

SS 666 : 2020
(ICS 25.030)

SINGAPORE STANDARD

**Qualification of parts printed by metal additive
manufacturing**



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

3D Metalforge Pte Ltd
ASTM International
Creatz3D Pte Ltd
DNV GL Singapore
Nanyang Technological University
National Metrology Centre
National University of Singapore
Setso Services Pte Ltd
Singapore Armed Forces
Singapore Centre for 3D Printing
Singapore Precision Engineering and Technology Association
Singapore Test Services Pte Ltd
Singapore University of Technology and Design
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Contents

	Page
Foreword _____	6
1 Scope _____	7
2 Normative references _____	7
3 Terms and definitions _____	9
4 Abbreviated terms _____	10
5 Part classification _____	11
6 Qualification of AM printed parts _____	14

Annex

A Statistical analysis for deciding the number of test specimen _____	38
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Tables

1 Item classification for military applications _____	14
2 Existing standards for finished part properties with PBF _____	19
3 Test standards for metal AM powder _____	20
4 Process parameter categories for PBF-LB/M _____	26
5 Summary of requirements for AM process qualification _____	27
6 Test requirements for reference and test specimens for AM parts _____	32
7 Mechanical test standards for AM metal material _____	33
8 List of NDT test standards _____	36
9 NDT requirements (part level) _____	36

Figures

1 A chart for part and process selections based on design complexity and production volume after design feasibility check _____	11
2 Key areas of focus for qualification of an AM printed part _____	15
3 Qualification procedure of AM printed parts _____	16
4 AM process qualification procedure _____	18
5 NDT inspectability according to part complexity _____	35

Bibliography _____	41
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Foreword

This Singapore Standard was prepared by the Working Group on Military Additive Manufacturing set up by the Technical Committee on Additive Manufacturing under the purview of MSC.

This standard provides users with a framework for qualification of additive manufacturing (AM) printed parts and processes during AM metal part production.

Potential users include AM design engineers, manufacturing engineers, maintenance engineers, industry associations, research institutions and government agencies.

Acknowledgement is made to the following organisations for their kind permission to reproduce their materials into this TR:

1. International Organization for Standardization, ISO/ASTM 52900:2015 Additive manufacturing – General principles – Terminology
2. Thales Alenia Space, figure in article “Large scale metal lattice structure for complex satellite part”.

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Qualification of parts printed by metal additive manufacturing

1 Scope

This Singapore Standard provides users with a framework for qualification and certification of additive manufacturing (AM) printed part and process during AM metal part production. To produce consistent AM parts, there is a need to consider the aspects of raw material, machine, operator and parts. This standard is applicable to the powder bed fusion (PBF), especially powder bed fusion of metal using laser beam (PBF-LB/M).

This standard also specifies the part classification and qualification requirements for AM processes and parts. These classification and qualification requirements are divided into part classification, pre-process qualification for AM machine, in-process qualification for AM parts at specimen level and post-process qualification for AM parts.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated reference, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

ASME B46.1	Surface texture (surface roughness, waviness, and lay)
ASTM E1417 / E1417M	Standard practice for liquid penetrant testing
ASTM E1441	Standard guide for computed tomography (CT)
ASTM E1444	Standard practice for magnetic particle testing
ASTM E1570	Standard practice for fan beam computed tomographic (CT) examination
ASTM E2884	Standard guide for eddy current testing of electrically conducting materials using conformable sensor arrays
ASTM F2924	Standard specification for additive manufacturing titanium-6 aluminum-4 vanadium with powder bed fusion
ASTM F3001	Standard specification for additive manufacturing titanium-6 aluminum-4 vanadium ELI (extra low interstitial) with powder bed fusion
ASTM F3055	Standard specification for additive manufacturing nickel alloy (UNS N07718) with powder bed fusion
ASTM F3056	Standard specification for additive manufacturing nickel alloy (UNS N06625) with powder bed fusion
ASTM F3184	Standard specification for additive manufacturing stainless steel alloy (UNS S31603) with powder bed fusion
ASTM F3213	Standard for additive manufacturing – Finished part properties – Standard specification for cobalt-28 chromium-6 molybdenum via powder bed fusion
ASTM F3302	Standard for additive manufacturing – Finished part properties – Standard specification for titanium alloys via powder bed fusion

ASTM F3318	Standard for additive manufacturing – Finished part properties – Specification for AlSi10Mg with powder bed fusion – Laser beam
ASTM F3434	Guide for additive manufacturing – Installation/operation and performance qualification (IQ/OQ/PQ) of laser-beam powder bed fusion equipment for production manufacturing
ASTM G59	Standard test method for conducting potentiodynamic polarization resistance measurements
ISO 17296-3	Additive manufacturing – General principles – Part 3: Main characteristics and corresponding test methods
ISO 17296-4	Additive manufacturing – General principles – Part 4: Overview of data processing
ISO/ASTM 52900	Additive manufacturing – General principles – Terminology
ISO/ASTM 52901	Additive manufacturing – General principles – Requirements for purchased AM parts
ISO/ASTM 52904	Additive manufacturing – Process characteristics and performance: – Practice for metal powder bed fusion process to meet critical applications
ISO/ASTM 52921	Standard terminology for additive manufacturing – Coordinate systems and test methodologies
ISO/ASTM 52926-1	Additive manufacturing of metals – Qualification principles – Part 1: General qualification of machine operators
ISO/ASTM 52926-2	Additive manufacturing of metals – Qualification principles – Part 2: Qualification of machine operators for PBF-LB
ISO/ASTM 52926-3	Additive manufacturing of metals – Qualification principles – Part 3: Qualification of machine operators for PBF-EB
ISO/ASTM 52926-4	Additive manufacturing of metals – Qualification principles – Part 4: Qualification of machine operators for DED-LB
ISO/ASTM 52926-5	Additive manufacturing of metals – Qualification principles – Part 5: Qualification of machine operators for DED-Arc
ISO/ASTM 52941	Additive manufacturing – System performance and reliability – Acceptance tests for laser metal powder-bed fusion machines for metallic materials for aerospace application
ISO/ASTM 52942	Additive manufacturing – Qualification principles – Qualifying machine operators of laser metal powder bed fusion machines and equipment used in aerospace applications
MIL-STD-810G	Department of defense test method standard – Environmental engineering considerations and laboratory tests
MSFC-SPEC-3717 (effective date 18 October 2017)	Specification for control and qualification of laser powder bed fusion metallurgical processes
MSFC-STD-3716	Standard for additively manufactured spaceflight hardware by laser powder bed fusion in metals