

INTERNATIONAL STANDARD

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Batch control -
Part 1: Models and terminology

Contrôle-commande des processus de fabrication par lots (batch) -
Partie 1: Modèles et terminologie



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Batch control - Part 1: Models and terminology

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IEC 61512-1 has been prepared by subcommittee 65A: System aspects, of IEC technical committee 65: Industrial-process measurement and control. It is an International Standard.

This second edition cancels and replaces the first edition published in 1997. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Models and text are modified to provide more detail and clarity. Key clarifications are:
 - 1) Two types of *equipment* modules are defined: generic and *recipe-aware*. All *recipe-aware equipment modules* contain procedural control and can be used as phases in the recipe.
 - 2) Execution of all procedural control contained directly in *units* is part of the Unit Supervision activity.
 - 3) The relationships between types of *recipes*, *recipe components*, and *equipment* control are more fully described and illustrated.
 - 4) Entity relationship diagrams have been replaced with more intuitive UML instance diagrams, except for the *equipment entity model*.
 - 5) The transition diagram for the procedural *states* example has been updated with a more intuitive and complete UML *state* diagram.
 - 6) References to other standards in the series and to IEC 62264 are included to provide direction for further clarification of selected topics.
 - 7) Activity names are capitalised to help prevent confusion with similar terms, such as their underlying functions.
- b) Previous Clauses 4 through 6 (now Clauses 4 through 8) were rearranged to provide a clearer top-down organisation of the document. Key changes are:
 - 1) Removing the lower levels of the physical (*role-based equipment*) model (see 4.4.2) to eliminate redundancy because their groupings are defined by the associated functionality in the *equipment entity model* and are not meaningful for batch control without those associations.
 - 2) Describing *equipment* control and the *equipment entity model* immediately after the physical (*role-based equipment*) model and describing each level as completely as possible without excessive use of forward references (see 4.4.3).
 - 3) Combining the descriptions of basic, procedural, and coordination control with their usage in each type of *equipment entity*, providing a single consolidated discussion of each type of control (see Clause 5).
 - 4) Additional considerations to support application of the models have been grouped in Clause 7 to clarify their supporting relationship to the core models.
- c) Clause 9 was added to define completeness, compliance, and conformance in relation to this document.
- d) Annex B was added to provide a more expansive procedural *state* reference model. The model found in Clause 7 can be considered a collapsed version of this more general model.
- e) Annex C was added to clarify a number of points concerning the models, their application, and the new Clause 9 on conformance and compliance.
- f) Annex E was added to more fully describe the changes in this update to IEC 61512-1:1997.

The text of this International Standard is based on the following documents:

Draft	Report on voting
65A/1178/FDIS	65A/1197/RVD

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 International Standard 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.

In this standard, the following print type is used:

Defined terms are italicised in the body of this document to avoid misinterpretation based on meanings outside of the IEC 61512 series.

A list of all parts in the IEC 61512 series, published under the general title *Batch control*, 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,
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INTRODUCTION

The IEC 61512 series of standards comprises several parts. This document describes an overarching framework of models and definitions for batch manufacturing. Other parts of the series describe in more detail particular focus areas within this framework.

All IEC documents follow a fixed structure consisting of Clause 1 “Scope”, Clause 2 “Normative references” and Clause 3 “Terms and definitions”. This document therefore contains a Normative references clause even if it is empty.

Clause 3 provides terms and definitions that are important for the understanding of certain terms used in the document. Each definition can be considered a summary statement for the associated term. Since this document defines models and terminology as a whole, all of its provisions contribute to each term’s full meaning and to its relationship to the models.

Clauses 4 through 8 incrementally complete these definitions by starting at a very high level, progressively detailing a set of conceptual models, and describing how they collectively interact to control of a production of a batch. The models are presumed to be complete as indicated. However, they can be collapsed and expanded as described in the explanation of each model.

Clause 4 Batch processes and equipment is normative. The intent of this clause is to provide models and terminology that describe *batch processes* and the *equipment* used to perform them.

Clause 5 Structure for batch control is normative. The intent is to describe three types of control used in *batch processing* and their relationships to the previously defined process and *equipment* models.

Clause 6 Recipes and procedural elements is normative. The intent is to describe the roles and contents of four types of *recipes* used in batch manufacturing, their use of the previously defined process and procedural control models, and their connection to *equipment* control.

Clause 7 Batch control considerations is normative. The intent is to describe additional considerations related to iterative design, exception handling, *modes* and states, production plans and schedules, and production information.

Clause 8 Activities and functions in batch control is normative. The intent is to describe the control activities that are necessary to address the diverse control requirements of batch manufacturing.

Clause 9 Completeness, compliance, and conformance is normative. The intent is to define compliance and conformance relative to the normative models and terminology in this document.

Annex A is informative. It provides guidance towards understanding the model types used in this document. Usage of UML instance diagrams and *state* diagrams is described in Annex A and contrasted with the corresponding figures of IEC 61512-1:1997 as shown in Annex E.

Annex B is informative. It provides a more expansive procedural *state* reference model. The model found in 7.5 can be considered a collapsed version of this more general model.

Annex C is informative. It provides answers to typical questions that can arise in applying this document.

Annex D is informative. It provides further explanation of the software entities listed in 4.2.

Annex E is informative. It provides a summary of the changes made in this update as compared with IEC 61512-1:1997.

The bibliography is informative, giving references for further investigation concerning safety and other relevant standards.

This document is intended for those who are

- involved in the design, *operation*, or both of batch manufacturing plants,
- responsible for specifying controls and the associated application programs for batch manufacturing plants, or
- involved in the design and marketing of products in the area of batch control.

This document defines standard models and terminology for specifying the control requirements for batch manufacturing plants. The models and terminology

- emphasise good practices for the design and *operation* of batch manufacturing plants,
- can be used to improve control of batch manufacturing plants, and
- can be applied regardless of the degree of automation.

This document provides standard terminology and a consistent set of concepts and models for batch manufacturing plants and batch control that are intended to

- improve communications between all parties involved,
- reduce the user's time to reach full production levels for new products,
- enable vendors to supply appropriate tools for implementing batch control,
- enable users to better identify their needs,
- make *recipe* development straightforward enough to be accomplished without the services of a control systems engineer,
- reduce the cost of automating batch processes, and
- reduce life-cycle engineering efforts.

It is not the intent of this document to

- suggest that there is only one way to implement or apply batch control,
- force users to abandon their current way of dealing with their batch processes, or
- restrict development in the area of batch control.

The key concepts defined in this document are:

- description of *recipes*, procedures, their contents, and their structure;
- definition of levels of *recipes* and procedures;
- recognition of product specific *recipes* and procedures that are separate from process-oriented *equipment* and its direct control;
- identification of a hierarchy of manufacturing *equipment* and its dedicated control;
- recognition of *equipment* capabilities that are utilised during *recipe* and procedure driven production; and
- recognition of the need for modular and reusable control functionality.

1 Scope

This part of IEC 61512 applies to systems, specifications, and their use for implementing batch and related procedure-oriented manufacturing controls in the process industries. This document establishes a reference model framework for procedure-oriented control, defines terms to help explain the model relationships and usage, and describes general criteria for evaluating conformance. This follows the principle of separation between *recipe procedural elements* and *equipment procedural elements* enabling *operations* to define *recipes* without the need of changes in *equipment* procedures.

2 Normative references

There are no normative references in this document.

3 Terms, definitions, abbreviated terms and acronyms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1.1 allocation

form of coordination control that assigns a *resource* or part of a *resource* to a *recipe*, a *procedural element*, or an *equipment entity* as appropriate

3.1.2

arbitration

form of *coordination control* that determines how a *resource* should be *allocated* when there are more requests for the *resource* than can be accommodated at one time

3.1.3

area

role-based equipment entity or component of a *site* that is identified by physical, geographical, operational, or logical segmentation within the *site*

Note 1 to entry: The area can contain *process cells*, production *units*, production lines, and storage zones.

3.1.4

basic control

control dedicated to establishing and maintaining a specific *state* or behaviour of *equipment* and process

Note 1 to entry: *Basic control* can include regulatory control, interlocking, physical and virtual monitoring, *exception handling* and discrete or sequential control necessary for establishing or maintaining a specific *state* or behaviour.

3.1.5

batch

finite quantity of material

3.1.6

batch control

control activities and functions that direct batch processes

3.1.7

batch process

process *that leads to the production of a batch according to a recipe*

3.1.8

batch schedule

ordered list of *batches of material* to be produced in a specific *process cell*

Note 1 to entry: The *ordered list of finite quantities of material to be produced in a specific process cell* typically contains such information as what is to be produced, how much is to be produced, when or in what order the *finite quantities of material* are to be produced, and what *equipment* is to be used.

3.1.9

campaign

collection of related *batches* for scheduling purposes

3.1.10

common resource

resource that can provide services to one or more requesters

Note 1 to entry: *Common resources* are identified as either *exclusive-use resources* or *shared-use resources*.

3.1.11

control activity model

conceptual model identifying interdependent activities (several of which are subdivided into functions) that manage control definition, execution, and information for batch processes

3.1.12

control module

lowest level functional grouping in the *equipment entity model* that can carry out basic control

Note 1 to entry: The *control module* level contains the interfaces to the *role-based equipment*.

3.1.13

control recipe

type of *recipe* which, through its execution, defines the manufacture of a single *batch*

3.1.14

coordination control

type of control that directs, initiates, modifies, or performs a combination of these for the execution of *procedural control* and the utilisation of *equipment entities*

3.1.15

enterprise

organisation that coordinates the manufacturing at one or more *sites*

3.1.16

equipment

collection of physical objects or *resources* having defined roles and capabilities in master and a control *recipe* for executing a process

3.1.17

equipment control

equipment-specific functionality that provides the actual control capability for an *equipment entity*, including *procedural control*, *basic control*, and *coordination control*

3.1.18**equipment entity**

collection of process *equipment*, control *equipment*, and *equipment control* grouped together to perform a certain control function or set of control functions

3.1.19**equipment entity model**

hierarchical model to logically organise the *role-based equipment* used in a *batch process* in combination with the control present at each level

3.1.20**equipment module**

functional grouping in the *equipment entity model* that can carry out specific minor *processing* activities

Note 1 to entry: An equipment module is typically centred around a piece of process *equipment* (a weigh tank, a process heater, a scrubber, etc.).

Note 2 to entry: Examples of minor *processing* activities are dosing and weighing.

Note 3 to entry: Two types of *equipment modules* are identified: *recipe-aware equipment modules* and *generic equipment modules*.

Note 4 to entry: Any reference to an *equipment module* in this document is understood to be a general reference to both the *recipe-aware equipment module* and the *generic equipment module* unless otherwise specified.

3.1.21**equipment operation**

operation that is part of *equipment control*

3.1.22**equipment phase**

phase that is part of *equipment control*

3.1.23**equipment procedure**

procedure that is part of *equipment control*

3.1.24**equipment unit procedure**

unit procedure that is part of *equipment control*

3.1.25**exception handling**

those functions that deal with plant or process contingencies and other events which occur outside the normal or desired behaviour of *batch control*

3.1.26**exclusive-use resource**

common resource that only one user can use at any given time

3.1.27**formula**

category of *recipe* information that includes *process inputs*, *process parameters*, and *process outputs*

3.1.28**general recipe**

type of *recipe* that expresses equipment and *site* independent *processing* requirements