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CWA 17918

Titel en:	Zero Defects Manufacturing — Vocabulary
Titel de:	Null-Fehler-Fertigung — Begriffe
Titel fr:	Fabrication zéro défaut — Vocabulaire

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Foreword

This CEN and CENELEC Workshop Agreement has been developed in accordance with the CEN-CENELEC Guide 29 “CEN/CENELEC Workshop Agreements – A rapid prototyping to standardization” and with the relevant provisions of CEN/CENELEC Internal Regulations - Part 2. It was approved by a Workshop of representatives of interested parties, the constitution of which was supported by CEN and CENELEC following the public call for participation made on 2020-09-23. However, this CEN and CENELEC Workshop Agreement does not necessarily include all relevant stakeholders.
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Introduction

Human communication requires the agreement on a common language, although a vocabulary is not the single requirement to guarantee an effective communication - since context has an impact on the meaning - each field requires its own vocabulary. Moreover, the establishment of common terminology is also becoming a foundation for developing ontologies and supporting human-machine interactions and collaboration in industrial settings.

The terminology of Zero-Defect Manufacturing (ZDM) is strongly connected to quality management, which has a significant number of standards and guidelines, where a broader approach addressing the quality improvement in manufacturing and its related processes is defined. The area of ZDM emerged as a natural aim of the manufacturers to reduce or eliminate all defects occurring during the manufacturing process due to the costs that defective products cause. ZDM is a holistic approach that includes several tools such as product life cycle assessment, diagnostic methods, preventive methods, predictive methods, process control methods, production control improvements, quality control and inspection methods that allow process adjustments through rapid feedforward and/or feedback control to achieve sustainable manufacturing. Sustainable manufacturing requires efficient use of resources, whether that might be natural resources, like materials, or labor time or any type of resources, which will result lower production costs and less time and higher sustainability levels. This is achieved by reducing defects and all types of waste or scrap that result from defective products or components that cannot be reworked or recycled. The main objective is not only to reduce defects through prevention and its propagation but to ensure that no defective products leave the production facility and reach the customer. Companies adopting the ZDM approach are expected to have an improvement in sustainable manufacturing metrics.

This document contains the main concepts associated to ZDM outside the already defined terminologies for interconnected fields such as quality management, metrology, maintenance, and condition monitoring. The proposed concepts can be used to enrich the already available standards in ISO and the IEC's Electropedia or to be used as a complement, together with standards such as ISO 9000, IATF 16949, IEC 60050-192 and ISO 13372 and support present and future researchers in the field to conduct their research using a common vocabulary.

1 Scope

The CWA defines terms for Zero-Defect Manufacturing (ZDM) in digital manufacturing with correlation to Industry 4.0 and quality management. The CWA does not define quality management requirements.

2 Normative references

There are no 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
zero-defect manufacturing
holistic approach for ensuring both *process* (ISO 9000:2015, 3.4.1) and *product* (ISO 9000:2015, 3.7.6) quality by reducing *defects* (ISO 9000:2015, 3.6.10)

Note 1 to entry: zero-defect manufacturing uses mainly data-driven technologies, e.g. originating from Big Data and Machine Learning domains/areas/fields for predictive or prescriptive analytics referred to as zero-defect manufacturing tools.

Note 2 to entry: zero-defect manufacturing requires that no defective products leave the production site and reach the *customer* (ISO 9000:2015, 3.2.4) by performing *100 % inspection* (ISO 3534-2:2006, 4.1.5).

Note 3 to entry: zero-defect manufacturing aims at higher manufacturing sustainability.

3.2
zero-defect manufacturing framework
structure of *processes* (ISO 9000:2015, 3.4.1) and *specifications* (ISO 9000:2015, 3.8.7) designed to support the implementation of zero-defect manufacturing

[SOURCE: ISO/IEEE 11073-10201:2020, 3.22, modified — The term was supplemented by “zero-defect manufacturing”, “a specific task” was replaced by “zero-defect manufacturing” and links to ISO 9000:2015, 3.4.1 and ISO 9000:2015, 3.8.7 were added.]

3.3
zero-defect manufacturing system
manufacturing system (ISO 20140-1:2019, 3.15), which implements the zero-defect manufacturing approach

Note 1 to entry: A zero-defect manufacturing system is commonly comprised of various software and hardware elements or tools to prevent the occurrence and propagation of defects.

Note 2 to entry: A zero-defect manufacturing system can combine various forms of inspection, such as final inspection, in-process inspection, incoming inspection, off-line inspection, at-line inspection, in-line inspection and on-machine inspection.

Note 3 to entry: A zero-defect manufacturing system is capable of issuing alarms and alerts.

3.4
zero-defect manufacturing tool
asset (IEV 741-01-04) that assists in achieving results or complete tasks related to zero-defect manufacturing.

EXAMPLE 1 Common examples of zero-defect manufacturing tools are: a machine learning algorithm used in predictive analytics to forecast a defect, the means for inspection, measurement, testing or gauging such as a *soft sensor* (ISO 15746-1:2015, 2.14) (or virtual sensor) or a non-destructive inspection (NDI) technique that contributes to 100 % inspection.

Note 1 to entry: A tool can be a physical entity or a digital entity.

3.5
design for zero-defect manufacturing
process design for quantifying the *specification* (ISO 9000:2015, 3.8.7) of manufacturing *equipment* (ISO 13372:2012, 1.6) to achieve zero-defect manufacturing

[SOURCE: Psarommatis, F., 2021. A generic methodology and a digital twin for zero defect manufacturing (ZDM) performance mapping towards design for ZDM. Journal of Manufacturing Systems, 59, pp.507-521]

3.6
cost of zero-defect manufacturing
costs for assuring quality comprising investment and operating costs for the implementation of *zero-defect manufacturing* (3.1)

3.7
zero waste
variation of zero-defect manufacturing, in which the amount of resources required to produce *defective* (ISO 9000:2015, 3.6.10) products is reduced to zero

3.8
sustainable manufacturing
creation of manufactured *products* (ISO 9000:2015, 3.7.6) through economically sound *processes* (ISO 9000:2015, 3.4.1) that minimize negative environmental impacts while conserving energy and natural resources and enhance working conditions, the impact to the community and product safety.

[SOURCE: United States Environmental Protection Agency https://www.epa.gov/]

[SOURCE: ForZDM Glossary https://www.forzdmproject.eu/content/public-results]

3.9
defect propagation
transmission of a *defect* (ISO 9000:2015, 3.6.10) to subsequent manufacturing steps in the *process* (ISO 9000:2015, 3.4.1) chain

[SOURCE: ForZDM Glossary https://www.forzdmproject.eu/content/public-results]

3.10
defect generation
appearance of a defect (ISO 9000:2015, 3.6.10) in a manufactured part

[SOURCE: ForZDM Glossary https://www.forzdmproject.eu/content/public-results]

3.11
virtual detection
action to evaluate product quality characteristics using only process data or some other form of data not linked to data from physical access to the part, with the goal of identifying the presence of product *defects* (ISO 9000:2015, 3.6.10).

EXAMPLE 1 Spindle rotation speed is an example of process data.

3.12
physical detection
action that evaluates the product or process quality characteristics using data from the physical product or *asset* (ISO/IEC 20924:2021, 3.1.4) with the goal of identifying the presence of product or process *defects* (ISO 9000:2015, 3.6.10)

Note 1 to entry: Data from the physical product or asset can be gathered by digital, analogue and human means.

3.13
hybrid detection
action resulting from the combination of physical and virtual detection

3.14
predictive action
action to forecast the occurrence of a *defect* (ISO 9000:2015, 3.6.10) and/or a *failure* (IEV 192-03-01)

3.15
prediction timeframe
time window that the prediction method can look ahead to predict a *defect* (ISO 9000:2015, 3.6.10) or *failure* (IEV 192-03-01)

3.16
process adjustment
action to reduce the deviation from the target in the output *characteristic* (ISO 9000:2015, 3.10.1) by *feed-forward control* (ISO 3534-2:2006, 2.3.25) and/or *feedback control* (ISO 3534-2:2006, 2.3.26)

Note 1 to entry: Continuous monitoring determines whether or not the process and/or the process adjustment system itself are in a state of statistical control.

[SOURCE: ISO 3534-2:2006, 2.3.24, modified — Note 1 to entry was replaced]

3.17
incoming inspection
inspection (ISO 9000:2015, 3.11.7) performed at the start of the manufacturing *process* (ISO 9000:2015, 3.4.1)

3.18
in-process inspection
inspection (ISO 9000:2015, 3.11.7) performed during the manufacturing cycle and before the completion of all manufacturing *processes* (ISO 9000:2015, 3.4.1)

3.19
final inspection
post-process inspection

inspection (ISO 9000:2015, 3.11.7) performed at the end of the manufacturing *process* (ISO 9000:2015, 3.4.1), before shipping to the customer

Note 1 to entry: Contrary to in-process inspection, this inspection is performed after the manufacturing process.

3.20
on-machine inspection
on-machine measurement

inspection (ISO 9000:2015, 3.11.7) performed using a measuring device integrated in the manufacturing machine

Note 1 to entry: On-machine inspection enables the smallest close loop control in a production line (inside the machine) reducing the number of steps required for component inspection and enables immediate correction of defective parts.

3.21
off-line inspection
inspection (ISO 9000:2015, 3.11.7) performed using dedicated measuring devices outside the production line, usually performed in a laboratory

Note 1 to entry: Contrary to on-machine inspection, this inspection is performed outside the machine and the production line.

Note 2 to entry: There is always a time delay between production and inspection.

Note 3 to entry: This inspection is usually performed in a controlled environment (i.e. laboratory).

3.22
at-line inspection
inspection (ISO 9000:2015, 3.11.7) performed outside the production line by the production operator

Note 1 to entry: At-line inspections may take a limited amount of time (such as seconds or minutes) allowing the process to quickly continue.

3.23
in-line inspection
inspection (ISO 9000:2015, 3.11.7) performed using a measuring device integrated into the production line

Note 1 to entry: The results from in-line inspections may be available immediately.

3.24
failure
<of an item> loss of ability to perform as required

Note 1 to entry: A failure of an item is an event that results in a fault of that item: see "fault" (IEV 192-04-01).

Note 2 to entry: Qualifiers, such as catastrophic, critical, major, minor, marginal and insignificant, can be used to categorize failures according to the severity of consequences, the choice and definitions of severity criteria depending upon the field of application.

Note 3 to entry: Qualifiers, such as misuse, mishandling and weakness, can be used to categorize failures according to the cause of failure.

Note 4 to entry: A failure is a form of process defect.

[SOURCE: IEV 192-03-01, modified — Note 4 to entry added.]

3.25
alarm
operational signal or message designed to notify a human when a detected anomaly (ISO 13372:2012, 4.4), or a logical combination of anomalies, requiring a *corrective action* (ISO 9000:2015, 3.12.2) is encountered

Note 1 to entry: An alarm represents a more severe anomaly zone than an alert (ISO 13372:2012, 4.3) and should be identified with a red indicator.

Note 2 to entry: The alarm should be addressed immediately according to severity

[SOURCE: ISO 13372:2012, 4.2, modified — The phrase “corrective actions” was replaced by “a corrective action”, the phrase “personnel” was replaced with “a human”, Note 2 to entry was added, link to ISO 9000:2015, 3.12.2 was added, in Note 1 to entry the phrase “alarm is” was replaced with “alarm represents”, “selected” was replaced with “detected”]

3.26
alert
operational signal or warning message designed to notify a human when a detected *anomaly* (ISO 13372:2012, 4.4), or a logical combination of anomalies, requiring a heightened awareness *corrective action* (ISO 9000:2015, 3.12.2) is encountered

Note 1 to entry: An alert is the first zone of an *anomaly* (ISO 13372:2012, 4.4) and should be identified with a yellow indicator.

[SOURCE: ISO 13372:2012, 4.3, modified — The phrase “heightened awareness” was replaced by “a heightened awareness preventive action”, the phrase “personnel” was replaced by “a human”, “selected” was replaced with “detected”]

3.27
digital platform
software *system* (IEV 151-11-27) in which application software is executed

EXAMPLE 1 An operating system for manufacturing on which software is executed.

[SOURCE: IEV 871-05-07, modified — “IT” was replaced by “digital”, reference to system was added, EXAMPLE 1 was replaced, Note 1 to entry was not taken over.]

Annex A
(informative)

ZDM Overview

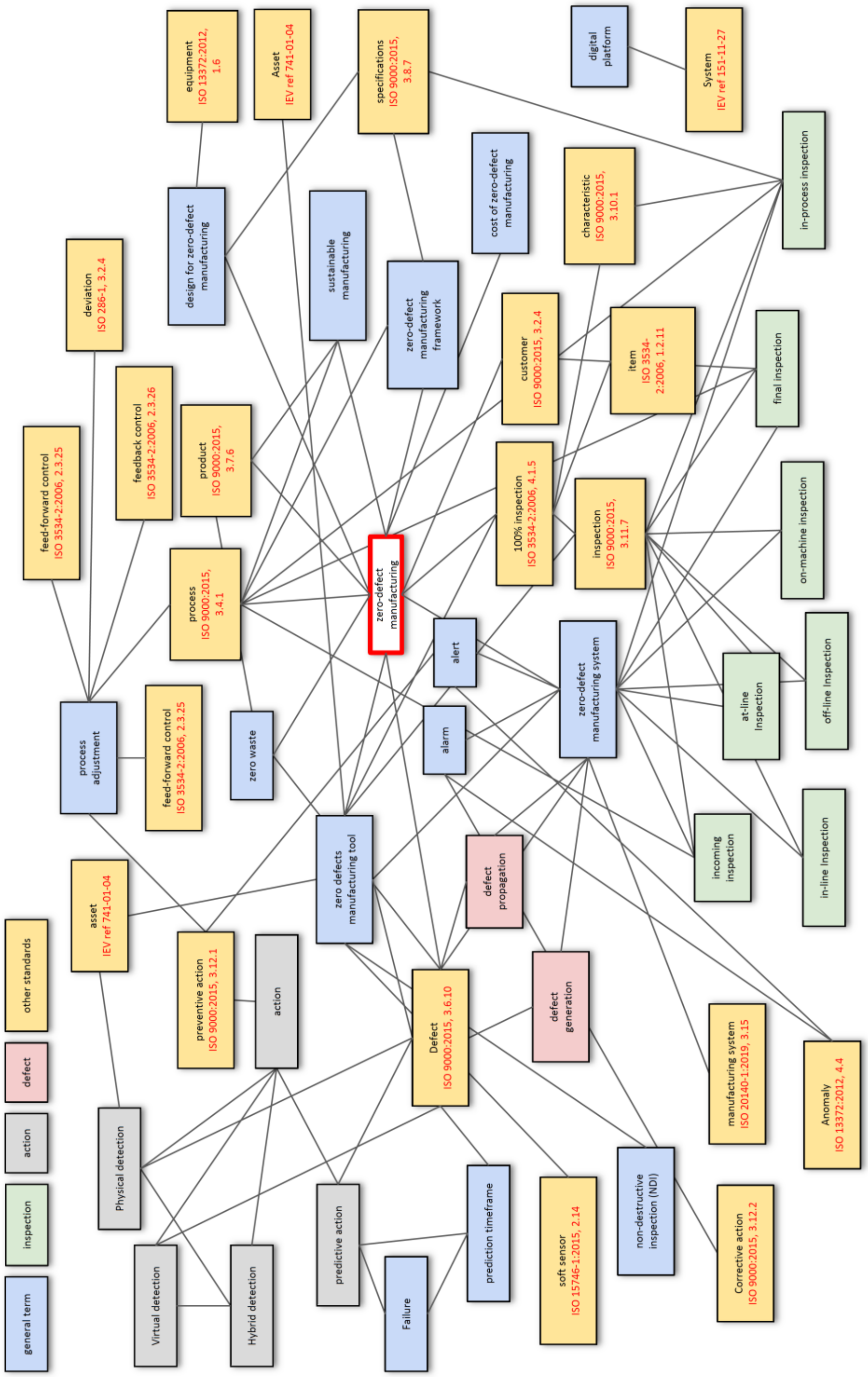

Figure A.1 — Relation of the terms

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[1] Psarommatis, F., 2021. A generic methodology and a digital twin for zero defect manufacturing (ZDM) performance mapping towards design for ZDM. Journal of Manufacturing Systems, 59, pp.507-521

[2] United States Environmental Protection Agency https://www.epa.gov/

[3] ForZDM Glossary https://www.forzdmproject.eu/content/public-results

[4] ISO 9000:2015 Quality management systems — Fundamentals and vocabulary

[5] ISO 3534-2:2006 Statistics — Vocabulary and symbols — Part 2: Applied statistics

[6] ISO/IEEE 11073-10201:2020 Health informatics — Device interoperability — Part 10201: Point-of-care medical device communication — Domain information model

[7] ISO 20140-1:2019 Automation systems and integration — Evaluating energy efficiency and other factors of manufacturing systems that influence the environment — Part 1: Overview and general principles

[8] ISO 15746-1:2015 Automation systems and integration — Integration of advanced process control and optimization capabilities for manufacturing systems — Part 1: Framework and functional model

[9] ISO 13372:2012 Condition monitoring and diagnostics of machines — Vocabulary

[10] ISO/IEC 20924:2021 Information technology — Internet of Things (IoT) — Vocabulary