Application note

RENISHAW
apply innovation™

AMS7003 —
Additive manufacturing for aerospace

www.renishaw.com/additivemanufacturing

#renishaw

Contents

1 Introduction

This document provides guidance on the role that Renishaw's additive manufacturing (AM) offering can play in demonstrating compliance with SAE International Aerospace Material Specification AMS7003.

This guidance is not intended to be an exhaustive guide to AMS7003 compliance. Renishaw's scope only extends to the direct actions of the Laser Powder Bed Fusion (L-PBF) system. The scope of this document is limited to the RenAM 500 series of Renishaw metal L-PBF systems.

1.1 Reading instructions

This document is intended to be read in parallel with SAE Aerospace Material Specification AMS7003.

Section 3 to section 5.5 of this document corresponds with the same section number in the AMS7003 document.

The appendix of this document includes information relating to the following appendices from the AMS7003 document.

- Appendix A - Key Process variables required for laser powder bed fusion process

- Appendix B - Calibration and verification requirements

NOTE: The guidance in this document is based on rev.A of AMS7003.

1.2 Glossary of terms

Term	Definition
Producer	The entity using the Laser Powder Bed Fusion (L-PBF) process to produce a part i.e. Renishaw's customer
OEM	Original Equipment Manufacturer. This is the L-PBF machine OEM, Renishaw. 'Renishaw' may also be used in place of 'L-PBF machine OEM' as used in AMS7003A.
AM	Additive Manufacturing
CAD	Computer Aided Design
CEO	Cognisant Engineering Organisation
L-PBF	Laser Powder Bed Fusion
PCD	Process Controls and Documentation
HMI	Human Machine Interface i.e. the touchscreen and buttons on the front of the RenAM 500 series

2 Contact details

Contact details for Renishaw are below:

Phone number:		**+44 (0) 1453 524524** Hours of work: Monday to Friday 08:00 to 17:00 hr (UTC and DST)
Email:	**For quotes and orders related to consumables, parts, and contracts**	**ampd.sales@renishaw.com**
	For scheduled maintenance visits, machine breakdowns or any machine operating queries	**am.support@renishaw.com**
	For any guidance or issues related to build file preparation, general machine operation, machine training, post build testing and analysis	**am_applications@renishaw.com**
	For any QuantAM licence issues or queries	**quantam.support@renishaw.com**
Service address:		Renishaw plc New Mills Wotton-under-Edge Gloucestershire GL12 8JR United Kingdom

Additional support can be sought by contacting your local Renishaw office.

Visit: **www.renishaw.com/contact**

3 Technical requirements

3.1 Process Control Document (PCD)

3.1.1 Key Process Variables (KPVs)

See the appendix for a list of variables considered to be KPVs for the AM process. The appendix includes how those variables are defined, the recommended tolerances and how the KPV is measured and recorded.

3.1.2 Process interruption

To support control and diagnosis of process interruptions:

- The system raises information, warning and error alerts through the machine software. Errors will cause the beacon light to show amber. When user action is required, the beacon light will show blue.
- All alerts raised by the system are logged and can be exported using the 'Export' button located in the Alerts Log page of the machine software.
- Sensor data and alerts are also available in Renishaw Central, our production monitoring software.
- The system will not automatically re-start following a build failure.

The Renishaw build file format (.renam) contains explicit laser and system controls and is deterministic (i.e. it contains explicit timing instructions for the laser and system). This enables the Producer to define the key build instructions, and ensure process timing is consistent.

Definition of allowable process interruptions is the responsibility of the Producer as this is application specific.

3.1.3 Digital file and software configuration control

Control of digital files within the company file management structure or operating system is the responsibility of the Producer.

Version information for QuantAM and InfiniAM software can be found under the 'About' menu, found by clicking on the *i* symbol in the top-right of the respective software.

Version information for the software that controls the RenAM 500 series - Machine Software Suite (MSS) - can be found on the 'System Information' screen accessible via the Human Machine Interface (HMI).

The Renishaw build file format (.renam) contains the following machine parameters: laser toolpath, laser parameters (e.g. power, focus, speed), laser assignment (i.e. which laser should process each section), elevator and recoater instructions. The instructions are deterministic (i.e. contain explicit timing).

Any other machine parameters are set via the HMI, which is access controlled via a username and password.

3.1.4 Calibration and verification plan

The table in the appendix includes the calibration or verification procedure and frequency for all relevant KPVs.

3.1.5 Maintenance plan

The list of recommended user maintenance tasks can be found in the RenAM 500 series additive manufacturing system user guide (Renishaw part no. H-5800-3693) in the section titled 'Preventative maintenance schedule'.

Maintenance tasks carried out by Renishaw service engineers are documented in visit reports.

3.1.6 Feedstock handling and storage plan

Renishaw's recommendations for safe feedstock handling and storage are documented in the RenAM 500 series site preparation and installation guide (Renishaw part no. H-5800-3692) in the section titled 'Safety information for metal powder'. This includes storage, transport and disposal. The section titled 'Operating environment' includes recommendations for system operating temperature and humidity. The section titled 'Argon supply' includes guidance on the purity of the processing gas.

The process for loading and removal of powder from the L-PBF machine is described in the RenAM 500 series additive manufacturing system user guide (Renishaw part no. H-5800-3693) in the section titled 'unloading and unpacking'.

Material safety data sheets from the metal powder supplier should be consulted for additional handling and storage recommendations. Renishaw material safety data sheets are available from the Renishaw website (www.renishaw.com/metalpowders).

Feedstock batch control and tracking is specific to the customer application and should be discussed between the CEO and Producer. Refer to section 2 to contact our applications team to discuss further support as required regarding sampling techniques.

3.1.7 Moisture and contamination control plan

Proper facility preparation and maintenance in accordance with the section titled 'Site and facilities preparation' of the RenAM 500 series site preparation and installation guide (Renishaw part no. H-5800-3692) are critical for minimising the risk of moisture, foreign material or other contaminants.

3.2 L-PBF machine approval

Compliance with L-PBF machine approval is specific to the customer application and should be discussed between the CEO and Producer. Refer to section 2 to contact our applications team to discuss further support as required.

3.3 L-PBF process approval

Compliance with L-PBF process approval is specific to the customer application and should be discussed between the CEO and Producer. Refer to section 2 to contact our applications team to discuss further support as required.

3.4 Statistical Process Control (SPC)

The table in the appendix contains the variables Renishaw considers to be KPVs for which SPC could be used. The table also includes the recommended Producer response if a KPV is out of tolerance.

4 Quality assurance provisions

The following documentation is available from Renishaw to support quality assurance activity:

- Machine install & commissioning report
- Machine service report(s), including calibration and verification checks
- Calibration records for factory-fitted sensors and replacements
- Release notes for all software versions
- Certificates of Conformity for Renishaw supplied feedstock

5 Process setup verification

See the following sections from the RenAM 500 series additive manufacturing system user guide (Renishaw part no. H-5800-3693) for information on process setup:

Process setup stage	RenAM 500 series user guide section
Selecting the build file	AB-017 Build file – select
Selecting machine settings and parameters	No machine settings have to be adjusted on a per-build basis
Pre-build machine check procedure	AB-025 Pre-build checklist
Build plate installation	AB-008 Build plate – install
Feedstock loading	AB-022 Feed hopper - fill

5.1 L-PBF process requalification

See section 4 for information on documentation that Renishaw will supply to support quality assurance activity, including process requalification.

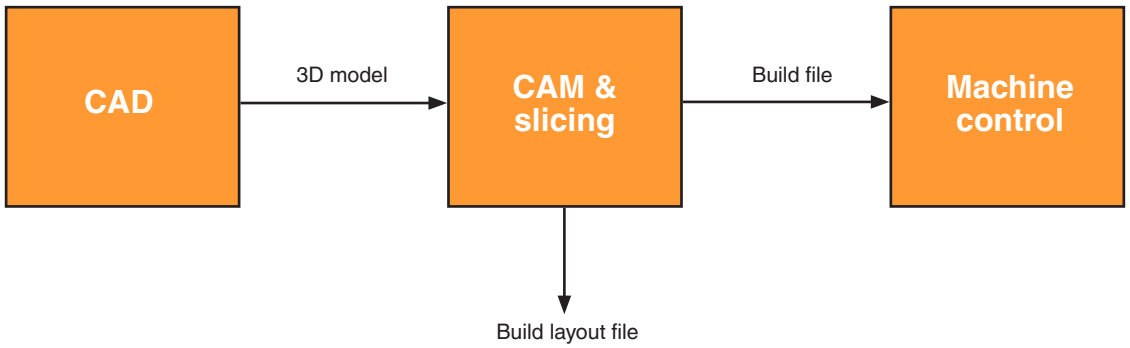
5.2 Build quality report

Build records, including build process data such as KPV timeseries data, is available through Renishaw Central production monitoring software. This includes sensor and build information (stored on an on-premise server) with data visualisation through a web interface or analysis via a REST Application Programming Interface (API).

A build report is also generated by the RenAM 500 series system after every build which provides a record of build file, machine settings, events and sensor readings.

5.3 Digital file traceability

Control and documentation of the digital process flow is the responsibility of the Producer.



Renishaw's QuantAM software can be used for build layout, adding supports, slicing, and machine parameter definition. QuantAM functions can be used via an API within select third-party CAD and CAM software. Build layout files can be exported from QuantAM.

NOTE: Version information for QuantAM software can be found under the 'About' menu, found by clicking on the *i* symbol in the top-right of the respective software.

The Renishaw build file format (.renam) contains the following machine parameters: laser toolpath, laser parameters (e.g. power, focus, speed), laser assignment (i.e. which laser should process each section), elevator and recoater instructions. The instructions are deterministic (i.e. contain explicit timing).

Each compatible metal has a specific set of laser and machine parameters that have been optimised for melting that metal. These parameters are stored in a "Material file", which can be exported as an .xml file for retention.

NOTE: Version information for the software that controls the RenAM 500 series - Machine Software Suite (MSS) - can be found on the 'System Information' screen accessible via the HMI.

SEE SECTION 4 FOR A LIST OF RENISHAW DOCUMENTATION DESIGNED TO SUPPORT QUALITY ASSURANCE ACTIVITIES, INCLUDING FOLLOWING SERVICE INTERVENTIONS SUCH AS SOFTWARE UPDATES.

5.4 Feedstock base alloy change

Renishaw doesn't recommend changing the base alloy feedstock on RenAM 500 series systems that include powder recirculation. Only RenAM 500 Flex models (with their open-loop powder systems) have been designed to accommodate changing the base alloy.

Documentation and training is available for the powder change process on a RenAM 500 Flex system. Refer to the section titled "Flex material change process" in the RenAM 500 series advanced procedure user guide (Renishaw part no. H-5800-4840) for step-by-step guidance. See section 5.5 of this document for training information.

Changing the batch of the same base alloy is supported on all models of the RenAM 500 series. Refer to the section titled "Powder batch change process" of the RenAM 500 series advanced procedure user guide (Renishaw part no. H-5800-4840) for step-by-step guidance. Any spare parts needed to complete these procedures are available through Renishaw.

5.5 Training requirements

The following training is available from Renishaw (contact your Renishaw sales representative for more information).

Service code	Description	Related AMS7003 Appendix C heading
CS-TRA-ONSI-14-AM	OPERATOR TRAINING	Feedstock Handling Machine Maintenance Machine Setup, Operation, and Part Removal Moisture and Contamination Control EH&S
CS-TRA-ONSI-14-AMAJ	OPTICAL SYSTEM VERIFICATION TRAINING	Machine Calibration and Verification
CS-TRA-ONSI-14-AMAK	SERVICE LEVEL ACCESS TRAINING	Machine Calibration and Verification
CS-TRA-ONSI-14-AMAN	RENAM 500 RBV USER TRAINING	Feedstock Handling Machine Maintenance Machine Setup, Operation, and Part Removal Moisture and Contamination Control EH&S
CS-TRA-ONSI-14-AMAO	QUANTAM BASIC USER TRAINING	Digital File Traceability
CS-TRA-ONSI-14-AMAP	AM ADVANCED USER TRAINING	Process Capability Process Monitoring
CS-TRA-ONSI-14-AMAV	TEMPUS TRAINING	Process Capability Digital File Traceability
CS-TRA-ONSI-14-FXMAT	AM500 FLEX MATERIAL CHANGE TRAINING	Feedstock Handling Moisture and Contamination Control EH&S
CS-TRA-ONSI-14-FXUSR	AM500 FLEX USER TRAINING	Feedstock Handling Machine Maintenance Machine Setup, Operation, and Part Removal Moisture and Contamination Control EH&S
CS-TRA-ONSI-14-AMAQ	INFINIAM SOFTWARE SUITE TRAINING	Process Monitoring

Appendix: Calibration and verification requirements and key process variables

NOTE: This table shows information relating to both 'APPENDIX A - KEY PROCESS VARIABLES REQUIRED FOR LASER POWDER BED FUSION PROCESS' and 'APPENDIX B - CALIBRATION AND VERIFICATION REQUIREMENTS' of AMS7003.

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
1	Build file	Producer defined name .renam build file.	N/A discrete	Producer responsibility to control electronic file.	N/A for SPC	N/A	N/A
2	Build plate configuration	Drawing available in the RenAM 500 series user guide (Renishaw part no. H-5800-3693) in section titled 'Build plate specification'.	As per drawing tolerances for thickness, parallelism and flatness.	Producer responsibility for build plate measurement. Build report includes plate thickness programmed value.	N/A for SPC	N/A	N/A

#	KPV	Nominal value specification specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
3	Build platform position	Initial platform position is set as the substrate thickness. Measured during build setup as per the RenAM 500 series user guide (Renishaw part no. H-5800-3693) in section titled 'Definitions of maintenance'. Renishaw RESOLUTE™ linear encoder controls elevator position, with rotary encoder on z-axis drive.	>15 mm	Machine generated build report includes plate thickness. Z-axis position data from encoder written to machine logs, available through Renishaw Central and build report.	N/A for SPC	Required by AMS7003 Appendix B. No calibration needed for stainless steel tape scale for absolute linear encoder. Linear encoder and rotary encoder enable failure detection.	N/A
4	Build layout	Defined in build file.	N/A discrete	Producer responsibility to control electronic file.	N/A for SPC	N/A	N/A
5	Manufacturer, model, and serial number of each laser	Factory configured.	N/A discrete	Factory configuration records available on request.	N/A for SPC	N/A	N/A

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
6	Laser optical train	Renishaw design.	N/A discrete	Factory configuration records available on request.	N/A for SPC	N/A	N/A
7	Laser position (galvos scanner mirrors, motor, control)	All laser nominal positions defined in build file. Galvo encoders control optics position.	Radial error. ±60 µm RMS (Root Mean Squared). ±120 µm max.	Producer responsibility to control electronic file. Optics errors are logged on machine.	Required by AMS7003 Appendix A. Recalibrate scanfield. Risk assessment for part geometric accuracy.	Required by AMS7003 Appendix B. User verification using Optical System Verification (OSV) – as per RenAM 500 series user guide (Renishaw part no. H-5800-3693) section titled 'Optical tests'. Service optical commissioning as per Optical commissioning procedure (Renishaw part no. PD-6521-9006).	Producer defined using OSV. 6 months (Renishaw service).

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
8	L-PBF machine manufacturer, model, and serial number	Factory configured.	N/A discrete	Included on machine serial plate, on rear of system.	N/A for SPC	N/A	N/A
9	Recoater mechanism configuration	Factory configured. Silicone recoater blade (Renishaw part no. A-5771-0025) installed as per RenAM 500 series user guide (Renishaw part no. H-5800-3693) in section titled AB-009 - Recoater blade - Install.	N/A discrete	Producer responsibility to record operator activity.	N/A for SPC	N/A	N/A
10	Integrated control system	Factory configured, or updated through service visit.	N/A discrete	Available in 'System Information' through HMI.	N/A for SPC	N/A	N/A
11	Recoater speed	Defined in build file (.renam). Default 100 mm/s forwards, 362 mm/s backwards. Closed loop recoater servo control.	±10%	Timestamps for recoater reaching front & back positions in log files.	N/A for SPC	Required by AMS7003 Appendix B. Time with stopwatch.	As required by Producer QMS.

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
12	Feedstock specification	Powder purchase order specification. Renishaw recommendations available from **www.renishaw.com/ metalpowders**	Various (by powder specification point), see Renishaw powder material data sheets.	Producer responsibility for incoming goods quality controls and ongoing feedstock monitoring.	Required by AMS7003 Appendix A. Contact powder supplier, or replace feedstock.	N/A	N/A
13	Feedstock powder particle size and distribution	Powder purchase order specification. Renishaw recommendations available from **www.renishaw.com/ metalpowders**	Various (by powder type). Typically 15 µm to 45 µm.	Producer responsibility for incoming goods quality controls and ongoing feedstock monitoring.	Required by AMS7003 Appendix A. Contact powder supplier, or replace feedstock.	N/A	N/A

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
14	Feedstock manufacturer	Producer feedstock supply agreements.	N/A discrete	Producer responsibility for feedstock supply agreements.	N/A for SPC	N/A	N/A
15	Build platform pre-heat temperature	Target set through machine HMI, Target can be set from ambient temperature up to 170 °C. Closed loop thermocouple control.	±10%	Temperature sensor data written to machine logs, available through Renishaw Central and build report.	Required by AMS7003 Appendix A. Contact Renishaw service to support diagnosis.	Required by AMS7003 Appendix B. Factory calibration. Independent verification with thermocouple by Producer.	As required by Producer QMS.
16	Shielding gas composition	Producer gas supply agreements. As per the RenAM 500 series installation guide (Renishaw part no. H-5800-3692) section titled 'Argon supply'.	≥99.998% pure argon	Producer responsibility for incoming goods quality controls.	N/A for SPC	Required by AMS7003 Appendix B. As per shielding gas supplier recommendations.	As required by Producer QMS.

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
17	Shielding gas flow rate	Target set through machine HMI for recirculation pump flow rate & filter differential pressure. Closed loop flow rate control of recirculation pump.	±5%	Differential pressure sensor and gas flow rate data written to machine logs, available through Renishaw Central.	Required by AMS7003 Appendix A. Contact Renishaw service to support diagnosis.	Required by AMS7003 Appendix B.	12 months
18	Shielding gas flow (hardware) configuration	Factory configured.	N/A discrete	Factory configuration records available on request.	N/A for SPC	N/A	N/A
19	Type of filtration	Factory configured.	N/A discrete	Factory configuration records available on request.	N/A for SPC	N/A	N/A
20	Build chamber (gas) temperature	Limit is factory configured (<65 °C).	As per limit.	Temperature sensor data written to machine logs, available through Renishaw Central and build report.	Required by AMS7003 Appendix A. Contact Renishaw service to support diagnosis.	Calibrated at factory. Independent verification with thermocouple by Producer.	As required by Producer QMS.

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
21	Build chamber (gas) moisture content	Limit is factory configured (<10 g/mm^3).	As per limit.	Sensor data written to machine logs, available through Renishaw Central and build report.	Required by AMS7003 Appendix A. Contact Renishaw service to support diagnosis.	Required by AMS7003 Appendix B. Calibrated at factory. Replace sensors on failure or verification interval.	As required by Producer QMS.
22	Chamber pressure urspacing	Vacuum and overpressure limits factory configured. Closed loop control of gas and vacuum systems.	<30 mbar during processing.	Sensor data written to machine logs, available through Renishaw Central and build report.	Contact Renishaw service to support diagnosis.	Required by AMS7003 Appendix B. Pressure and vacuum decay service test as per Atmospheric testing procedure (Renishaw part no. PD-6521-9826) verify system performance. Calibrated at factory. Replace sensors on failure or verification interval.	As required by Producer QMS.

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
23	Oxygen content	Limit set through machine HMI. Closed loop control of gas and vacuum systems.	As per limit.	Sensor data written to machine logs, available through Renishaw Central and build report.	Required by AMS7003 Appendix A Contact Renishaw service to support diagnosis.	Required by AMS7003 Appendix B. Calibrated at factory. Replace sensors on failure or verification interval.	As required by Producer QMS.
24	Layer thickness	Defined in build file. Renishaw RESOLUTE™ linear encoder controls elevator position, with rotary encoder on z-axis drive.	N/A discrete	Producer responsibility to control electronic file. Z-axis position data from encoder written to machine logs, available through Renishaw Central and build report.	N/A for SPC	No calibration needed for stainless steel tape scale for absolute linear encoder. Linear encoder and rotary encoder enable failure detection.	N/A

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
25	Power of each laser	Defined in build file.	≤6% for powers ≥100 W	Producer responsibility to control electronic file. Laser output power recorded using LaserVIEW photodiode and available in InfiniAM software.	Required by AMS7003 Appendix A. Recalibrate laser power. Risk assessment for part quality.	Required by AMS7003 Appendix B. User verification using OSV as per RenAM 500 series user guide (Renishaw part no. H-5800-3693) section titled 'Optical tests'. Service optical commissioning as per Optical commissioning procedure (Renishaw part no. PD-6521-9006).	Producer defined, using OSV. 6 months (Renishaw service).
26	Contour spacing	Defined in build file.	Application specific.	Producer responsibility to control electronic file.	N/A for SPC	N/A	N/A
27	Contour overlap	Defined in build file.	Application specific.	Producer responsibility to control electronic file.	N/A for SPC	N/A	N/A
28	Hatch spacing	Defined in build file.	Application specific.	Producer responsibility to control electronic file.	N/A for SPC	N/A	N/A
29	Hatch overlap	Defined in build file.	Application specific.	Producer responsibility to control electronic file.	N/A for SPC	N/A	N/A

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
30	Beam spot size and shape of each laser (profile)	Factory configured. Nominally 82.5 µm.	±10 µm	Factory configuration records available on request. Measured during Renishaw service.	Required by AMS7003 Appendix A. Contact Renishaw service to support diagnosis.	Required by AMS7003 Appendix B. Service optical commissioning as per Optical commissioning procedure (Renishaw part no. PD-6521-9006).	6 months
31	Beam quality/ stability of each laser	Factory configured.	Ellipticity <1.15	Factory configuration records available on request. Measured during Renishaw service.	Required by AMS7003 Appendix A. Contact Renishaw service to support diagnosis.	Required by AMS7003 Appendix B. Service optical commissioning as per Optical commissioning procedure (Renishaw part no. PD-6521-9006).	6 months

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
32	Beam pulse characteristic of each laser	Defined in build file for modulated build-styles.	Application specific.	Producer responsibility to control electronic file.	N/A for SPC	Required by AMS7003 Appendix B. Independent verification of system timing by Producer.	As required by Producer QMS.
33	Scan speed	Defined in build file for continuous build-styles.	Application specific.	Producer responsibility to control electronic file.	N/A for SPC	Required by AMS7003 Appendix B. Independent verification of system timing by Producer.	As required by Producer QMS.

#	KPV	Nominal value specification (control method)	Recommended tolerance	Measurement & recording method	Reaction plan if SPC outside limits	Calibration/ verification procedure	Calibration/ verification frequency
34	Scan strategy	Defined in build file.	N/A discrete	Producer responsibility to control electronic file.	N/A for SPC	N/A	N/A
35	Overlap zone	Laser positions, including overlap defined in build file. All lasers can address the entire bed. Galvo encoders control optics position.	Radial laser-to-laser error. ±60 µm RMS (Root Mean Squared). ±120 µm max.	Producer responsibility to control electronic file. Optics errors are logged on machine.	Required by AMS7003 Appendix A. Recalibrate scanfield. Risk assessment for part geometric accuracy.	User verification using (OSV) – as per RenAM 500 series user guide (Renishaw part no. H-5800-3693) section titled 'Optical tests'. Service optical commissioning as per Optical commissioning procedure (Renishaw part no. PD-6521-9006).	Producer defined, using OSV. 6 months (Renishaw service).
36	Process interruption	.renam build file contains explicit timing controls, preventing unintended process interruption without raising an error.	Application specific.	Machine errors (including inability to meet build file explicit timing commands) logged on machine.	N/A for SPC	N/A	N/A

RENISHAW
apply innovation™

www.renishaw.com/additivemanufacturing

#renishaw

+44 (0) 1453 524524 uk@renishaw.com

Part no.: H-5800-7003-01-B

Issued: 07.2025