TR 87 : 2021
(ICS 25.030; 13.340)

TECHNICAL REFERENCE

Safety of additive manufacturing facilities

Singapore Standards Council

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The organisations in which the experts of the Working Group are involved are:

Advanced Remanufacturing and Technology Centre
Institute of Chemical and Engineering Sciences
JTC Corporation

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Foreword

This Technical Reference was prepared by the Working Group on Safety of Additive Manufacturing Facilities set up by the Technical Committee on Additive Manufacturing under the purview of MSC.

This TR is a provisional standard made available for application over a period of three years. The aim is to use the experience gained to update the TR so that it can be adopted as a Singapore Standard. Users of the TR are invited to provide feedback on its technical content, clarity and ease of use. Feedback can be submitted using the form provided in the TR. At the end of the three years, the TR will be reviewed, taking into account any feedback or other considerations, to further its development into a Singapore Standard if found suitable.

It is presupposed that in the course of their work, users will comply with all relevant regulatory and statutory requirements. Some examples of relervant regulations and acts are listed in the Bibliography. The Singapore Standards Council and Enterprise Singapore will not be responsible for identifying all of such legal obligations.

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1. Underwriters Laboratories Inc. (UL). Besides adopting the content structure and using it as a base document, C.1, E.1, E.2, E.3 and are adopted from UL 3400 “Outline of Investigation for Additive Manufacturing Facility Safety Management” for the development of this standard.

2. National Fire Protection Association (NFPA)

   Annex E.4 and Table E.1 from NFPA® 499, “Recommended Practice for the Classification of Combustible Dust and Hazards (Classified) Locations for Electrical Installations in Chemical Process Areas”, 2013 edition, Copyright © 2012 National Fire Protection Association®.
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3. Singapore Civil Defence Force (SCDF). Clauses 3.10 and 3.11 from “Code of practice for fire precautions in buildings, 2018”.

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NOTE

1. *Singapore Standards (SSs) and Technical References (TRs) are reviewed periodically to keep abreast of technical changes, technological developments and industry practices. The changes are documented through the issue of either amendments or revisions. Where SSs are deemed to be stable, i.e. no foreseeable changes in them, they will be classified as “Mature Standards”. Mature Standards will not be subject to further review, unless there are requests to review such standards.*

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Safety of additive manufacturing facilities

0 Introduction

Additive manufacturing (AM) has experienced substantial growth in recent years, resulting in more facilities being set up worldwide. The growth is more profound in metal AM sector, primarily due to the design freedom and ease of fabrication that enabled the direct realisation of functional end-use parts.

Different AM systems can be classified into three major categories: power-based, liquid-based and solid-based.

Although the introduction of AM technologies has the potential to transform modern industrial production, it also brings new considerations on the set-up and safe operation of these facilities. There is a need to align the understanding among various stakeholders such as employers, employees, regulators, as well as insurance firms underwriting AM facilities, on the inherent material, technology and equipment risks.

The lack of International Standards that address the needs of this rapidly evolving technology to align the safety of an AM facility has resulted in the development of this Technical Reference (TR).

1 Scope

This TR specifies the safety for designing, operating and maintaining an AM facility using powder as the feedstock material. It seeks to equip local AM companies, especially new entrants, with internationally recognised provisions on the safe setup, operations and maintenance of additive manufacturing facilities.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI/ISEA 105	American national standard for hand protection classification
ANSI/ISEA Z87.1	American national standard for occupational and educational personal eye and face protection devices
ASTM F2413	Standard specification for performance requirements for protective (safety) toe cap footwear
CP 52	Code of practice for automatic fire sprinkler system
EN 143	Respiratory protective devices – Particle filters
EN 166	Personal eye-protection – Specifications
EN 374	Modified standard for chemical protective gloves
EN 407	Protective gloves and other hand protective equipment against thermal risks (heat and/or fire)
IEC 61340-4-3	Electrostatics – Part 4-3: Standard test methods for specific applications – Footwear

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ISO 11611	Protective clothing for use in welding and allied processes
ISO 11612	Protective clothing – Clothing to protect against heat and flame – Minimum performance requirements
ISO 17493	Clothing and equipment for protection against heat – Test method for convective heat resistance using a hot air circulating oven
ISO 20349	Personal protective equipment – Footwear protecting against thermal risks and molten metal splashes as found in foundries and welding – Requirements and test method
ISO/TS 16975-1	Respiratory protective devices – Selection, use and maintenance – Part 1: Establishing and implementing a respiratory protective device programme
NFPA 13	Standard for the installation of sprinkler systems
NFPA 17	Standard for dry chemical extinguishing systems
NFPA 30	Flammable and combustible liquids code
NFPA 33	Standard for spray application using flammable or combustible materials
NFPA 34	Standard for dipping, coating, and printing processes using flammable or combustible liquids
NFPA 484	Standard for combustible metals
NFPA 654	Standard for the prevention of fire and dust explosions from the manufacturing, processing, and handling of combustible particulate solids
NFPA 2112	Standard on flame-resistant clothing for protection of industrial personnel against short-duration thermal exposures from fire
SS 513-1	Specification for personal protective equipment – Footwear – Part 1 : Safety footwear
SS 532	Code of practice for the storage of flammable liquids
SS 548	Code of practice for selection, use and maintenance of respiratory protective devices
SS 551	Code of practice for earthing
SS 567	Code of practice for factory layout – Safety, health and welfare considerations
SS 575	Code of practice for fire hydrant, rising mains and hose reel systems
SS 578	Code of practice for the use and maintenance of portable fire extinguishers
SS 638	Code of practice for electrical installations
SS 645	Code of practice for the installation and servicing of electrical fire alarm systems
SS 651	Safety and health management system for the chemical industry – Requirements with guidance for use

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