INTERNATIONAL STANDARD

ISO 15746-3

First edition
2020-02

Automation systems and integration — Integration of advanced process control and optimization capabilities for manufacturing systems —

Part 3: Verification and validation

Systèmes d'automatisation et intégration — Intégration de contrôles de processus avancés et capacités d'optimisation des systèmes de fabrication —

Partie 3: Vérification et validation

Reference number
ISO 15746-3:2020(E)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 5, *Interoperability, integration and architectures for enterprise systems and automation applications*.

A list of all parts in the ISO 15746 series can be found on the ISO website.

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

As a crucial part of the increasingly complex manufacturing systems, automation and control applications which are enabled by advanced process control and optimization (APC-O) methodology and solutions are implemented under the direction of production planning and scheduling. This task involves initially the specific use of APC-O that will eventually enable the integration of manufacturing operations management (MOM) with the automation and control of manufacturing process and equipment.

Automation solutions equipped with both software and hardware components are provided by different suppliers to accomplish APC-O functions. Due to the diversity of development environments and the variety of demand focus, the automation solutions from various suppliers tend to be isolated and relatively independent, which make it harder for the automation solutions to be integrated. Consequently, various automation solution components that the customers can have access to are filled with redundant and duplicated functions, resulting in a waste of resources and limited interoperability. This document offers an interoperability framework for advanced process control and optimization with the intention of maximizing both the integration and the interoperability of automation solutions.

It is not the intent of this document to suggest that there is only one way of implementing APC-O or to force users to abandon their current way of implementing APC-O.

The target users of this document include users and providers of advanced process control and optimization solutions, such as, project solution suppliers, automation systems integrators, production departments of companies, process engineers, independent software testing organizations, implementation and consulting service organizations of advanced process control and optimization software, and relevant government and academic organizations.

Automation systems and integration — Integration of advanced process control and optimization capabilities for manufacturing systems —

Part 3: Verification and validation

1 Scope

This document defines the principle of verification and validation according to the activity models and workflow of an advanced process control and optimization (APC-O) system, analyses and defines the general process for verification and validation of APC-O systems, and specifies a set of indicators and checkpoints used for verification and validation.

2 Normative references

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:

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

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

3.1
checkpoint
point where *verification* (3.6) and *validation* (3.5) activities needed to be performed throughout the APC-O lifecycle

3.2
indicator
measurement of an aspect of the system or component

Note 1 to entry: There are two types of indicators: *quantitative indicators* (3.3) and *judgement indicators* (3.4).

3.3
quantitative indicator
indicator (3.2) that is calculated using formulae

3.4
judgement indicator
indicator (3.2) that is evaluated using the evaluation method

3.5
validation
process of evaluating an APC-O system to determine whether it satisfies the stakeholders' requirements for that system

3.6
verification
process of evaluating an APC-O system to determine whether the output of a phase satisfies the conditions imposed at the start of that phase

4 Abbreviated terms

APC-O Advanced Process Control and Optimization

MOM Manufacturing Operations Management

V&V Verification and Validation

5 Principle and purpose

5.1 Principle of verification and validation

This document provides a specification for both users and suppliers of the APC-O systems. The APC-O system that conforms to the specification will satisfy the customer requirements and facilitate the integration between different APC-O systems, as illustrated in Figure 1.

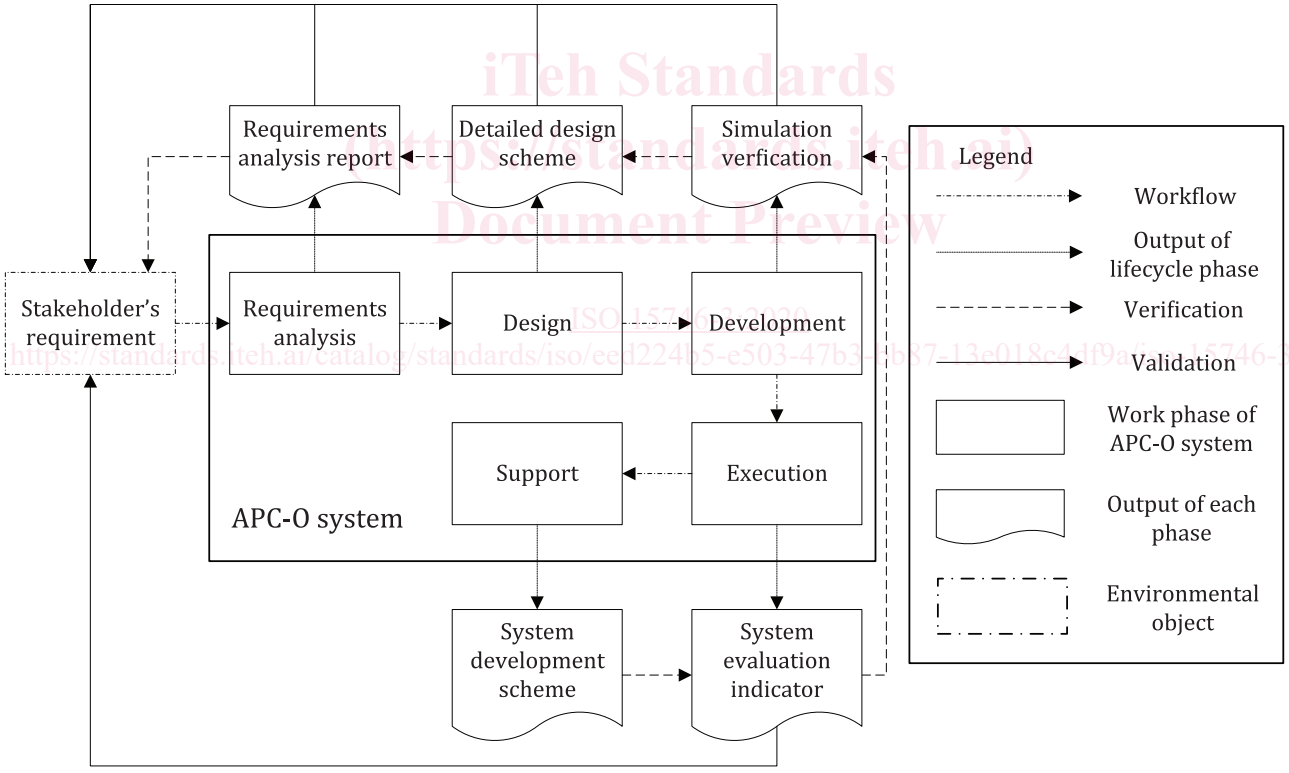

Figure 1 — Verification and validation of APC-O systems

Workflow: The workflow of an APC-O system relates to the phases of the lifecycle.

Output of lifecycle phase: Each work phase has an object.

Work phase: The lifecycle of an APC-O system consists of the following phases:

a) Requirements analysis;

b) Design;

c) Development;

d) Execution;

e) Support.

5.2 Structures of indicators

5.2.1 General

Both the quantitative indicators and the judgement indicators are expressed in the manner of the structure specified in ISO 22400-2. The structure identifies the descriptive element of indicator in the left column and gives a description of each element in the right column.

5.2.2 Structure of quantitative indicators

Table 1 presents an overview of the main elements of quantitative indicator structure.

Table 2 is an example of quantitative indicator.

Table 1 — Quantitative indicator structure

Name	Name of the indicator
ID	Unique identification
Description	A brief description of the indicator
Scope	The object that the indicator is used for, including the lifecycle phases or the elements/activities within a lifecycle phase
Formula	The mathematical formula of the indicator defined in terms of elements
Unit of measure	The basic unit or dimension of the indicator
Range	Defines the upper and lower logical limits of the indicator
Trend	The information that indicates the direction for improvement, e.g. if a higher or lower value is better
Audience	Users and providers of APC-O solutions, such as project solution suppliers, automation systems integrators, production departments of companies, process engineers, independent software testing organizations, implementation and consulting service organizations of APC-O software, and relevant government and academic organizations

Table 2 — Example of quantitative indicator

Name	Mean squared error (MSE)
ID	
Description	This checkpoint is used to describe the stable rate NOTE Definition of MSE
Formula	Mean[(SV – PV) ^2]
Unit of measure	%
Range	Min: 0 % Max: 100 %
Trend	The lower, the better
Audience	Engineers and operators of process

5.2.3 Structure of judgement indicator

Table 3 presents an overview of the main elements of judgement indicator structure.

Table 4 is an example of judgement indicator.

Table 3 — Judgement indicator structure

Name	Name of the indicator
ID	Unique identification
Description	A brief description of the indicator
Scope	Determine the object that the indicator is used for, which can be a lifecycle phase or the elements/activities within the lifecycle phase
Evaluation method	Check whether the object meets the desired requirements
Evaluation result	Pass or fail
Audience	Users and providers of APC-O solutions, such as project solution suppliers, automation systems integrators, production departments of companies, process engineers, independent software testing organizations, implementation and consulting service organizations of APC-O software, and relevant government and academic organizations

Table 4 — Example of judgement indicator

Name	Optimal scheme of realization of an APC-O project
ID	
Description	
Scope	Requirement analysis phase
Evaluation method	
Evaluation result	Pass or fail
Audience	Managers of the APC-O project

5.3 General process for verification and validation

The general process of verification and validation in the workflow of the APC-O system is illustrated in Figure 2.

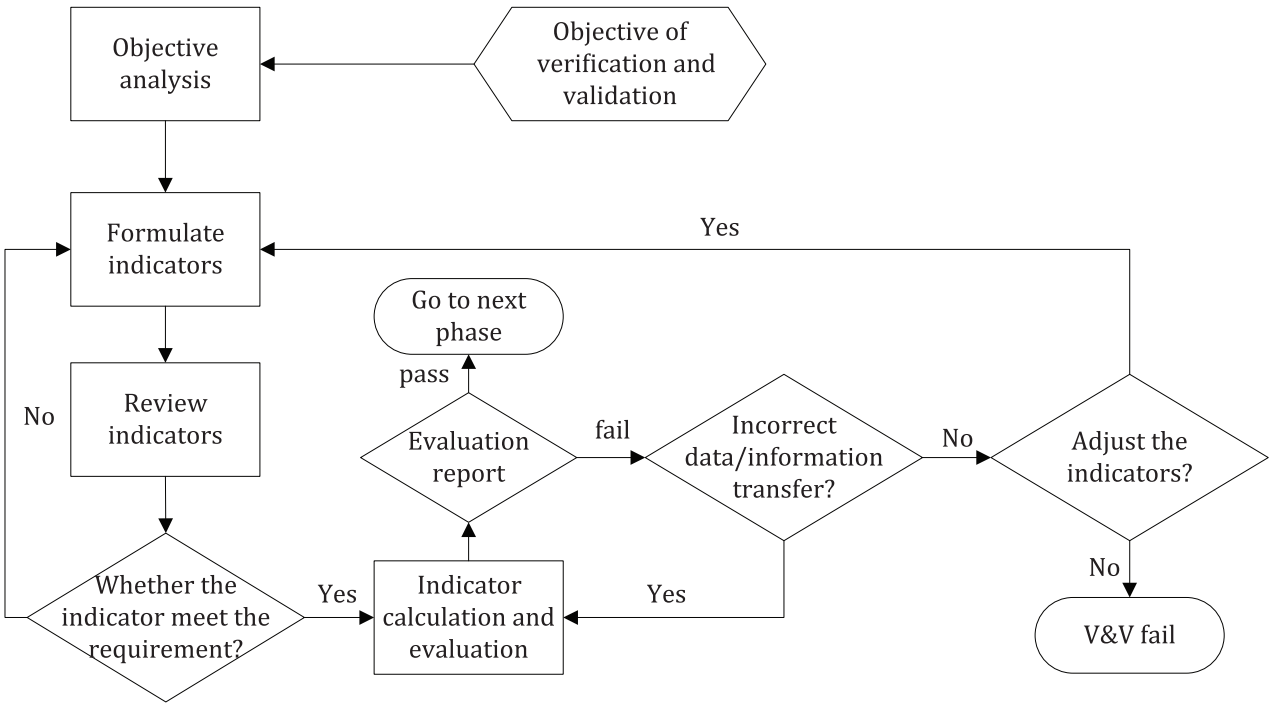

Figure 2 — General process for verification and validation