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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11

Email: copyright@iso.org
Website: www.iso.org

ASTM International
100 Barr Harbor Drive, PO Box C700
West Conshohocken, PA 19428-2959, USA
Phone: +610 832 9634
Fax: +610 832 9635
Email: khooper@astm.org
Website: www.astm.org

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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.

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The committee responsible for this document is ISO/TC 261, *Additive manufacturing*, in cooperation with ASTM Committee F42, *Additive manufacturing technologies*, on the basis of a partnership agreement between ISO and ASTM International with the aim to create a common set of ISO/ASTM standards on additive manufacturing, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 438, *Additive manufacturing,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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Introduction

The use of additive manufacturing (AM) processes with polymer materials entails a number of hazards. It is therefore important, as a first step, to implement a high level of protection during manufacturing and installation of the additive manufacturing machine or system.

In addition, the users of additive manufacturing plants have the duty to reduce the risks for the operators remaining after installation so that they fulfil the nationally or regionally pertinent regulations for health and safety at work. The latter are very different worldwide and the requirements of a standard cannot fully reflect them. For users of additive manufacturing plants, the guidelines and requirements of this document are, therefore, particularly relevant with regard to aspects not sufficiently covered by pertinent national or regional regulations for safety and health at work.

While this document outlines general principles and best practices to mitigate the hazards associated with polymeric additive manufacturing with material extrusion, these best practices intend to be generic and provide the users with the means to fulfil any local laws and regulations.

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Additive manufacturing of polymers — Environment, health and safety — General principles for use of polymers with material extrusion

1 Scope

This document provides guidance and requirements for risk assessment and implementation of prevention and protection measures relating to material extrusion-based additive manufacturing with polymer materials.

The risks covered by this document concern all sub-processes composing the manufacturing process, including the management of waste.

This document does not specify requirements for the design of machinery and equipment used for additive manufacturing.

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 16321-1, *Eye and face protection for occupational use — Part 1: General requirements*

ISO 16321-3, *Eye and face protection for occupational use — Part 3: Additional requirements for mesh protectors*

ISO/ASTM 52900, *Additive manufacturing — General principles — Fundamentals and vocabulary*

IEC 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres*

IEC 60079-10-2, *Explosive atmospheres — Part 10-2: classification of areas — Combustible dust atmospheres*

ANSI Z87.1, *Practice for Occupational and Educational Eye and Face Protection*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900 apply.

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

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

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

4 Abbreviations

The abbreviations and acronyms used in this document are listed in Table 1.

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Table 1 — Abbreviations and acronyms

Abbreviation	Signification
ACGIH	American Conference of Governmental Industrial Hygienists
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
AHU	air handling unit
ATEX	atmospheres explosives
CLP	classification, labelling, packaging
CMR	carcinogenic, mutagenic or reprotoxic
DOT	United States Department of Transportation
EChA	European Chemicals Agency
EHS	environmental health and safety
GHS	globally harmonized system
MSD	musculo skeletal disorder
NIOSH	National Institute for Occupational Safety and Health
OEL	occupational exposure limit
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
REACh	registration, evaluation and authorisation of chemicals
SDS	safety data sheet
UNECE	United Nations Economic Commission for Europe

5 Methodology

5.1 General

The method described in this document allows the user to assess the EHS risks considering the following:

— polymer materials used;

— AM process;

— AM system installation conditions;

— applicable good practices;

— feedback from experience.

The methodology is based on a characterization of physical hazards (e.g. fire and explosion), hazards to the health of the operator or the potentially exposed third parties and to the environment. The overall approach to risk assessment and implementation of prevention measures is illustrated in Figure 1 and detailed in Table 2.

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