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

Part 235: Application protocol: Engineering properties for product design and verification

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

Partie 235: Protocole d'application: Propriétés d'ingénierie pour la conception de produits et vérification

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10303-235 was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data*.

ISO 10303 is organized as a series of parts, each published separately. The structure of ISO 10303 is described in ISO 10303-1.

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 part of ISO 10303 is a member of the application protocols series.

A complete list of the parts of ISO 10303 is available from the Internet:

http://www.tc184-sc4.org/titles/STEP_titles.htm .

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation of product information and for the exchange of product data. The objective is to provide a neutral mechanism capable of describing products throughout their life cycle. This mechanism is suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases, and as a basis for archiving.

This part of ISO 10303 is a member of the application protocol series. This part of ISO 10303 specifies an application protocol (AP) for those properties of products that can be used for product design and design validation.

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

Application protocols provide the basis for developing implementations of ISO 10303 and abstract test suites for the conformance testing of AP implementations.

Clause 1 defines the scope of this part of ISO 10303 and summarizes the functionality and data covered by this part of ISO 10303. Clause 3 lists the words defined in this part of ISO 10303 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, is given in Annex G.

Resource constructs 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 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 value of an engineering property of a product is dependent on the process used to measure the property value and 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 part of ISO 10303 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, but not always, possible to test the whole product. Accordingly, a sample of a product can be taken to represent the bulk of the product and the procedure for taking this sample can be specified in some 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 have to be controlled to be within specified limits. Manufactured products can be assemblies or single products, but they are rarely homogenous or isotropic in their properties, and so it is necessary to know the relationships between the test piece, the sample and the original product if the results of the measurement are 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 the process is specified in the standard that describes how to make the measurement. Data values 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 central 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 has 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 part of ISO 10303. 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 assocation 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 part of ISO 10303, 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 part of ISO 10303 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 part of ISO 10303 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 part of ISO 10303. 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 [13] in the Bibliography.

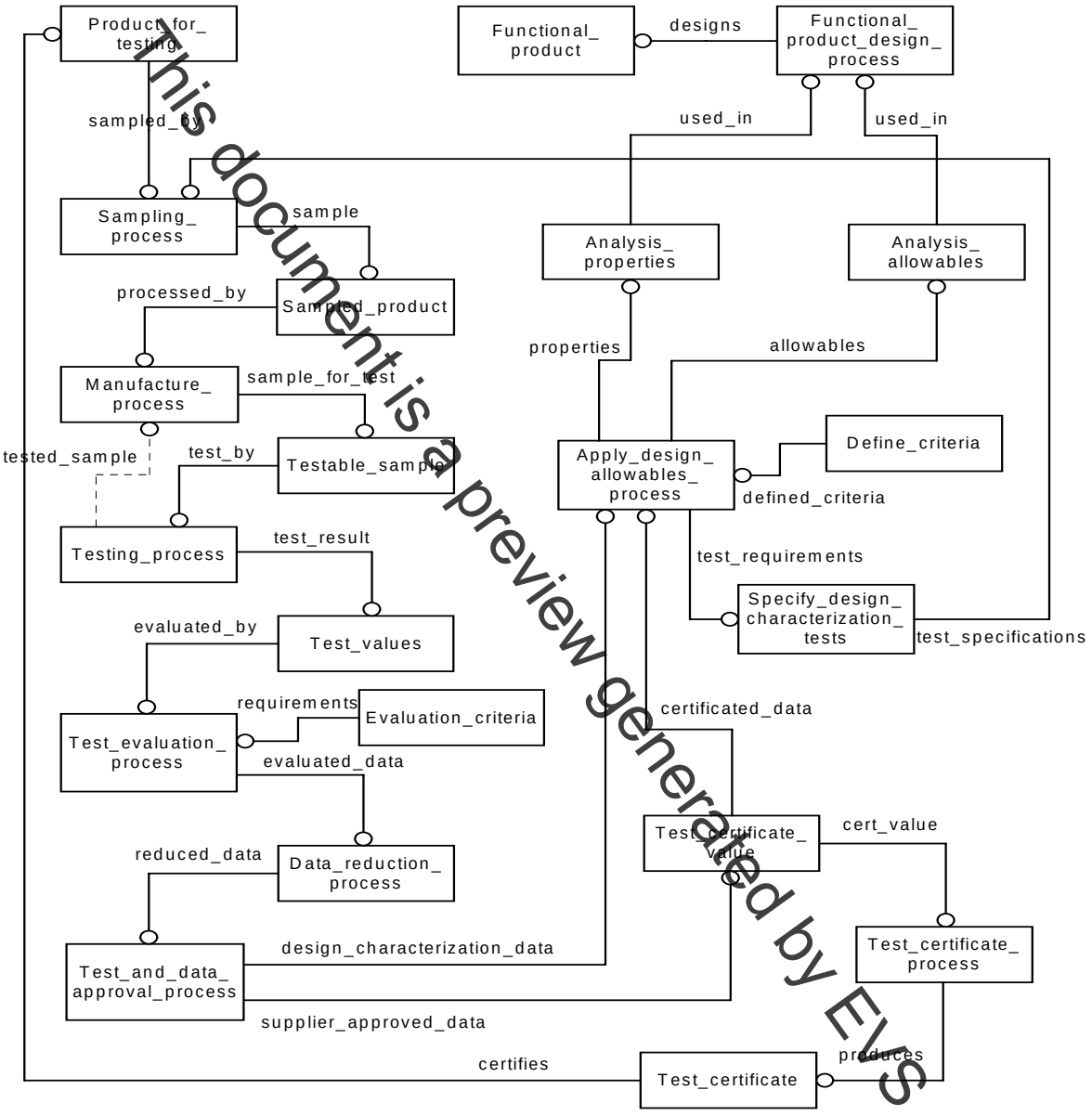

Figure 1 — Processes for the measurement and approval of engineering properties

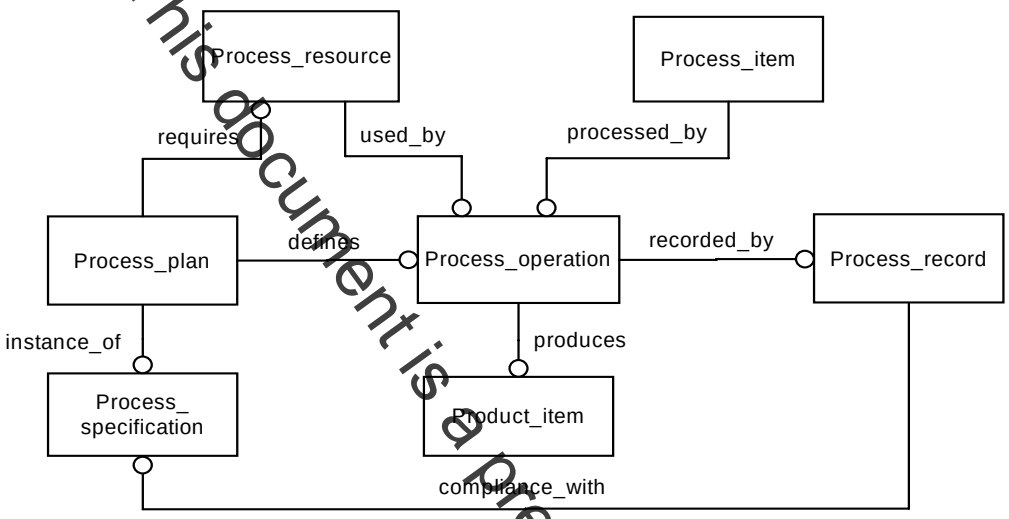

Figure 2 — Generic model for a process

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

Part 235:
Application protocol: Engineering properties for product design and verification

1 Scope

This part of ISO 10303 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 and product validation.

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 part of ISO 10303.

The following are within the scope of this part of ISO 10303:

— 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 and design validation.

NOTE 2 Data representations described in this part of ISO 10303 might need to be archived to meet legal and regulatory requirements and to meet quality objectives.

The following are outside the scope of this part of ISO 10303:

— 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 classify measurement methods and their associated property types.

2 Normative references

The following referenced documents are indespensible 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.

ISO 639-2, *Codes for the representation of names of languages - Part 2: Alpha-3 code.*

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions - Part 1: Country codes.*

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

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 10303-54 *Industrial automation systems and integration — Product data representation and exchange — Part 54: Integrated generic resource: Classification and set theory*.

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 part families.*

3 Terms and definitions

3.1 Terms defined in ISO 10303-1

For the purposes of this document, the following terms defined in ISO 10303-1 apply:

— application;

— application activity model (AAM);

— application context;

— application interpreted model (AIM);

— application object;

— application protocol (AP);

— application reference model (ARM);

— conformance class;

— conformance requirement;

— data;

— data exchange;

— generic resource;

— information;

— information model;

— presentation;

— product;

— product data;

— product information;

— product information model;

— structure;

— unit of functionality.