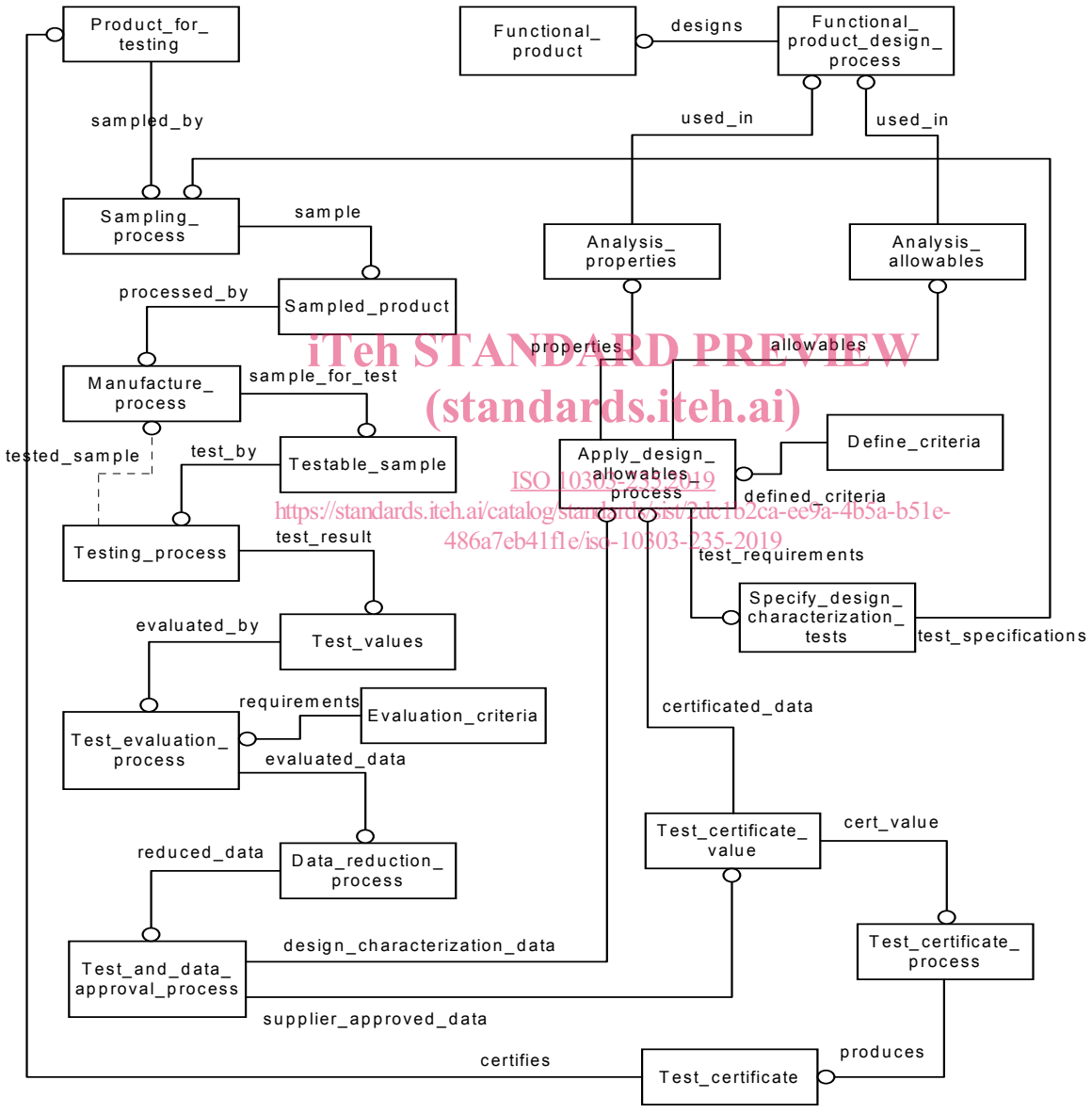

Figure 1 — Processes for the measurement and approval of engineering properties

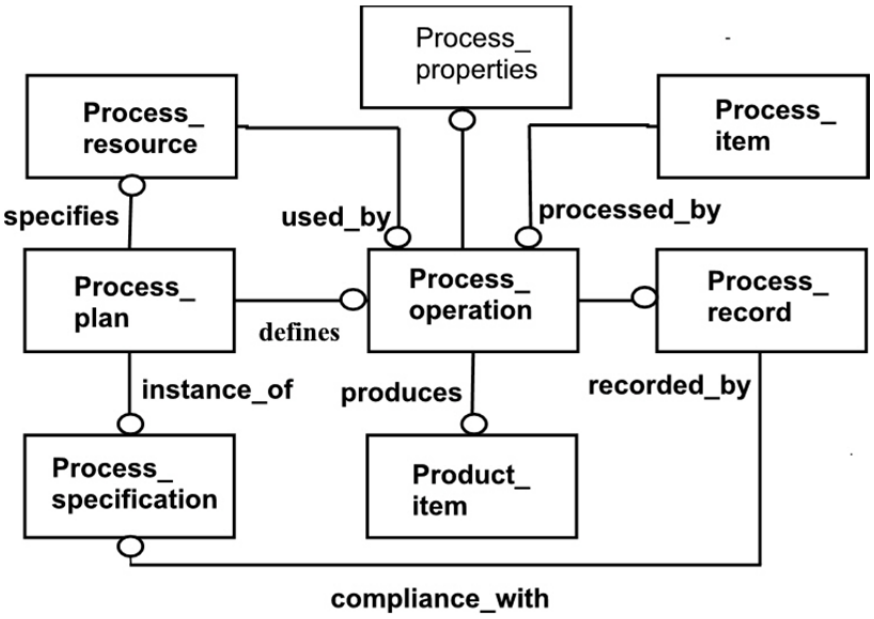

Figure 2 — Generic model for a process

Industrial automation systems and integration — Product data representation and exchange

Part 235: Application protocol: Engineering properties and materials information

1 Scope

This document specifies the use of the integrated resources necessary for the scope and information requirements for the representation of engineering property data that are used for product design, product validation and other purposes.

NOTE 1 The application activity model in Annex F provides a graphical representation of the processes and information flows that are the basis for the definition of the scope of this document.

The following are within the scope of this document:

— descriptions and definitions of the manufactured product, the sample of the product and the testable version of the sample;

— description of the composition and substance of the product;

— description of the processes used in the measurement;

— descriptions of the data values produced by the measurement, with the specification of the conditions in which the data is valid;

— references to standards and other documents wherein sampling, measurement and other details of testing and measurement processes can be specified or described;

— descriptions and qualifications of the personnel and or organizations responsible for the measurement;

— specification of the requirements, conditions and tolerances to be satisfied in the measurement and a description of the outcome;

— descriptions of the locations of the measurement process and the effectivity of the results;

— descriptions of the approval that establishes the validity of the measurements and the use of the properties for product design, design validation and other product characteristics such as structural integrity.

NOTE 2 Data representations sometimes need to be archived to meet legal and regulatory requirements and to meet quality objectives.

The following are outside the scope of this document:

— data describing rules, guidelines and expert knowledge in the testing of products;

— names of properties and test methods;

— data describing why a decision was made to use a particular process;

— scheduling data for measurement processes;

— algorithms used for data evaluation and data processing.

NOTE 3 The names and definitions of properties and test methods are assumed to be provided in computer processable dictionaries, conforming to ISO 13584 Parts Libraries, which could classify measurement methods and their associated property types.

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/IEC 8824-1, *Information technology — Abstract Syntax Notation One (ASN.1) — Part 1: Specification of basic notation*

ISO 10303-1, *Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles*

ISO 10303-11, *Industrial automation systems and integration — Product data representation and exchange — Part 11: Description methods: The EXPRESS language reference manual*

ISO 10303-21, *Industrial automation systems and integration — Product data representation and exchange — Part 21: Implementation methods: Clear text encoding of the exchange structure*

ISO 10303-31, *Industrial automation systems and integration — Product data representation and exchange —Part 31: Conformance testing methodology and framework: General concepts*

ISO 10303-41, *Industrial automation systems and integration — Product data representation and exchange —Part 41: Integrated generic resource: Fundamentals of product description and support*

ISO 10303-42, *Industrial automation systems and integration — Product data representation and exchange — Part 42: Integrated generic resource: Geometric and topological representation*

ISO 10303-43, *Industrial automation systems and integration — Product data representation and exchange — Part 43: Integrated generic resource: Representation structures*

ISO 10303-45, *Industrial automation systems and integration — Product data representation and exchange — Part 45: Integrated generic resource: Material and other engineering properties*

ISO 10303-47, *Industrial automation systems and integration — Product data representation and exchange —Part 47: Integrated generic resource: Shape variation tolerances*

ISO 10303-49, *Industrial automation systems and integration — Product data representation and exchange — Part 49: Integrated generic resources: Process structure and properties*

ISO 10303-50, *Industrial automation systems and integration — Product data representation and exchange — Part 50: Integrated generic resource: Mathematical constructs*

ISO 10303-56, *Industrial automation systems and integration — Product data representation and exchange — Part 56: Integrated generic resource: State*

ISO 10303-519, *Industrial automation systems and integration — Product data representation and exchange — Part 519: Application interpreted construct: Geometric tolerances*

ISO 13584-20, *Industrial automation systems and integration — Parts library — Part 20: Logical resource: Logical model of expressions*

ISO 13584-26, *Industrial automation systems and integration — Parts library — Part 26: Logical resource: Information supplier identification*

ISO 13584-42, *Industrial automation systems and integration — Parts library — Part 42: Description methodology: Methodology for structuring parts families*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10303-1 and the following apply.

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

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

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

3.1
application
group of one or more processes using product data

3.2
application model
model that describes an application in terms of its processes and information flows

3.3
application construct
collection of EXPRESS language entities, types, functions, rules and references that are based on resource constructs and that specialize those resource constructs as necessary in order to define a valid description of an aspect of product data for specific application areas

3.4
application context
subset of an application activity model

3.5
application interpreted construct
AIC

logical grouping of interpreted constructs that supports a specific function for the usage of product data across multiple application contexts

3.6
application interpreted model
AIM
information model that includes the application constructs necessary to satisfy the requirements of an application reference model

3.7
application object
atomic element of an application reference model that defines a unique concept of the application and contains attributes specifying the data elements of the object

3.8
application protocol
AP
part of ISO 10303 that specifies an application interpreted model satisfying the scope and information requirements for a specific application

3.9
application reference model
ARM
information model that describes the information requirements and constraints of an application within an application protocol

3.10
unit of functionality
UoF
collection of application objects and their relationships that defines one or more concepts within the application context such that removal of any component would render the concepts incomplete or ambiguous

3.11
conformance class
subset of an application protocol for which compliance can be claimed

3.12
conformance requirement
precise, text definition of a characteristic required to be present in an implementation for achieving compliance

3.13
data
representation of information in a formal manner suitable for communication, interpretation, or processing by human beings or computers

3.14
data exchange
storing, accessing, transferring and archiving of data

3.15
exchange structure
computer-interpretable format used for storing, accessing, transferring and archiving data

3.16
implementation method
part of ISO 10303 that specifies a technique used by computer systems to exchange product data that is described using the EXPRESS data specification language

3.17
information
facts, concepts, or instructions

3.18
information model
formal model of a bounded set of facts, concepts or instructions to meet a specific requirement

3.19
resource construct
collection of EXPRESS language entities, types, functions, rules and references that together define a valid description of product data

3.20
integrated resource
IR
part of ISO 10303 that defines a group of resource constructs used as the basis for product data

3.21
generic resource
integrated resource whose contexts are context-independent

3.22
interpretation
process of adapting a resource construct to satisfy an application-specific requirement of an application protocol

Note 1 entry: This can involve the additions of restrictions on attribute, the addition of constraints and the addition of assignments.

3.23
product
thing or substance produced by a natural or artificial process

3.24
product data
representation of information about a product in a formal manner suitable for communication, interpretation, or processing by human beings or by computers

3.25
product information
facts, concepts, or instructions about a product

3.26
product information model
information model that provides an abstract description of facts, concepts and instructions about a product