

RenAM 500 series additive manufacturing system



Contents

1.	Legal notices	8
1.1	Terms and conditions and warranty	8
1.2	Declaration of conformity	8
1.3	WEEE directive	8
1.4	Battery safety	9
1.5	Disposal of batteries	9
1.6	FCC information (USA)	9
1.6.1	47CFR section 15.19	9
1.6.2	47CFR section 15.21	9
1.6.3	47CFR section 15.105	10
1.7	REACH	10
1.8	Control of pollution, applicable in the People's Republic of China	10
1.9	China RoHS	10
1.10	Industrial, Scientific and Medical Equipment (ISM) (Canada only)	10
1.11	Changes to equipment	10
2.	Introduction.	11
2.1	Intended use	11
2.2	RenAM 500 series models	11
2.3	Reference documentation	12
2.4	Critical information in this guide	12
2.4.1	Warning	12
2.4.2	Caution	12
2.4.3	Note	13
3.	Safety	14
3.1	General safety information	14
3.1.1	Read instructions	14
3.1.2	Safety signs and laser safety labels.	14
3.1.3	Safety function diagrams	18
3.1.3.1	RenAM 500 front view – safety functions	18
3.1.3.2	RenAM 500 rear view – safety functions	19
3.1.3.3	RenAM 500 top view – safety functions.	20

3.2	Safety information for the system	20
3.2.1	Transport and system relocation	21
3.2.2	Responsibilities	21
3.2.3	Basic safety measures.	22
3.2.4	Explosion prevention	23
3.2.5	Emergency response.	23
3.2.6	Normal operation	23
3.2.7	Hazards due to unexpected malfunctions	23
3.2.8	Approvals, compliance and certification.	24
3.2.9	Residual risks, maintenance and protective measures	24
3.2.10	Housekeeping	24
3.2.11	Electro-magnetic compatibility	24
3.2.12	Decommissioning	25
3.3	Safety information for the lasers	25
3.4	Personal safety instructions	28
3.4.1	Manual handling.	28
3.4.2	Fire-fighting	28
3.4.3	Laser safety precautions	29
3.4.4	Oxygen level monitoring within the process room	29
3.4.5	Training	30
3.4.6	Correct usage	30
3.4.7	Improper use	30
3.4.8	Personal protective equipment (PPE)	31
3.4.9	Toxicity and personnel exposure	32
3.4.10	Thermal hazards	33
3.4.11	Hazards due to latent energy sources	33
3.4.12	System ergonomics	33
3.5	Safety information for inert gas	34
3.6	Safety information for metal powder	35
3.6.1	Metal powder handling advice	35
3.6.2	Flammability.	37
3.6.2.4	Combustibility	37
3.6.2.5	Explosivity	38
3.6.3	Safe disposal of waste products	38
3.6.4	Handling and processing	39

3.6.5	Storage	39
3.6.6	Spills	40
3.6.7	Metal powder safety checklist	40
3.6.8	Hazards due to fire or explosion	41
3.6.9	Identifiable ignition sources	42
3.6.10	Hydrogen gas	43
3.6.11	Safety data sheets	43
3.6.12	Metal condensate	44
4.	System overview	45
4.1	Model configuration	45
4.2	Technical specification	45
4.3	Hardware overview	45
4.3.1	RenAM 500 front view	46
4.3.2	RenAM 500 rear view	47
4.3.3	RenAM 500 right-hand end view	48
4.3.4	RenAM 500 front view with powder fill and large SafeChange™ filter door open	49
4.3.5	RenAM 500 Flex front view with overflow and large SafeChange™ filter door open	50
4.3.6	RenAM 500 rear view with rear right-hand cupboard door open	51
4.3.7	RenAM 500 Flex rear view with rear right-hand and middle cupboard doors open	52
4.3.8	RenAM 500 plan view	53
5.	Ancillary equipment	54
5.1	ATEX vacuum cleaner (mandatory)	55
5.1.1	Technical specification	56
5.1.2	ATEX vacuum cleaner safety	56
5.1.3	ATEX vacuum cleaner operation	57
5.2	Chiller (mandatory)	58
5.2.1	Air-cooled chiller – technical specification	59
5.2.2	Water-cooled chiller – technical specification	60
5.3	Bead blaster and extractor (optional)	61
5.3.1	Technical specification	62
5.4	Furnace (optional)	63
5.4.1	Technical specification	64
5.4.2	Furnace argon gas consumption	64

5.5	Universal lifter (recommended for RenAM 500 and RenAM 500 Ultra) (mandatory for RenAM 500 Flex)	65
5.6	Hopper trolley (recommended for RenAM 500 and RenAM 500 Ultra).	66
5.6.1	Technical specification	66
5.7	Powder recovery system (sieve) (recommended for RenAM 500 and RenAM 500 Ultra) (mandatory for RenAM 500 Flex)	67
5.7.1	Technical specification	68
5.8	Working platform (recommended for RenAM 500 and RenAM 500 Ultra) (mandatory for RenAM 500 Flex)	69
5.8.1	Technical specification	69
5.9	Optical System Verification (OSV) (recommended)	70
6.	Site and facilities preparation	71
6.1	Process room requirements	71
6.1.1	Machine room space requirement	72
6.1.2	Ancillary equipment floor space requirement.	74
6.1.3	Sample process room layout	77
6.2	Process room construction requirements	78
6.3	Floor requirements	81
6.4	Power requirements	82
6.4.1	RenAM 500 series system and ancillary equipment power ratings	83
6.4.2	Uninterrupted power supply	84
6.5	Requirements for heat removal devices	86
6.5.1	Customer-supplied heat exchanger	87
6.6	Plumbing and water requirements	87
6.6.1	Large SafeChange™ filter requirements	87
6.6.2	Waste water	87
6.6.3	Facility water requirements for chiller / heat exchanger	87
6.6.4	Water-cooled chiller	88
6.6.5	Heat exchanger	89
6.7	Pneumatic supply	89
6.7.1	Bead blaster air requirements	89
6.8	Operating environment	89
6.8.1	Electrical and thermal loads.	91
6.8.2	Equipment emissions.	92
6.9	Electro-magnetic compatibility	92
6.10	Argon supply	92

6.11	ATEX zoning	94
6.12	Vibration	94
6.12.1	Vibration impact	94
6.12.2	Mitigating vibration	94
6.13	Data	95
6.13.1	Network requirements	95
6.13.2	Network connection	96
6.13.3	Connection to a single computer	96
6.13.4	Firewall	96
6.14	Handling considerations	96
6.15	Safety signs and labels	97
7.	Receiving the RenAM 500 series system.	99
7.1	Scope of supply.	99
7.1.1	Standard equipment for RenAM 500 Flex	99
7.1.2	Standard equipment for RenAM 500	100
7.1.3	Standard equipment for RenAM 500 Ultra	100
7.2	Installation plan	101
7.3	Exterior requirements	101
7.4	Lifting requirements.	101
7.5	Crate sizes and weights	102
7.6	Inspection	102
7.7	Storage requirements	102
7.8	Site transportation requirements.	103
8.	Unloading and unpacking.	104
8.1	Unloading RenAM 500 series machine crate	104
8.1.1	Tools and equipment required	104
8.1.2	General safety advice	104
8.1.3	Procedure	105
8.2	Removing RenAM 500 series machine from the crate	106
8.2.1	Tools and equipment required	106
8.2.2	Procedure	107
8.3	Moving RenAM 500 series machine to the process room.	117
8.3.1	Tools and equipment required	117
8.3.2	General safety advice	117
8.3.3	Procedure	117

9.	System configuration	119
9.1	General safety advice	119
9.2	Installing the power cable	119
9.3	Connecting to the transformer input terminal	121
10.	Essential materials and equipment	124
10.1	Fire extinguishers	124
10.2	Argon regulators and cylinders	124
10.3	Low-level oxygen sensors	124
10.4	Personal protective equipment (PPE)	125
10.5	Electrical components	125
10.6	IPA and cleaning items	126
10.7	Waste storage	126
10.8	Powder storage	126
10.9	Workbenches	126
10.10	Mobile safety steps	126
10.11	PPE storage	126
10.12	First aid and eye wash	126
10.13	File preparation PC	126
11.	Installation and commissioning	127
11.1	Pre-installation questionnaire	128
11.1.1	Contact details	128
11.1.2	System details	128
11.1.3	Pre-preparation and safety documentation	128
11.1.4	Site facilities and preparation	129
11.1.5	Receipt of goods	131
11.1.6	Installation and commissioning	131
11.1.7	Ancillary equipment	131
11.1.8	Additional equipment supplied by the customer	131
11.1.9	Confirmation	132
12.	Training	133
13.	Customer support	134
13.1	Contact details	134
14.	Glossary	136
14.1	Definitions	136
14.2	Abbreviations	136

1. Legal notices

1.1 Terms and conditions and warranty

Unless you and Renishaw have agreed and signed a separate written agreement, the equipment and/or software are sold subject to the Renishaw Standard Terms and Conditions supplied with such equipment and/or software, or available on request from your local Renishaw office.

Renishaw warrants its equipment and software for a limited period (as set out in the Standard Terms and Conditions), provided that they are installed and used exactly as defined in associated Renishaw documentation. You should consult these Standard Terms and Conditions to find out the full details of your warranty.

Equipment and/or software purchased by you from a third-party supplier is subject to separate terms and conditions supplied with such equipment and/or software. You should contact your third-party supplier for details.

1.2 Declaration of conformity



Renishaw plc hereby declares that the RenAM 500 series is in compliance with the essential requirements and other relevant provisions of:

- The applicable EU directives
- The relevant statutory instruments under UK law
- The product regulatory laws of Australia and New Zealand

The full text of the declaration of conformity is available at:

Product compliance – Additive manufacturing ([renishaw.com](https://www.renishaw.com))

1.3 WEEE directive



The use of this symbol on Renishaw products and/or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic equipment (WEEE) to enable reuse or recycling. Correct disposal of this product will help to save valuable resources and prevent potential negative effects on the environment. For more information, please contact your local waste disposal service or Renishaw distributor.

1.4 Battery safety

This product is supplied with non-rechargeable lithium metal batteries. These batteries are embedded in the machine and should only be replaced by a Renishaw Service Engineer.

- Do not attempt to recharge the batteries.
- Do not disassemble, apply excessive pressure, pierce, deform or subject the batteries to impact.
- Dispose of waste batteries in accordance with your local environmental and safety laws.

Ensure that you comply with international and national battery transport regulations when transporting this product with the batteries inserted.

Lithium metal batteries are classified as dangerous goods for transportation and require labelling and packaging in accordance with the dangerous goods regulations before being offered for transportation. To reduce the risk of shipment delays, should you need to return this product to Renishaw for any reason, do not return any batteries.

1.5 Disposal of batteries



The use of this symbol on the batteries, packaging or accompanying documents indicates that used batteries should not be mixed with general household waste. Dispose of the used batteries at a designated collection point. This will prevent potential negative effects on the environment and human health which could otherwise arise from inappropriate waste handling. Contact your local authority or waste disposal service concerning the separate collection and disposal of batteries. All lithium and rechargeable batteries must be fully discharged or protected from short circuiting prior to disposal.

1.6 FCC information (USA)

1.6.1 47CFR section 15.19

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

1.6.2 47CFR section 15.21

The user is cautioned that any changes or modifications not expressly approved by Renishaw plc or authorised representative could void the user's authority to operate the equipment.

1.6.3 47CFR section 15.105

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

1.7 REACH

Information required by Article 33(1) of Regulation (EC) No. 1907/2006 (“REACH”) relating to products containing substances of very high concern (SVHCs) is available at:

Product Environmental Compliance – Additive manufacturing ([renishaw.com](https://www.renishaw.com))

1.8 Control of pollution, applicable in the People’s Republic of China

Renishaw have prepared a table in accordance with the provisions of SJ/T 11364. This is available on request from Renishaw.

1.9 China RoHS

For more information on China RoHS, visit:

Product compliance – Additive manufacturing ([renishaw.com](https://www.renishaw.com))

1.10 Industrial, Scientific and Medical Equipment (ISM) (Canada only)

This ISM device complies with ICES-003(A) / NMB-003(A).

Cet appareil ISM est conforme à la norme ICES-003(A) / NMB-003(A).

1.11 Changes to equipment

Renishaw reserves the right to change equipment specifications without notice.

2. Introduction

The Renishaw additive manufacturing (AM) process allows you to create homogeneous solid metal components directly from 3D CAD data using high-powered laser energy to melt fine metal powder. This manufacturing process is known as Laser Powder Bed Fusion (LPBF).

The RenAM 500 series is a complex and sophisticated AM machine designed to support the Renishaw AM process. To ensure that your site is properly equipped for your new system, and to minimise the possibility of problems or delays in system installation, it is essential to follow the guidelines outlined in this site preparation and installation guide. This manual also describes the controlled safety and handling protocols for installing the RenAM 500 series machine at your facility. The site and machine must be configured strictly in accordance with the instructions and advice provided in this manual to guarantee optimum performance. After successfully preparing the site and configuring the machine, you must complete the questionnaire provided in this guide and return it to Renishaw before the installation and commissioning by a Renishaw representative.

NOTE: This document is intended as a guide to prepare the site and configure the system prior to the installation and commissioning by a Renishaw representative. It is not meant to serve as a comprehensive manual for the system's installation.

2.1 Intended use

The Renishaw RenAM 500 series machines are a complex piece of AM equipment used for supporting the Renishaw AM process. They use the industry-leading gas flow system, precision dynamic control and software for connected digital workflows for scaling your AM application.

2.2 RenAM 500 series models

Renishaw's RenAM 500 series is a comprehensive platform of multiple-laser digital AM machines, each designed with unique features and capabilities. The series includes the following variants:

- **RenAM Flex models (RenAM 500S Flex, RenAM 500D Flex, RenAM 500Q Flex):** These models are equipped with a flexible total-loss powder management system, providing a high degree of adaptability in managing the powder used in the manufacturing process.
- **RenAM 500 Ultra models (RenAM 500S Ultra, RenAM 500D Ultra, RenAM 500Q Ultra):** These models come with on-board powder filtration and recirculation systems. They also feature advanced TEMPUS™ technology and have LaserVIEW™ and MeltVIEW™ hardware installed as standard, enhancing the precision and efficiency of the manufacturing process.
- **RenAM 500 models (RenAM 500S, RenAM 500D, RenAM 500Q):** These models are equipped with on-board powder filtration and recirculation systems. However, unlike the Ultra variants, they do not include the TEMPUS technology, LaserVIEW, and MeltVIEW hardware as standard features.

The 'S' and 'Q' in the model names denote the number of laser system used:

- 'S' stands for a Single (1) laser system.
- 'D' stands for a Dual (2) laser system.
- 'Q' stands for a Quad (4) laser system.

In summary, the RenAM 500 series offers a range of configurations, each tailored to meet specific manufacturing needs and requirements. From flexible powder management to advanced on-board filtration and recirculation systems, and from single to quad laser systems, the RenAM 500 series system provides a comprehensive solution for digital AM.

2.3 Reference documentation

In addition to this site preparation and installation guide, refer to the following documents for information about other aspects of the RenAM 500 series system:

- RenAM 500 series additive manufacturing system user guide (Renishaw part no. H-5800-3693)
- RenAM 500 series additive manufacturing systems data sheet (Renishaw part no. H-5800-4030)

NOTE: To access the latest Material data sheets and Safety data sheets for each of the metal powders developed for the RenAM 500 series system, go to **Material and safety data sheets - Additive manufacturing (renishaw.com)**.

2.4 Critical information in this guide

Within this guide additional information that is important to read and understand is presented as a Warning, Caution or Note. The definition of each of these and an example of each is below.

2.4.1 Warning

An example of a Warning is as follows:

WARNING: A warning is to tell the end user that there is a possibility of injury to themselves or other people in the vicinity if the described course of action is not followed.

2.4.2 Caution

An example of a Caution is as follows:

CAUTION: A Caution is to tell the end user that there is a possibility of damage to the equipment if the described course of action is not followed.

2.4.3 Note

An example of a Note is as follows:

NOTE: A Note is to advise the end user of important information that is related to, or will assist them in the task or activity they are carrying out.

3. Safety

3.1 General safety information

For the secure installation, operation and/or maintenance of your RenAM 500 series machine, it is the responsibility of the equipment owner to make sure that each person who operates the system reads and understands the manufacturer's instructions. This includes the labels applied on the equipment as well as the user manuals.

CAUTION: Installation and commissioning of the RenAM system by personnel other than Renishaw representatives will invalidate the warranty on the system. Contact Renishaw for more information on installation.

WARNING: Ensure all operators have completed a Renishaw-approved training course before operating the RenAM 500 series system. Operating the system without completing a Renishaw-approved training course may not only invalidate the system's warranty, but also potentially cause damage to the system and pose a serious risk of injury to the operator and others in the vicinity.

CAUTION: Any use of controls, adjustments, or procedures not explicitly specified in this manual may result in hazardous radiation exposure. Follow the instructions provided in this guide to ensure safety.

3.1.1 Read instructions

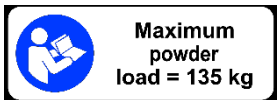
WARNING: Before installing, operating and/or maintaining the RenAM 500 series system or the ancillary equipment, you must read the manufacturer's instructions. If the instructions are not followed, you may injure yourselves or others, or cause damage to the equipment.

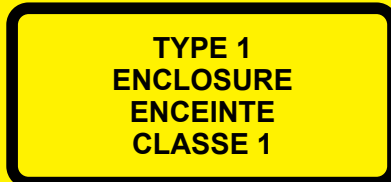
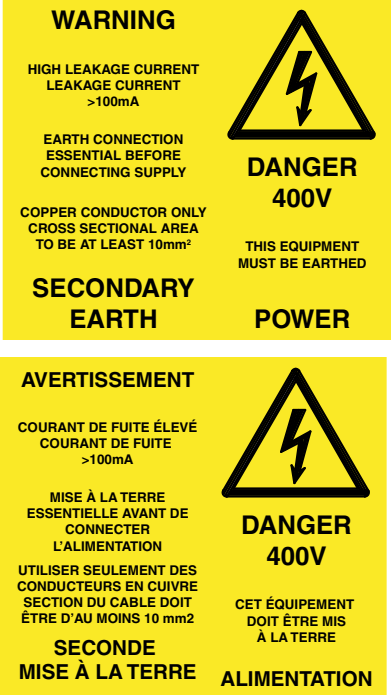
3.1.2 Safety signs and laser safety labels

There are various safety signs and laser labels fitted to the RenAM 500 series system. They warn of hazards from the system and advise on laser safety. Replacement safety signs can be ordered from Renishaw.

NOTE: Safety signs and laser labels fitted to the RenAM 500 series machine are in accordance with the mandatory language requirements of TÜV SÜD and CE. Safety signs and laser labels in non-mandatory languages are available by request.

The safety signs and their location are described in the table below:

Safety sign	Description and location
	Read the manual before proceeding One sticker, on the front of the RenAM 500 series to the left of the reset button below the touch screen control panel. Part no.: M-6252-0264
	RenAM 500 Flex only: One sticker, on the powder loading arm. Part no.: M-6810-2051
	RenAM 500 Flex only: One sticker, on the powder feed hopper. Part no.: M-6810-1047
	Two stickers, on the top panel next to the argon gas exhaust. Part no.: M-6521-3811
 	WARNING: HIGH VOLTAGES PRESENT WARNING: ISOLATE MACHINE BEFORE OPENING Two × two stickers, on the front electrical cupboard door, next to the two security locks. Two × two stickers, on the rear electrical cupboard door, next to the two security locks. Two × two stickers, on the rear centre electrical and recirculation pump access door next to the two security locks. Three × two stickers, one on each of the three top panels. Part no.: M-5774-1710
	WARNING: DANGER OF ASPHYXIATION One sticker, on the top panel next to the argon gas exhaust. Part no.: M-5774-0657

	TYPE 1 ENCLOSURE Fitted to the nameplate on the rear of the system. Part no.: M-5778-8904
	WARNING: HIGH LEAKAGE CURRENT EARTH CONNECTION ESSENTIAL BEFORE CONNECTING SUPPLY One sticker on the rear of the system as part of the system nameplate. Part no.: M-5774-5558
	Forklift here Two stickers on the front of the system low down above the plinth, indicating where a forklift should lift the system if required. Part no.: M-5778-8915
	DANGER 400V THIS EQUIPMENT MUST BE EARTHED One label on the left-hand side of the system at low level where argon gas and power enter the system. Part no.: M-6521-1391

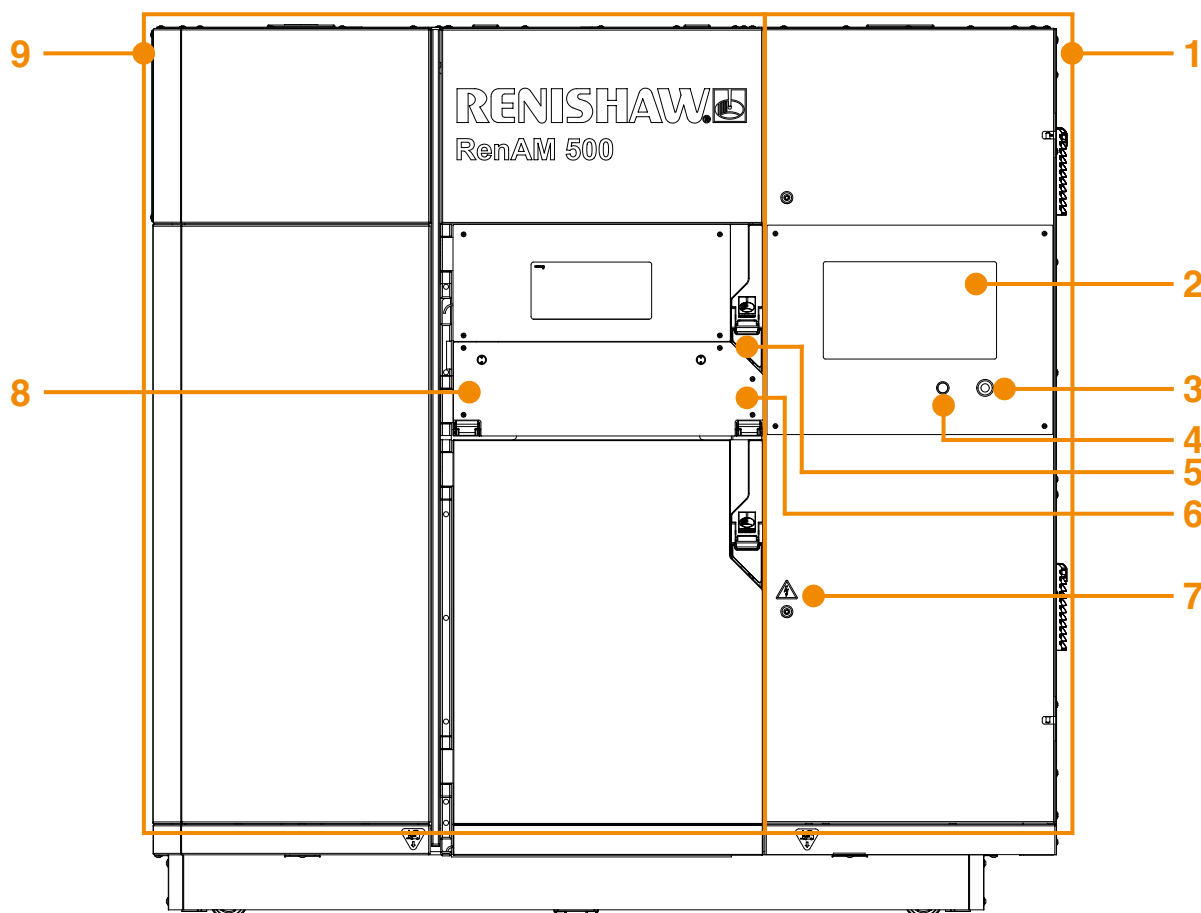
WARNING HIGH LEAKAGE CURRENT LEAKAGE CURRENT >100mA EARTH CONNECTION ESSENTIAL BEFORE CONNECTING SUPPLY COPPER CONDUCTOR ONLY CROSS SECTIONAL AREA TO BE AT LEAST 10mm² SECONDARY EARTH  DANGER 400V THIS EQUIPMENT MUST BE EARTHED POWER	WARNING: HIGH LEAKAGE CURRENT. LEAKAGE CURRENT >100mA EARTH CONNECTION ESSENTIAL BEFORE CONNECTING SUPPLY COPPER CONDUCTOR ONLY CROSS SECTIONAL AREA TO BE AT LEAST 10mm² One label on the left-hand side of the system at low level where argon gas and power enter the system. Part no.: M-6521-1391
AVERTISSEMENT COURANT DE FUITE ÉLEVÉ COURANT DE FUITE >100mA MISE À LA TERRE ESSENTIELLE AVANT DE CONNECTER L'ALIMENTATION UTILISER SEULEMENT DES CONDUCTEURS EN CUIVRE SECTION DU CÂBLE DOIT ÊTRE D'AU MOINS 10 mm² SECONDE MISE À LA TERRE  DANGER 400V CET ÉQUIPEMENT DOIT ÊTRE MIS À LA TERRE ALIMENTATION	

3.1.3 Safety function diagrams

The following figures illustrate the safety functions of the RenAM 500 series AM systems.

NOTE: The following figures show the front, rear and plan views of the RenAM 500 only. However, the same safety functions are found in the same locations on the RenAM 500 Flex and RenAM 500 Ultra.

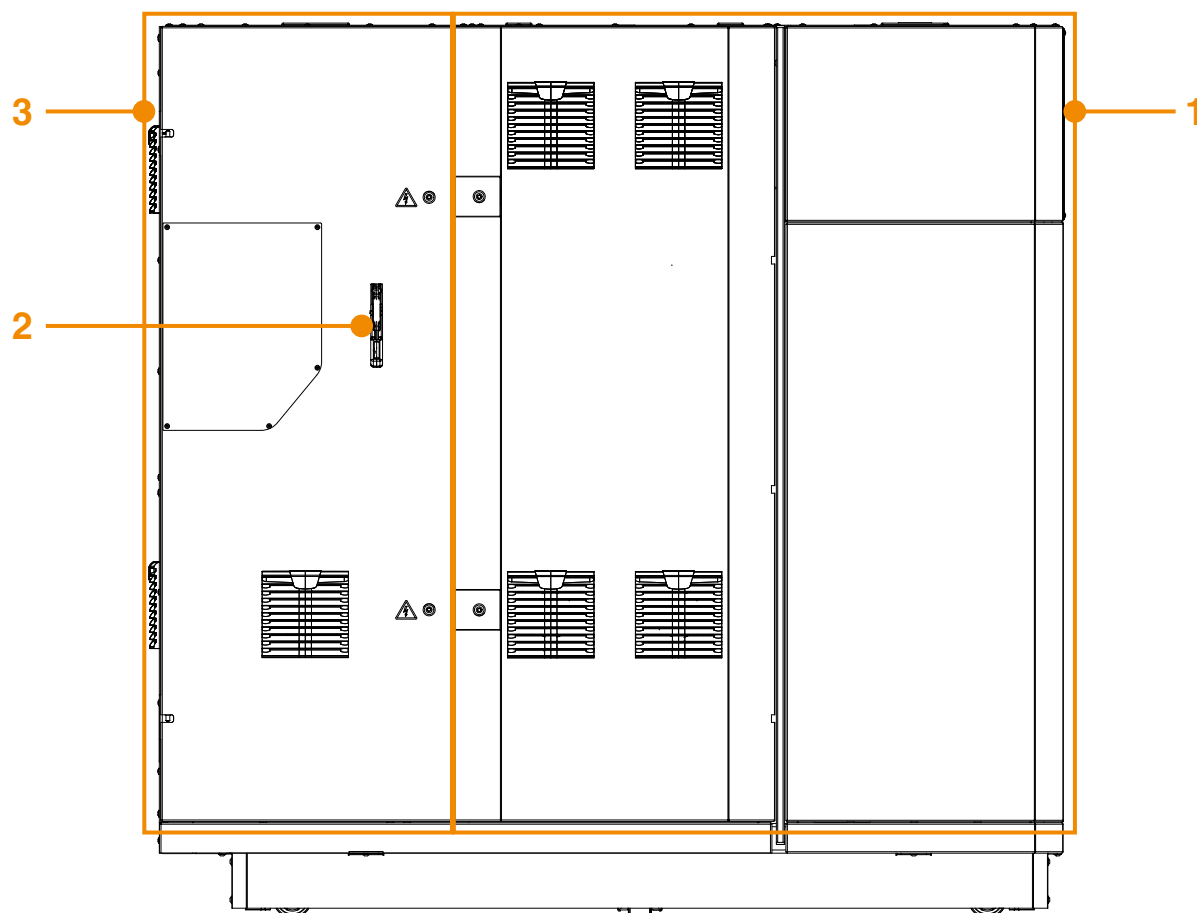
3.1.3.1 RenAM 500 front view – safety functions



1	Hazard zone 2: electrical control cabinet	6	Mechanical door lock
2	Operator touch screen control panel	7	Service mode switch
3	"Emergency Stop" button	8	Glovebox door magnetic switch
4	"Reset" button	9	Hazard zone 1: work/maintenance area
5	Build chamber door magnetic switch		

Figure 1 RenAM 500 front view – safety functions

3.1.3.2 RenAM 500 rear view – safety functions



1	Hazard zone 1: work/maintenance area
2	Hazard zone 2: electrical control cabinet
3	Electrical isolator

Figure 2 RenAM 500 rear view – safety functions

3.1.3.3 RenAM 500 top view – safety functions

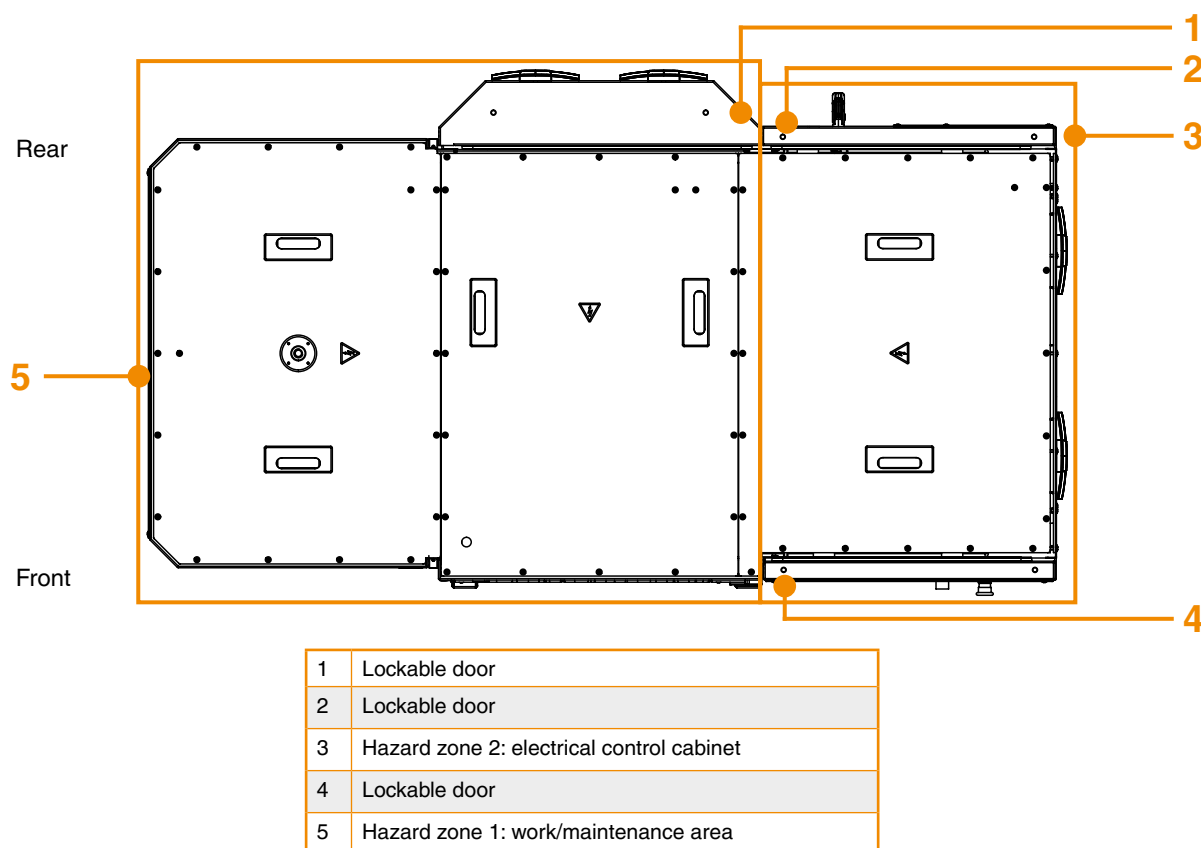


Figure 3 RenAM 500 top view – safety functions

3.2 Safety information for the system

The RenAM 500 series has been designed with safety in mind and has a number of in-built safety features. However, there are risks involved, but with sufficient planning and careful management these can be mitigated. RenAM 500 series safety features include:

- Sealed argon environment for processing.
- RenAM 500 and RenAM 500 Ultra only: Four oxygen sensors (two are SIL rated) and a chamber pressure sensor.
- RenAM 500 Flex only: Three oxygen sensors (one is SIL rated) and a chamber pressure sensor.
- RenAM 500 and RenAM 500 Ultra only: Fully sealed powder environment with automated recycling.
- Environmentally sealed powder flasks for powder filling.
- Powder adaptor for decanting powder from suppliers' powder bottles into powder flasks.
- Glovebox allowing the majority of powder handling to be carried out under argon.
- Interlocked Class 1 laser enclosure.

- Large SafeChange™ filters are flooded with water to make safe before disassembly.
- Renishaw approved and recommended ancillary equipment to simplify and facilitate the process of operating the machine and producing builds.

3.2.1 Transport and system relocation

If your RenAM 500 series system is to be moved to an alternative production facility or resold, Renishaw is happy to assist and advise. With this in mind, please inform us at your earliest convenience.

CAUTION: The transportation of the RenAM 500 series should only be carried out following the advice and recommendations of Renishaw plc.

3.2.2 Responsibilities

This document is intended as a guide. It is not intended as a complete work instruction for the installation of a system. Equipment installation and commissioning will be carried out by a Renishaw service engineer.

As an equipment owner, you must make sure that all the necessary local and national legislation, regulations, procedures and requirements have been considered and adhered to. Although not exhaustive, the list may include:

- Fire safety.
- Risk assessments.
- Management of hydrogen potentially generated by wet powder.
- Electrical wiring.
- Walkway clearances and fire exits.
- Air handling and filtration.
- Storage of compressed gas.
- Suitable lifting equipment.
- PPE – must not generate static charge.
- Filing of Safety data sheets.
- Provision of operator work instructions.
- Completion of an explosion prevention document.

NOTE: Read this guide thoroughly and ensure that all instructions are followed. Also, make sure to complete and submit the checklist contained in this guide to Renishaw. This process ensures that you have all the necessary resources, skills, facilities, equipment, services, systems and processes for the successful installation and commissioning of your RenAM 500 series system at your facility.

Should you require it, Renishaw can assist you in completing this checklist. This will help ensure a smooth process when receiving, installing, and operating the machine and its ancillary equipment. Since Renishaw's guidance is specific to the supplied equipment, it is essential that the equipment installer takes responsibility for planning the overall installation.

3.2.3 Basic safety measures

Relevant national legislation and internal company policies will dictate normal minimum requirements for health and safety. Risk assessments must be carried out prior to operating the system.

All end user companies must undertake a full risk assessment to establish the requirement for additional measures such as a COSHH and DSEAR assessment. This will subsequently inform the provision of correct PPE and site operating conditions and procedures for safe use of the equipment, storage and handling of raw materials and waste product. Any ancillary equipment must be selected giving due consideration to these requirements.

Governing and regulatory bodies will differ depending upon the geographic location where the RenAM 500 series is located. The appropriate governing and regulatory bodies must be identified for the geographic location where the RenAM 500 series is located. Considerations need to include regulations governing:

- Machinery safety.
- Electrical safety.
- EMC.
- The operation of lasers.
- The use of fine metallic powders.
- The use, storage and monitoring of inert gas.
- Small quantities of waste product including nanoparticles captured by the filter system and its correct disposal.
- The management of electrostatic charge.

Review all Safety data sheets for the materials being used.

By following the correct procedures, it is possible for most powder handling to be executed under an inert atmosphere; however measures must be taken to minimise exposure to any airborne metallic powder produced during the handling and processing of builds by the use of the appropriate PPE and other equipment as the components are removed from the system.

If in doubt about the health and safety issues and your legal obligations, our recommendation is to engage the services of a competent person.

3.2.4 Explosion prevention

The system, components and accessories are not suitable for operation or storage in areas containing explosive gases. Renishaw recommends that you develop and maintain an explosion prevention document in accordance with the applicable local legislation in the geographic area where the RenAM 500 series is located. In the absence of applicable local legislation, Renishaw recommends that you refer to the applicable DSEAR (ATEX 137) or NFPA standard (NFPA 484) and develop your explosion prevention document in accordance with one of these standards.

3.2.5 Emergency response

In case of emergency, immediately press the Emergency Stop button located on the front panel of the RenAM 500 series to stop the system. After operation of the Emergency Stop button, take action in accordance with the local rules and procedures for dealing with an emergency event. Operation of the Emergency Stop will stop the build.



Figure 4 “Emergency Stop” button on front of RenAM 500 series system

3.2.6 Normal operation

WARNING: During the operation of equipment and/or ancillary equipment, no safety devices may be removed or disabled. If the safety devices are removed or disabled, you may injure yourselves or others, or cause damage to the equipment.

The equipment may only be operated from the area directly in front of the touch screen. Operating the system from any other location is unsafe. The operating staff must ensure that no unauthorised persons enter the working area of the system, if it is unsafe to do so.

3.2.7 Hazards due to unexpected malfunctions

WARNING: Make sure all safety protocols are followed, and remain attentive during system operation. Non-compliance with these safety measures could lead to serious injury.

Although this equipment has been rigorously tested, the danger of unexpected malfunctions cannot be entirely ruled out when working on the equipment. Malfunctions may occur as a result of:

- Failure of the control system.

- Restoration of the power supply after a power failure.
- External influences on electrical equipment.

3.2.8 Approvals, compliance and certification

Information about the approvals, compliance and certification of the RenAM 500 series can be found on the declaration of conformity. The declaration of conformity will be supplied with your RenAM 500 series system.

3.2.9 Residual risks, maintenance and protective measures

Ensure that risk assessments have been carried out to ensure that the Renishaw RenAM 500 series system operates in a safe manner under normal defined operating conditions.

Ensure that the risk assessments are reviewed regularly and revised as necessary, particularly if any process variables change, such as new materials, changes to the type of inert gas used and other material changes to the operating conditions, as these can affect the control measures and equipment used when operating the system.

3.2.10 Housekeeping

Renishaw recommends a comprehensive schedule of the following to ensure your RenAM 500 series system and all ancillary equipment (for example, suitable lifting equipment, Ruwac vacuum cleaner, etc) function safely and as designed:

- Maintenance (user)
- Housekeeping (user)
- Servicing (Renishaw Service engineer)
- Calibration (Renishaw Service engineer)

Records of the above activities should to be made. Contact Renishaw if you need advice or assistance.

3.2.11 Electro-magnetic compatibility

WARNING: The RenAM 500 series is industrial in design and not intended for use at any time in a residential environment or to be powered from the public low-voltage mains.

3.2.12 Decommissioning

There are no known residual risks associated with the RenAM 500 series systems. However, when decommissioning the system, the following steps must be taken:

- Inert and remove the large SafeChange filter/filters.
- Remove all powder, clear the system of powder and clean to remove any residual powder.

WARNING: Before starting this task, ensure you are wearing the correct PPE: ESD safety footwear, eye protection, full-face respirator (to EN143 Type P3 + A1), protective gloves and full-length clothing.

NOTE: Renishaw recommends that full-length clothing is made from non-static-generating fabric such as cotton (avoid wool and synthetic fabrics). Avoid turn-ups or pockets that may trap powder. Refer to NFPA 484 for details.

- Clean the system of any residual dirt or process emissions.
- Shut off the inert gas supply and open the gas inlet valve to de-pressurise the system.
- Remove the inert gas supply hose.
- Follow the PC shutdown procedure.
- Isolate electrical power to the RenAM 500 series system.
- Drain down the system coolant.

WARNING: Refer to any applicable PPE requirements for handling system coolant.

It is the user's responsibility to document the powder types that have been used in the system and highlight any that may pose a residual risk. Contact Renishaw for packaging, and relocation or disposal guidance.

3.3 Safety information for the lasers

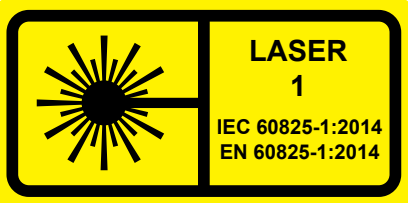
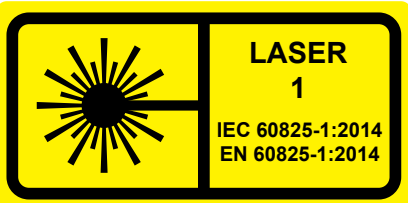
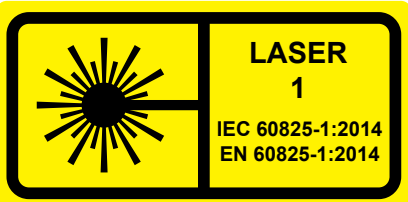
In order to comply with international standards, the Renishaw RenAM 500 series carries various laser safety labels regarding the emission of laser light. These labels form part of the safety information and it is recommended that users regularly check the condition and presence of the labels in the locations shown in the following images.

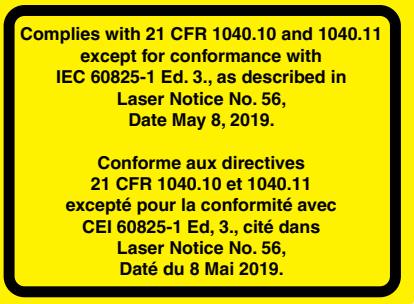
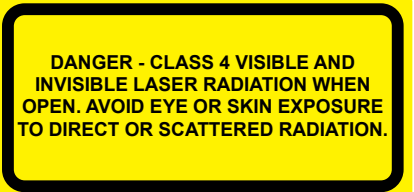
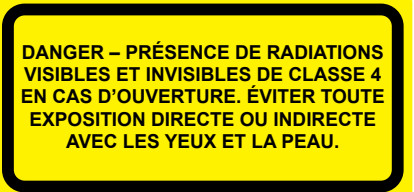
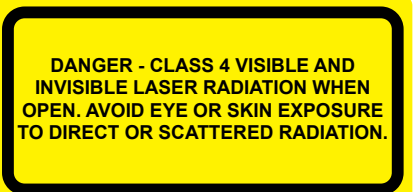
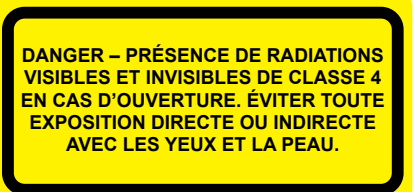
The higher the laser power Class number, the greater the laser radiation hazard. Refer to international standard IEC 60825 for details. The Renishaw RenAM 500 series in normal operation is classified as Class 1 according to the Standard EN 60825-1, edition: 2014, Safety of Laser Equipment – Part 1.

A summary of the standard is as follows:

Laser Class	Definition
Class 1	Output power is below the level at which it is believed eye damage will occur. May contain laser systems of a higher Class with adequate engineering control measures to ensure that access to the beam is not reasonably likely.
Class 1M	Can be harmful to the eye if the beam is viewed using magnifying optical instruments.
Class 2	More powerful than Class 1, natural aversion (blink response) should terminate the eye exposure before eye damage can occur. Repeated, deliberate exposure to the laser beam may not be safe.
Class 2M	Similar to a Class 2 laser product. However, these products can be harmful to the eye if the beam is viewed using magnifying optical instruments or for long periods of time.
Class 3R	Users must avoid viewing the beam directly. Although the risk of eye injury is low, the power exceeds the maximum permissible exposure for accidental viewing and can potentially cause eye injuries.
Class 3B	Class 3B lasers may have sufficient power to cause an eye injury, both from the direct beam and from reflections.
Class 4	Class 4 lasers are capable of causing injury to both the eye and the skin, and may also present a fire hazard.

The laser safety labels and location are described in the following table. Replacement laser safety labels can be ordered from Renishaw.

Laser label	Description and location
	Laser 1 classification label. Laser 1. IEC 60825-1:2014. EN 60825-1:2014. Fitted to the nameplate on the rear of the system. Part no.: M-5774-0561
	Laser 1 classification label. Laser 1. IEC 60825-1:2014. EN 60825-1:2014 Fitted to the three cover panels (front, back and top) of the optical module. Part no.: M-5774-0561
	Laser 1 classification label. Laser 1. IEC 60825-1:2014. EN 60825-1:2014 Fitted to the front of the system, in the top right-hand corner of the top door. Part no.: M-6521-0561

Laser label	Description and location
	Conformance label. Complies with 21 CFR 1040.10 and 1040.11. Except for deviations pursuant to Laser Notice No. 56 Date May 8, 2019. Fitted to the nameplate on the rear of the system. Part no.: M-6521-1961
 	Class 4 classification label. DANGER – CLASS 4 VISIBLE AND INVISIBLE LASER RADIATION WHEN OPEN. AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION. Fitted to the three cover panels (front, back and top) of the optical module. Part no.: M-6521-2102
 	Class 4 classification label. DANGER – CLASS 4 VISIBLE AND INVISIBLE LASER RADIATION WHEN OPEN. AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION. Fitted to the four beam delivery optic (BDO) cover panels. Part no.: M-6521-2102

3.4 Personal safety instructions

3.4.1 Manual handling

Operation and servicing of the RenAM 500 series will necessitate a certain amount of manual handling. Where this is necessary, the weight to be moved will be specified. Renishaw recommends purchasing suitable lifting equipment to move heavy items, such as the large SafeChange filters when full of water, and full powder flasks; specification can be supplied upon request. Renishaw recommends carrying out a risk assessment of all manual handling tasks to ensure they comply with applicable local legislation and guidelines.

RenAM 500 Flex only: A Renishaw universal lifter is included as standard equipment upon purchase of a RenAM 500 Flex for moving heavy items, such as the large SafeChange filters and full powder flasks. This equipment is also required for ergonomically difficult tasks such as the installation and removal of the feed hopper during material change. Specification can be supplied upon request.

3.4.2 Fire-fighting

Do not place yourself at risk. In all cases when tackling a fire, the first action is to call the emergency services. At all stages, the fire-fighting method must be appropriate for the material concerned and the Safety data sheets should be consulted before assigning particular fire-fighting equipment to the areas where the materials are stored and used.

In all cases, Renishaw recommends that specialist fire-fighting advice is sought before commencing operation of the RenAM 500 series.

In general, metal powder fires should be isolated and contained rather than extinguished. This can usually be accomplished by surrounding the fire with an inert material such as sand or salt, or using a type D powder fire extinguisher.

WARNING: Do not use water or pressurised fire extinguishers, as there is a risk that the metal powder could be forced into a dust cloud.

WARNING: In all cases of fire, call the emergency services and advise on the exact nature of the materials being processed and those in storage.

CAUTION: Always use caution when cleaning up burned metal powder, as re-ignition of unburned material is possible.

Place the following safety sign and warning notice on all access doors to the process room.



OPEN FLAMES, SMOKING AND FIRE ARE PROHIBITED

Figure 5 Fire safety sign

An assessment of the risks from fire should form part of the risk assessment you carry out before commencing operation of the RenAM 500 series.

3.4.3 Laser safety precautions

When operating or maintaining laser equipment, any local regulations or legislation take precedence over these instructions.

WARNING: Maintenance work on the laser system may only be carried out by employees of Renishaw or Renishaw authorised service personnel.

Normal system maintenance can be undertaken without risking exposure to laser light. Under no circumstances will it be necessary for maintenance to be undertaken with laser covers removed.

The RenAM 500 series has a Class 4 laser enclosed in a Class 1 system.

WARNING: Do not defeat or override safety interlocks.

3.4.4 Oxygen level monitoring within the process room

The end user must carry out risk assessments to determine whether or not there is a need for low-level oxygen level monitoring within the process room in case of an argon leak. A small amount of argon gas is discharged into the process room when the top door is opened. Additionally, while the system is purging, argon is exhausted to the atmosphere.

WARNING: Renishaw strongly recommends that a process room oxygen sensor is installed.

WARNING: If a furnace has been purchased, Renishaw strongly recommends that a process room oxygen sensor is installed, as the furnace emits more argon than the RenAM 500 series system.

3.4.5 Training

The RenAM 500 series has the potential to injure personnel if it is incorrectly operated. The RenAM 500 series system can only be operated by users who have completed a Renishaw-approved training program. Training is included in the scope of supply of the Renishaw RenAM 500 series, unless the user indicates that no training is required, for instance where a local Renishaw-approved trainer already exists.

WARNING: Operation of the RenAM 500 series is only permitted by operators who have completed a Renishaw-approved training program.

3.4.6 Correct usage

The Renishaw RenAM 500 series is designed for the construction of components from metal powder.

Acceptable metal powder is provided by Renishaw, or a specification can be provided for third-party supply.

It is recommended that the use of other metal powders is discussed in advance with Renishaw to ensure safe processing, and the appropriate processing parameters are used, if available. Renishaw powders have been tested and validated for use in the RenAM 500 series system.

Successful part production depends upon the system being properly serviced and maintained, and the use of Renishaw process parameters.

Where Renishaw materials and process parameters are NOT used, users must satisfy themselves that the necessary material validation is carried out. Renishaw cannot be held liable for performance when third-party materials or process parameters are used.

Where non-Renishaw metal powder is being used, always refer to the applicable Safety data sheets and carry out a risk assessment before using the non-Renishaw metal powder. As an example, non-Renishaw metal powder may produce laser spectral emissions that exceed the attenuation specification of the glass panel fitted to the top door on the RenAM 500 series system. This must be risk assessed and the risks understood before using the non-Renishaw powder. Contact Renishaw for further advice.

3.4.7 Improper use

Anything that contravenes or is not specifically mentioned in this manual can be described as improper use, in particular the following:

- The use of non-approved or highly toxic metal powders and other hazardous substances not approved by Renishaw. For system servicing purposes, Renishaw requires full knowledge of all the materials that have been used in the system in order to protect our staff.
- The removal of system components and/or the operation of system components in a position other than the one prescribed for them.
- Disabling the safety devices.
- Warning and safety instructions not properly maintained.
- Modifications to hardware components that have not been authorised by Renishaw.

- Modifications to software elements that have not been authorised by Renishaw.
- Operation without a suitable and approved shielding gas such as argon.
- The fitment of unapproved/unauthorised parts or the making of unapproved/unauthorised modifications to the RenAM 500 series system without the prior approval of Renishaw.

3.4.8 Personal protective equipment (PPE)

Renishaw recommends that full PPE is worn when handling metal powder, a minimum of:

- Gloves/gauntlets – if a furnace has been specified, heat-resistant gauntlets are required.
- Eye protection.
- Full face respirator conforming to EN143 Type P3 (dust protection factor) + A1 (gas/vapour protection factor when using IPA or solvent cleaners).
- ESD dissipative safety footwear with toe protection (essential for ATEX zones and recommended for all areas).
- Full-length clothing, made from non-static-generating fabric such as cotton (avoid wool and synthetic fabrics). Avoid turn-ups or pockets that may trap powder. Refer to NFPA 484 for details.



Figure 6 Example of suitable PPE

WARNING: It is the responsibility of the end user to ensure the correct PPE is available for every operator and that it is worn correctly.

Wash any metal powder contaminated clothing separately from other clothing.

WARNING: PPE used in an ATEX-rated area (for example, battery-operated respirators) must be ATEX rated.

WARNING: Wear protective eyewear, full-face respirator (conforming to EN143 Type P3 + A1) and suitable protective clothing.

WARNING: Do not allow the metallic powder or waste products to form a dust cloud.

WARNING: Never eat, drink or smoke in the vicinity of the Renishaw AM system or components produced by the process that have not been properly cleaned.

WARNING: Wash hands thoroughly with water and soap after disposal of metal powder.

3.4.9 Toxicity and personnel exposure

Some metal powders may be harmful to health. This can only be ascertained by consulting the Safety data sheets and once again going through the risk assessment procedure and taking note of the guidance and procedures. Regular health surveillance should be carried out on employees who use the equipment and materials. In general, metal powders create a family of hazards (harmful or not), for example:

- Fine airborne solids can create a nuisance dust and prolonged exposure may cause lung irritation. Many powders have a maximum permissible Workplace Exposure Limit of 0.5 mg/m³ (WEL 8 hour limit). The recommended Workplace Exposure Limit will be indicated on the Safety data sheet for each respective powder.
- Eye contact may cause irritation and burning. In the event of such exposure, the procedure indicated on the Safety data sheet should be followed.
- If skin is exposed, the procedure indicated in the Safety data sheet should be followed.
- If large quantities of powder are inhaled, the procedure indicated in the Safety data sheet should be followed.

Measures should be taken to minimise contact with metal powders and monitor the environment:

- PPE for all regular operators. Regular maintenance and inspection of PPE is necessary.
- Training to avoid powder spillages. Any spillage must be immediately cleaned up using appropriate equipment.
- Regular housekeeping and auditing to ensure dust or powder does not accumulate.
- Regular air quality monitoring.
- Annual spirometry (lung capacity) tests should be considered for all regular operators.
- Personnel must be trained, including awareness of the Safety data sheet before using a new material.

3.4.10 Thermal hazards

If work is to be carried out on the RenAM 500 series, the equipment must be isolated and a period of time should be allowed for hot parts of the equipment to cool. Care must also be taken if unplanned work is to be carried out.

WARNING: Hot surfaces can cause injury. Take care when using the glovebox to access the build chamber.

3.4.11 Hazards due to latent energy sources

Isolated equipment may still present hazards to maintenance technicians. Some typical examples of latent energy sources are as follows:

- Heated components will remain hot. The period of time required to cool to a safe temperature of $\leq 60\text{ }^{\circ}\text{C}$ ($\leq 140\text{ }^{\circ}\text{F}$) is dependent on the material of construction and the shape and mass of the component.
- Some components may continue in motion after a process has halted. The period of time required for the component to become stationary is dependent on the shape and mass of the component.
- Some components may be stopped in positions which make them unsafe.
- Sealed pneumatic lines will remain pressurised.
- Other fluid lines may remain pressurised.
- Capacitors may remain charged in electrical circuits.
- Risk assessments and method statements for maintenance work should identify any latent hazards and the steps required to nullify them.

3.4.12 System ergonomics

NOTE: Space in the build chamber is limited, especially for two-handed working. To reach some areas of the build chamber, you may need to adopt an awkward body position. Minimise the time you spend in awkward body positions and take a break if you feel discomfort. As far as is practical, carry out tasks with one hand at a time, especially when working through the glovebox, and ensure you change hands regularly.

3.5 Safety information for inert gas

WARNING: The concentration of inert gas in the ambient air needs to be monitored and a low oxygen concentration (< 19.5%) indicated by a visible and audible warning means.

The RenAM 500 series is designed to consume minimal amounts of inert gas. It is possible to use either argon or nitrogen to create an inert atmosphere, but the RenAM 500 series has been qualified using argon gas only. As a consequence of this low gas consumption, Renishaw recommends using argon gas, which offers the additional benefit of being compatible with materials that are nitrogen reactive.

CAUTION: It is possible that nitrogen gas may give you build results which are more suitable for your AM application. The RenAM 500 series has been qualified using argon gas and Renishaw recommends the use of argon gas during builds.

WARNING: It is the user's responsibility to ensure the correct gas is used for the material being processed. Failure to do so may result in damage to the RenAM 500 series system and hazards to health.

WARNING: Nitrogen gas is not inert with all metals and may react exothermically.

When the RenAM 500 series is in use, a small amount of inert gas is emitted from the two gas outlets located on the top of the system. DO NOT connect the two gas outlets to any form of extraction system and DO NOT obstruct the two gas outlets.

Argon gas is odourless, heavier than air and, as it displaces oxygen, is an asphyxiant. This creates a potential hazard and, although the concentration of argon gas under normal operation is low, there is a potential danger of suffocation. On this basis, Renishaw recommends that the process room is well-ventilated in accordance with local regulations and requirements from Renishaw.

Under normal use with argon, ground level oxygen level monitoring is advised.

WARNING: Argon gas cylinders are heavy. Ensure gas cylinders are correctly secured to prevent them from falling over. Use suitable equipment and processes to move cylinders. Consider contacting your argon gas supplier for equipment, information and advice on handling gas cylinders.

3.6 Safety information for metal powder

3.6.1 Metal powder handling advice

WARNING: The following constitutes general advice. Always consult the Safety data sheet for specific handling and safety information for each material.

WARNING: Ensure you are wearing the correct PPE: ESD safety footwear, eye protection, full face respirator (to EN143 Type P3 + A1), protective gloves and full-length clothing.

NOTE: Renishaw recommends that full-length clothing is made from non-static-generating fabric such as cotton (avoid wool and synthetic fabrics). Avoid turn-ups or pockets that may trap powder. Refer to NFPA 484 for details.

WARNING: Always identify and label hazardous metal powders.

WARNING: In areas where powder is not expected to be present but may be present for short periods, all equipment (including portable) must be electrically bonded and earthed. Renishaw recommends that all portable equipment is fitted with static dissipative wheels. Renishaw recommends that all portable equipment is also grounded with an external ground wire. Renishaw recommends giving consideration to the creation of an ATEX zone 22 or NFPA 484 in powder-handling areas.

WARNING: ATEX vacuum cleaner nozzles, hoses and fittings must be conductive (electrostatic-dissipative) and non-sparking. Never use insulating plastic or domestic nozzles, or make any unapproved modifications.

WARNING: ATEX vacuum cleaner ESD fittings should be clearly marked (with yellow tape and ESD symbol) to ensure they are not to be mixed with non-ESD plastic fittings.

WARNING: Components/build plates being vacuumed should be earthed. Practically, this can be achieved by constructing benchtops and worktops from conductive material (non-sparking metal, for example aluminium, or ESD matting) which is earthed. Metallic benches must be earthed.

WARNING: Renishaw recommends fitting supplementary bonding between the ATEX vacuum cleaner and the object being vacuumed (build plate, bench top or AM system). Renishaw or Ruwac can provide a supplementary bonding lead (Ruwac part no. 59803 for NA7).

WARNING: A routine inspection, testing and maintenance program including testing of electrical continuity (bonding between pieces of equipment) and earthing/grounding (resistance to ground) should be implemented. ESD-dissipative materials typically have a resistance of 10^6 and 10^8 ohms. The lower limit (10^6 ohms) is specified to protect personnel from electrocution due to inadvertent contact with energised electrical equipment, while the upper resistance limit (10^8 ohms) is specified to ensure adequate charge dissipation. Flooring or footwear may have a lower resistivity, but not below 2.5×10^4 ohms, provided the total resistance to earth is sufficient to prevent electrocution (typically 1 megohm or greater) and dissipate charge (typically less than 100 megohms).

WARNING: As much powder as possible must be removed within the AM build chamber. Where practical, powder must be swept up using non-sparking receptacles and brushes with natural fibre bristles (non-static-generating). Vacuuming is only permitted for residual powder that cannot be removed using the previous methods.

WARNING: Do not use compressed air for powder removal or cleaning, as it will generate a dust suspension.

WARNING:

All metal powders are potentially combustible. The user must review the Safety data sheet and ensure that the correct handling procedures are followed.

Combustible metal powders must be used, stored and disposed of in non-sparking (anti-static) or approved containers.

Powder must be stored in a sealed dry container, as damp or humid powder may give off flammable hydrogen gas.

Containers containing combustible metal powders must be labelled to identify a "Flammable Solid".

Combustible metal powder must not be stored in plastic bags because of the possibility of electro-static discharge.

Always keep combustible metal powders away from any sources of ignition.

When cleaning up spills of combustible metal powders, ensure that the cleaning equipment is safe to use.

Never use compressed air to clean spills or residual traces of combustible metal powder, as this could cause a potentially explosive dust cloud to form.

Do not brush combustible metal powders for long distances, as this could cause electrostatic charges to be formed.

Where multiple powder types are used in the same facility, Renishaw strongly recommends labelling and colour-coding powder flasks and other equipment to identify the powder type. In addition, robust procedures to ensure powder type segregation should be implemented.

We recommend the following safety equipment:

- ATEX vacuum cleaner, suitable for use with combustible metal powder with a gas ventilation capability.
- Washbasin with eye washing station.
- Non-sparking containers for the storage of waste powder residues.

WARNING: Always risk-assess the handling of metal powder. The risk assessment should include, but not be restricted to: careful examination of the appropriate Safety data sheet, the processes that will be followed, applicable legislation and local rules.

Some metal powders are reactive and spontaneously form a hard, protective oxide film on contact with oxygen. This oxygen may be in the form of a gas (air, for instance), or in some other form, for example water.

The ability to rapidly oxidise necessitates careful handling of metal powder. The potential for fire exists, because the oxidation of the powder gives off heat and, in some cases, explosive gas and is therefore potentially volatile and self-sustaining. Avoid disturbing powder, particularly in an oxygen-rich atmosphere. Risk assess any metal powders by careful examination of the appropriate Safety data sheet.

3.6.2 Flammability

The fire risks of handling powder should be assessed before use and the Safety data sheets must be reviewed to ensure that the correct handling procedures are followed. Metal powders burn rapidly, at elevated temperatures, and can produce noxious gases. Metal powder in layers or in bulk may catch fire and burn if subject to a sufficiently energetic ignition source. Airborne suspensions above the limits indicated in the Safety data sheet can pose a dust explosion hazard. Minimum ignition values for a range of powders are available on request.

3.6.2.4 Combustibility

The fire triangle demonstrates the three prerequisites for a fire. All elements and molecules that react with oxygen are combustible and are a source of fuel. Most metals in solid form are not normally considered a fire risk due to their poorly mixed fuel-to-air ratio. Metal powders will burn readily if subjected to a high ignition temperature.

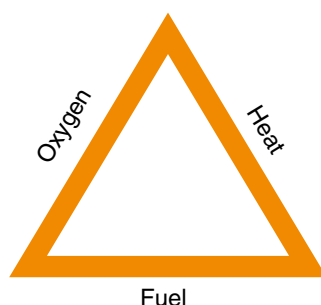


Figure 7 Fire triangle

3.6.2.5 Explosivity

An explosion is caused by rapid burning – as the fuel burns, heat and expanding gases are released, creating pressure. The explosion pentagon demonstrates the five prerequisites for an explosion. To cause an explosion, the fuel and oxygen must be sufficiently well mixed in the correct proportions. Fine dusts, such as metal powders suspended in air, will propagate a flame readily – generating an explosion.

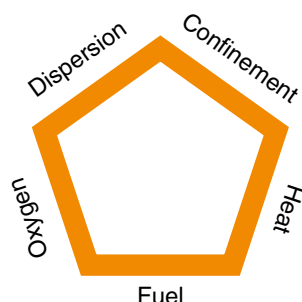


Figure 8 Explosion pentagon

In the correct ratio, a dust cloud can be ignited by electrical spark. The Minimum Ignition Energy (MIE) varies by powder type. Titanium powder requires ESD precautions to be in place. Other metal powders may have a higher ignition energy (are less likely to ignite), but observing the MIE for titanium is a good benchmark standard.

Metal dimensions	Overall surface area	Active source of ignition	Effect
Metal cube 1 cm ³ (0.4 in × 0.4 in × 0.4 in)	6 cm ² (0.93 in ²)	Extreme heat or flame	Burns with difficulty
Metal powder 30 µm (0.001 in) spheres	1 000 cm ² (155 in ²)	Flame, hot surface	Burns
Metal powder 30 µm (0.001 in) spheres in suspension in air	1 000 cm ² (155 in ²)	Sparks or static discharge	Explosive
Nanoparticles and condensate (black deposits in filter)	> 30 000 cm ² (4650 in ²)	Sparks or static discharge	Explosive

3.6.3 Safe disposal of waste products

All waste products must be disposed of in a safe and environmentally friendly manner in accordance with local regulations.

WARNING: The substances indicated below must be disposed of in a safe manner. They must not be allowed to contaminate the environment.

Disposal of metal powder, whether new, used, or in the form of contaminated components, cleaning materials and filters, must be done in accordance with the relevant Safety data sheet and/or the local or national requirements. Similarly, metal powders should be handled with caution at all times due to their combustible nature in a normal atmosphere, in accordance with DSEAR guidelines. Disposal of waste product, including process emissions and unused waste powder, must be in accordance with local regulations for hazardous waste.

Before disposal, waste products should be stored in an appropriate manner, in practical terms:

- Solid waste that accumulates on the sieve mesh, waste from the oversize separator, waste from the cyclone separator or spilt powder can be swept, using a non-static-generating brush, into a non-sparking receptacle (metal or approved plastic – NEVER plastic bags or non-approved plastic containers due to the risk of static sparks). This should then be stored dry in a sealed container. Alternatively, waste, and waste powder, can be vacuumed up using an ATEX vacuum cleaner, as supplied by Renishaw. NEVER use any other type of vacuum cleaner.
- Filters must be immersed in water, then stored immersed in water in a ventilated drum in a well-ventilated area.
- ATEX vacuum cleaner fluid should be stored in a ventilated drum in a well-ventilated area as there is a possibility of hydrogen gas being generated, see section 3.6.10, “Hydrogen gas”.
- Where practical, measures should be taken to segregate metal types to aid recycling.

3.6.4 Handling and processing

Avoid contact of metal powders with potential ignition sources (for example flames or sparks).

Ensure that any vacuuming of powder is kept to a minimum – ideally only vacuum what cannot easily be collected by brushing. Brushing must only be done with non-sparking tools and avoiding the creation of a dust cloud, see section 3.6.6, “Spills”. Only ever use an ATEX vacuum cleaner approved for use with combustible metal dusts.

Stagnation points should be minimised.

Good housekeeping measures should be implemented and adhered to, with regular and thorough cleaning regimes in place at all times.

Generating airborne dust clouds of metal powder must be avoided.

Avoid the creating of static sparks – the use of static dissipative footwear or inserts is recommended.

Methods of transport of metal powders are dependent on the type of material. Consult the Safety data sheet. Note that original containers may have been inert gas purged.

All hazardous shipments need to quote a hazardous material classification code (UN/US Department of Transport) and a proper shipping name.

Some metal powders, for example titanium powder, are subject to export control regulations.

3.6.5 Storage

Generally, metal powder should be stored in a cool dry place in hermetically sealed non-flammable containers away from ignition sources. Bulk storage should be in accordance with local building and fire codes. Consider zone-classified storage cabinets. Refer to the Safety data sheet supplied with the metal powder.

3.6.6 Spills

Avoid contact of spilled material with greases, oils, solvents or combustibles.

Spills of powder should be immediately cleaned up by gentle sweeping using a non-synthetic non-static-generating brush into a metal receptacle (anti-static dustpan and brush).

Small amounts of residual material may be removed using an ATEX vacuum cleaner approved for use with combustible metal dusts. Ensure that any vacuuming of powder is kept to a minimum – ideally only vacuum what cannot easily be collected by brushing.

WARNING: Do not use compressed air to clean up spills of metal powder.

3.6.7 Metal powder safety checklist

- Have you informed your insurance provider of the powder on site and process being used?
- Have you read and understood the metal powder's physical and chemical properties and the associated hazards from the supplied Safety data sheet and other product information?
- Are you compliant with all national, regional, and local building and fire codes for the handling and storage of metal powder? For example, in the United Kingdom refer to the National Fire Protection Association (NFPA), International Building Code® (IBC), and International Fire Consultants (IFC).
- Are there other flammable materials stored in this area?
- Is the metal powder stored under proper conditions and isolated from:
 - Fuels
 - Strong oxidising agents
 - Steam
 - Oils
 - Grease
 - Water
- Are the metal powder storage area doors kept closed?
- Does the metal powder storage area have limited access?
- Is the metal powder inventory controlled?
- Have you contacted the local fire protection agency to make them aware of the specific fire-fighting procedures and equipment required in the event of a metal powder fire?
- Have you contacted the local fire protection agency to make them aware of the type and quantity of metal powder used on your site?
- Have you supplied the local fire protection agency with a copy of the Safety data sheet?

- Have area personnel been trained to handle small metal powder fires?
- Do personnel know whom to contact if they are unable to isolate and contain a metal powder fire?
- Are emergency contact phone numbers posted?
- Are correct metal powder fire-fighting materials readily available to isolate and handle small fires?
- Does your business have written standard operating procedures for all aspects of metal powder handling and processing, including proper risk assessment, control of substances hazardous to health assessment, and personal protection equipment assessment?
- Is there a written procedure in place or engineering controls present to address the reduction or elimination of metal powder dust formation during handling?
- Are employees appropriately trained on workplace hazards?
- Are written procedures in place which address safety issues to be considered during maintenance and repair activities in metal powder storage or processing areas?
- Is there a written procedure for metal powder shipping that meets international standards?
- Are correct containers available?
- Are there written procedures in place for spillage clean-up and waste disposal for metal powder?
- Is the ancillary equipment, such as an ATEX vacuum cleaner, approved for use with the materials in use?
- If multiple powder types are being used in a facility, has the powder handling equipment been labelled and colour coded for each powder type?
- If multiple powder types are being used in a facility, are there robust procedures in place to ensure powder type segregation?
- This checklist, along with any other documents relating to risk management, should be stored in your organisation's explosion prevention document.

3.6.8 Hazards due to fire or explosion

Metal powders may produce flammable or explosive events under certain conditions. All measures must be taken to ensure that the conditions required to cause such an event are understood by the operators so that the possibility does not arise. In order for a fire or explosion to occur, the following basic elements must be present:

- A combustible powder or inflammable substance.
- An oxygen source (air).
- An ignition source.

An explosion risk assessment will define the risk of an explosive event and the requirement for definition of zone classifications.

WARNING: Fire and/or explosions may cause serious injury or death to personnel and damage to property.

WARNING: ATEX and DSEAR regulations require risk assessments to determine the required area zone classification before putting the equipment into use.

3.6.9 Identifiable ignition sources

All potential ignition sources should be listed in accordance with BS EN 1127-1:2011:

- Hot surfaces.
- Flames and hot gases, including hot particles.
- Mechanically generated sparks.
- Electrical apparatus.
- Stray electric currents, cathodic corrosion protection.
- Static electricity.
- Lightning.
- Radio frequency (RF) electro-magnetic waves from 10^4 Hz to 10^{11} Hz.
- Electro-magnetic waves from 3×10^{11} Hz to 3×10^{15} Hz.
- Ionising radiation.
- Ultrasonics.
- Adiabatic compression and shock waves.
- Exothermic reactions, including self-ignition of dusts.
- Laser energy.
- Electrostatic discharge – electrostatic discharge is recognised as an initiator of fires or explosions when the correct amounts of combustible dust (metal powder), or any other hazardous substances, and oxygen are present. All equipment and ancillary equipment must be at the same electrical potential as everything within the area zone classification, including the operators and any other personnel authorised to be in the area. All electrical earth bonding straps must be in place and maintained. All operators and any authorised personnel must wear anti-static footwear and clothing.

- Only tools and other items that are suitable for the zone classification may be used in that area.

WARNING: Ensure PPE is worn to reduce the risk of a spark from electrostatic discharge.

3.6.10 Hydrogen gas

Wet metal powder may react to liberate hydrogen gas. The reaction rate is dependent on a number of factors – metal type, particle size, water pH, and temperature. The Ruwac ATEX vacuum cleaner has ventilation valves to prevent the concentration of hydrogen gas from building up. The following precautions should be taken:

- Regularly check the Ruwac ATEX vacuum cleaner ventilation valves are functioning correctly.
- Use Hydra-Sol-MAG additive when vacuuming aluminium alloy powder.
- Avoid repacking damp or wet powder in sealed containers.
- Store in well-ventilated areas, and dispose of in accordance with applicable national and local regulations.

NOTE: For information about Hydra-Sol-MAG additive, refer to the Safety data sheet.

NOTE: Always operate and maintain the ATEX vacuum cleaner in accordance with the manufacturer's instructions. Refer to the manufacturer's website www.ruwac.de for details.

WARNING: Water-based fire extinguishers and sprinkler systems may also provide a source of water, and hydrogen, in some cases. Refer to NFPA 484.

3.6.11 Safety data sheets

Safety data sheets can be found on the Renishaw website, www.renishaw.com/amdatasheets.

In addition to metal powder, the information for fluids and additives used within Renishaw equipment such as Hydra-Sol MAG vacuum cleaner additive and Nalco chiller fluid can be found here.

WARNING: Always risk assess any powders by careful examination of the appropriate Safety data sheet.

3.6.12 Metal condensate

NOTE: Processes requiring the removal of components for clean-down or service can lead to localised exothermic reactions. These rare events are expected and should not cause alarm. Some processes may instruct the closure or opening of valves etc to ensure the reaction remains localised. Any risks can be further mitigated by maintaining a high standard of cleanliness of the machine and the working environment.

During the AM process, rapid heating of metal powder occurs and, as a result, some of the metal powder is vaporised. This smoke-like emission is composed of fine metal particles often referred to as metal condensate, metal fume, process emissions, sooty deposit, or soot. It is removed using an inert gas stream and collected in a disposable filter inside the sealed system.

Ordinarily, energetic metals form an oxide skin, called a passivation layer, which protects from any further oxidation. As these emissions are produced in an inert atmosphere, they are partially passivated but can still react on exposure to oxygen. As they also have a high surface area, this exothermic reaction is a potential spontaneous ignition hazard.

Higher processing rates and longer builds at lower in-chamber oxygen levels contribute to the condensate risk. The build chamber clean-down procedure will limit the risk and ensure condensate can be safely removed.

Evidence indicates that condensate (smaller particle) has a lower minimum ignition energy (MIE), making it more susceptible to static ignition (less than 1 mJ ignition energy).

CAUTION: Isolate and remove SafeChange filter assemblies prior to machine maintenance to make sure they are not affected by any localised exothermic reactions.

4. System overview

This section provides a detailed overview of the RenAM 500 series system and its user-accessible hardware features. It also lists the technical specifications of the RenAM 500 series system, offering a comprehensive understanding of its capabilities.

4.1 Model configuration

Machine	Single laser	Dual laser	Four lasers	Powder recirculation	CameraVIEW	LaserVIEW and MeltVIEW	TEMPUS technology
RenAM 500S Flex	✓				✓	*	*
RenAM 500S	✓			✓	✓	*	*
RenAM 500S Ultra	✓			✓	✓	✓	✓
RenAM 500D Flex		✓			✓	*	*
RenAM 500D		✓		✓	✓	*	*
RenAM 500D Ultra		✓		✓	✓	✓	✓
RenAM 500Q Flex			✓		✓	*	*
RenAM 500Q			✓	✓	✓	*	*
RenAM 500Q Ultra			✓	✓	✓	✓	✓

* Model can be upgraded to support this technology.

4.2 Technical specification

The technical specification of the RenAM 500 series system is available in the RenAM 500 series additive manufacturing systems data sheet (Renishaw part no. H-5800-4030). Any specification not listed in the data sheet is available upon request; see section 13, “Customer support”, for the contact details of your local Renishaw office.

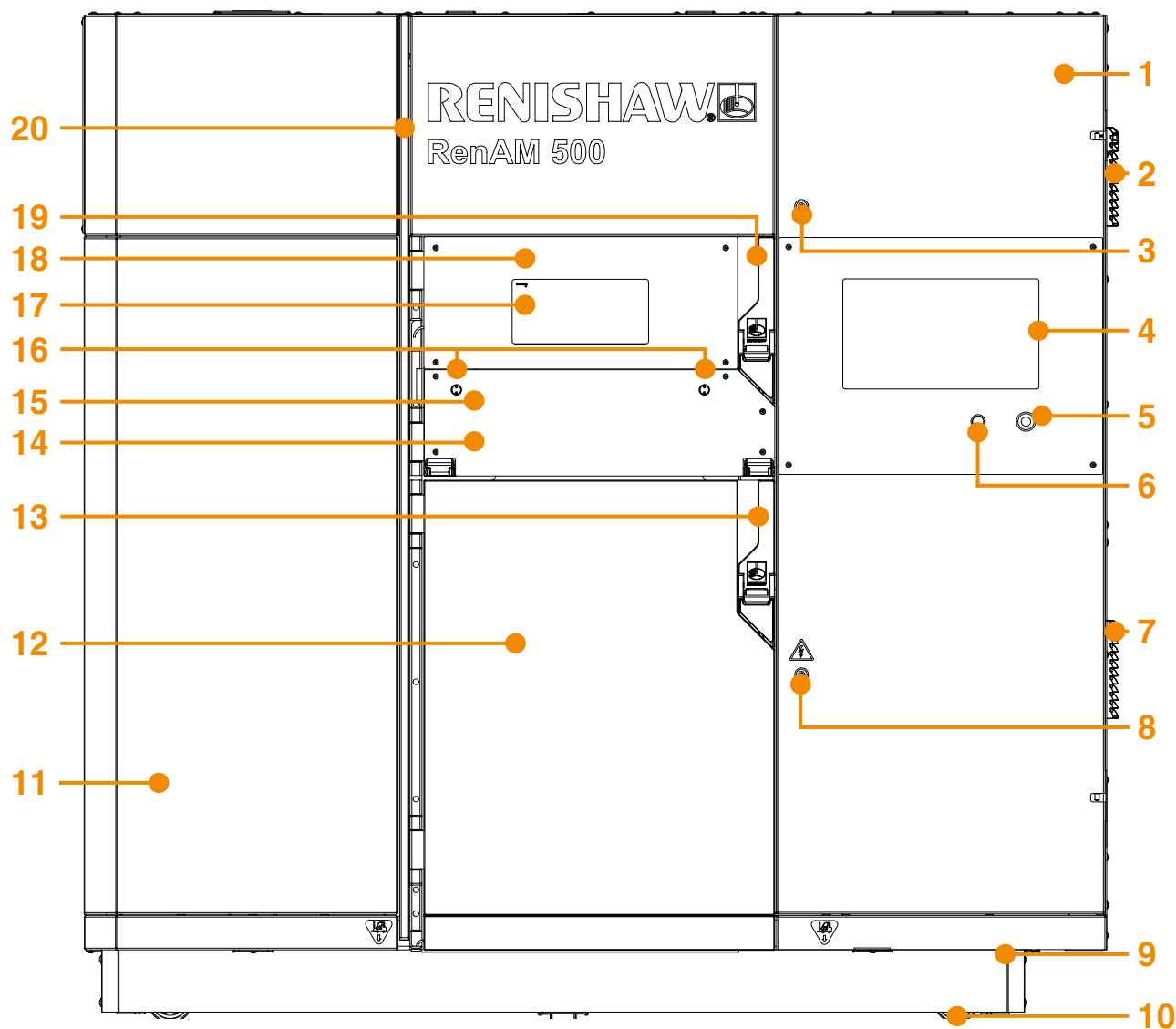
NOTE: Technical specifications may change from time to time. Renishaw reserves the right to change any technical specification at any time.

4.3 Hardware overview

The images of components and the user interface shown in this document are only examples. The appearance of these images may vary according to your system configuration.

4.3.1 RenAM 500 front view

NOTE: The features shown apply to RenAM 500, RenAM 500 Flex and RenAM 500 Ultra.

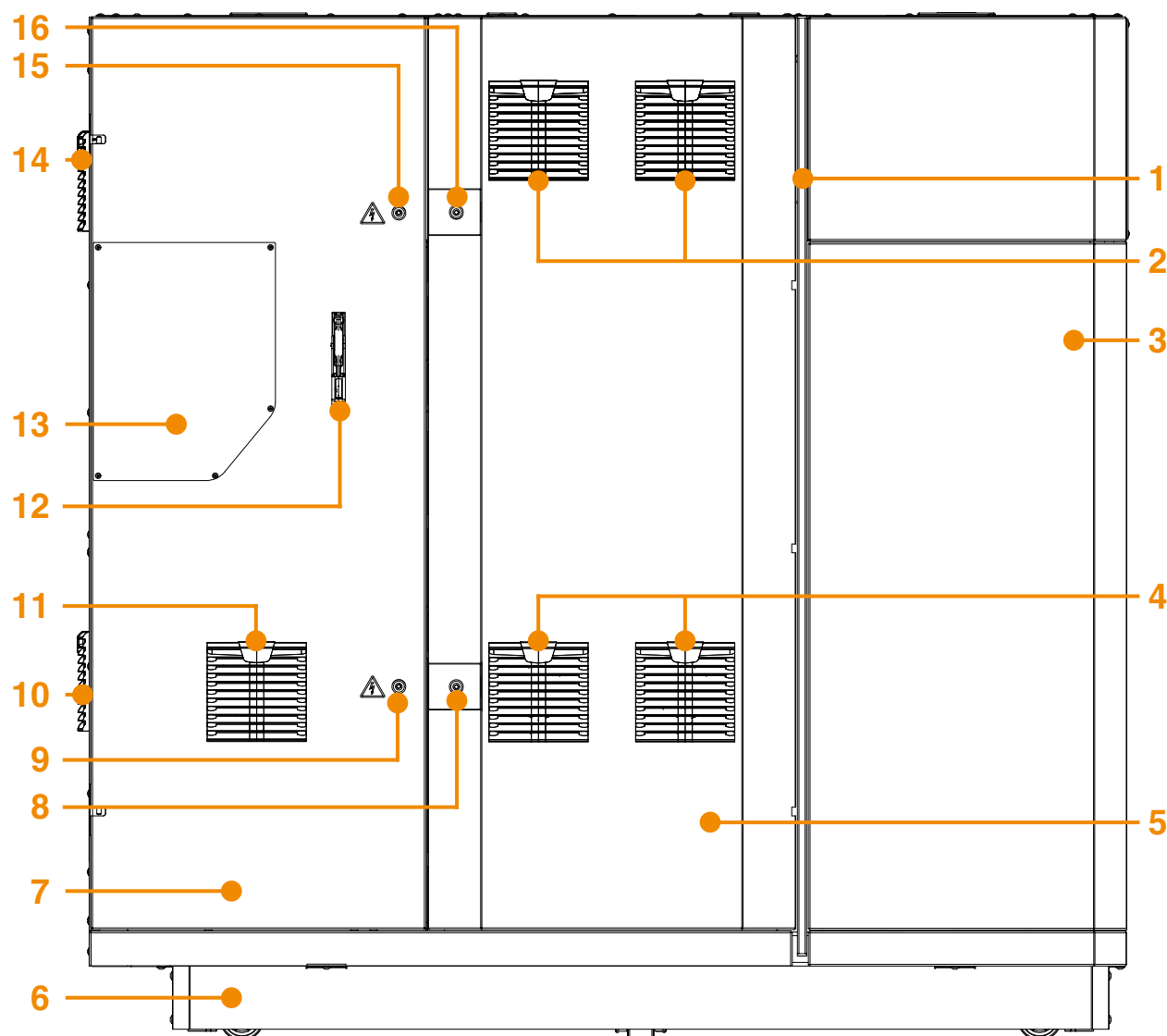


1	Front right-hand electrical cupboard door	11	Front left cupboard door – powder fill/overflow and large SafeChange filter change
2	Air vent	12	Bottom door
3	Security lock	13	Bottom door handle with interlock
4	Operator touch screen control panel	14	Glovebox lockable door with interlock
5	"Emergency Stop" button	15	Build chamber access gloves (behind door)
6	"Reset" button	16	Glovebox door locks
7	Air vent	17	Build chamber viewing window
8	Security lock	18	Top door
9	Plinth (covering combined castor and adjustable jacking feet)	19	Top door handle with interlock
10	Combined castor and adjustable jacking feet (behind plinth) x 5	20	LED strip light

Figure 9 RenAM 500 front view

4.3.2 RenAM 500 rear view

NOTE: The features shown apply to RenAM 500, RenAM 500 Flex and RenAM 500 Ultra.

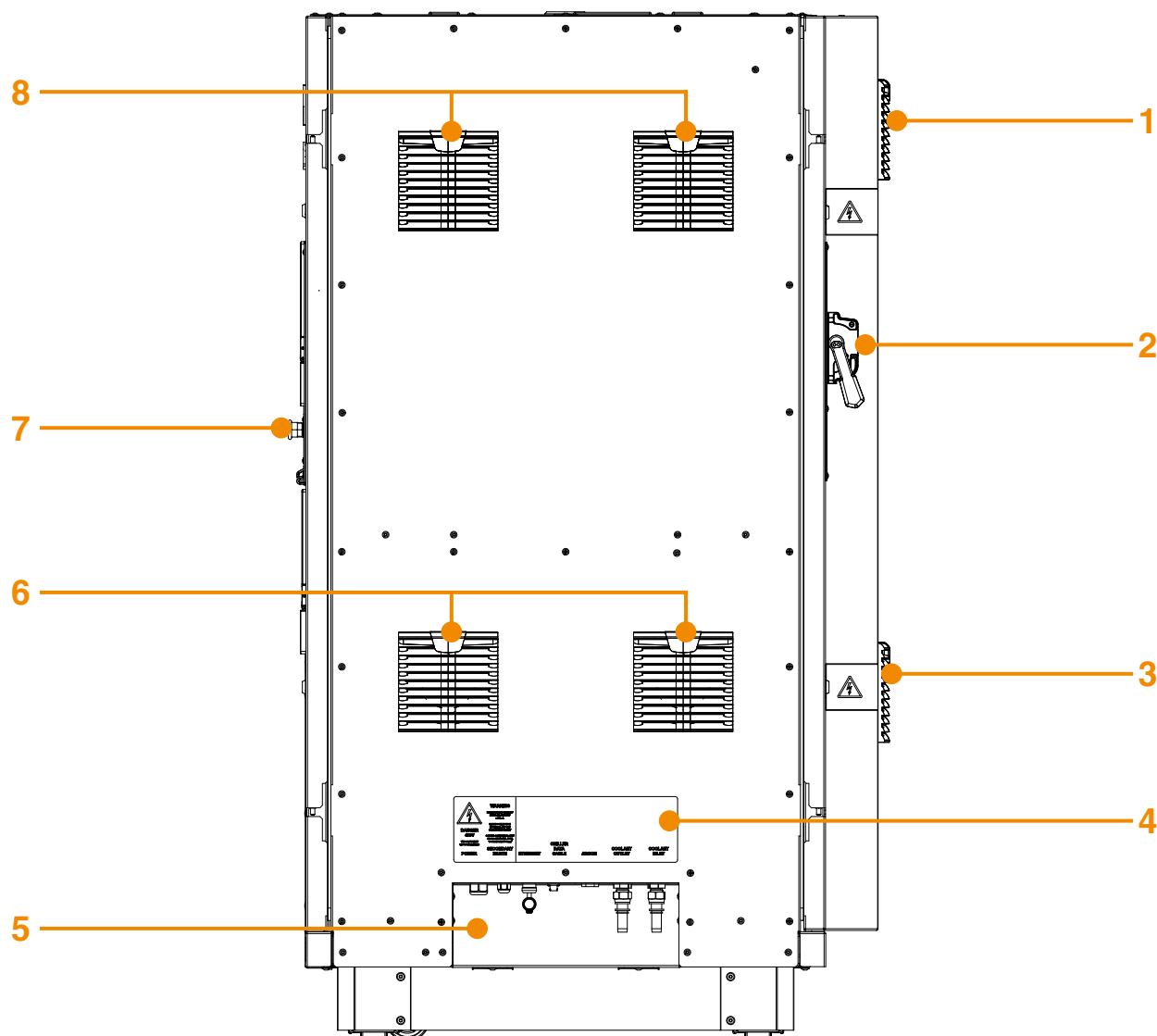


1	LED strip light	9	Security lock
2	Air vents	10	Air vent
3	Rear right-hand door	11	Air vent
4	Air vents	12	Main isolating switch
5	Rear centre equipment cupboard door	13	System nameplate
6	Plinth (covering combined castor and adjustable jacking feet)	14	Air vent
7	Rear left-hand electrical cupboard door	15	Security lock
8	Security lock	16	Security lock

Figure 10 RenAM 500 rear view

4.3.3 RenAM 500 right-hand end view

NOTE: The features shown apply to RenAM 500, RenAM 500 Flex and RenAM 500 Ultra.

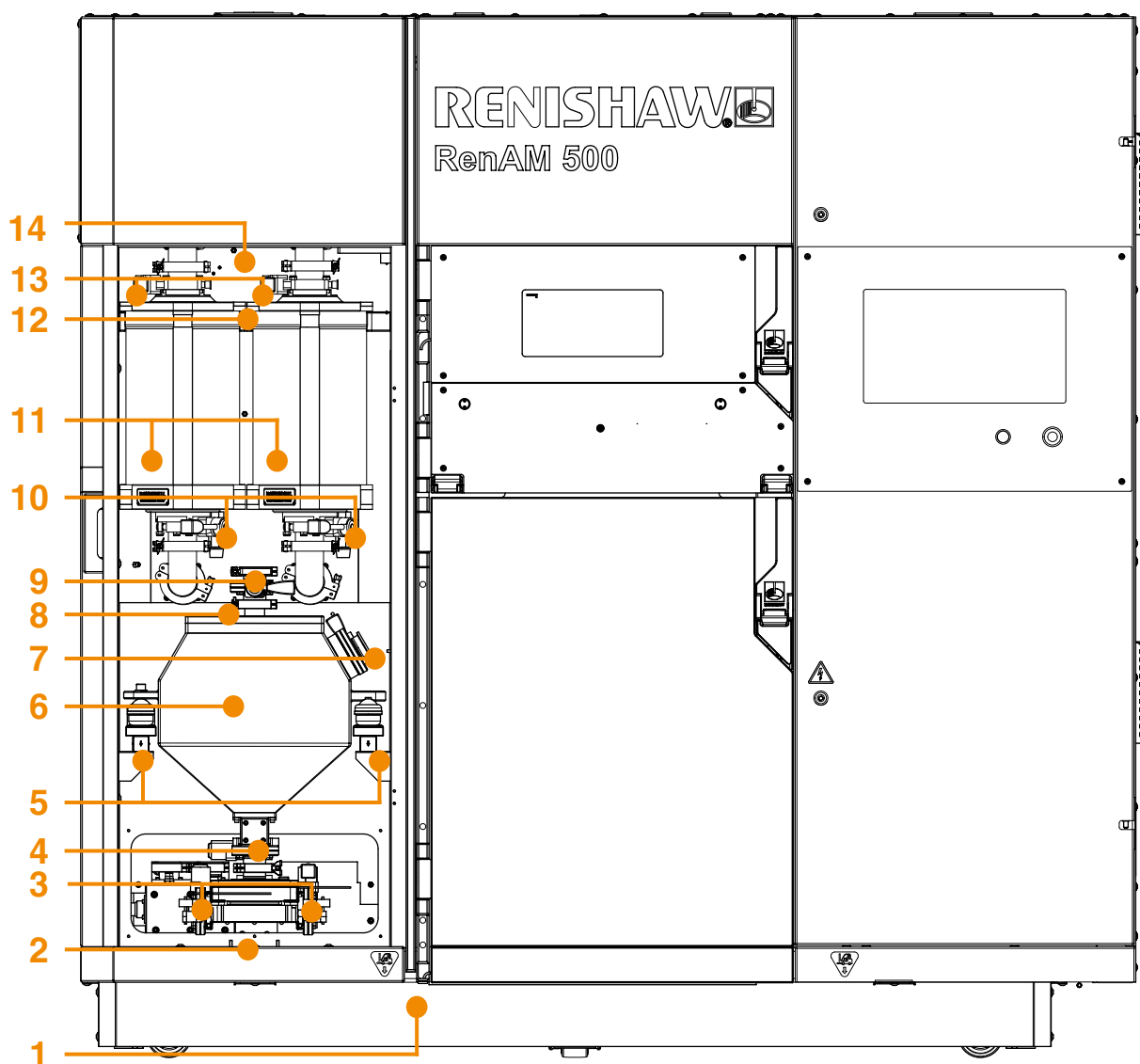


1	Air vent
2	Main isolating switch
3	Air vent
4	External services label
5	System external connections (electrical power, secondary earth, Ethernet, chiller data cable, argon inlet, coolant inlet and coolant outlet)
6	Air vents
7	"Emergency stop" button
8	Air vents

Figure 11 RenAM 500 right-hand end view

4.3.4 RenAM 500 front view with powder fill and large SafeChange™ filter door open

NOTE: The features shown apply to RenAM 500 and RenAM 500 Ultra models. Some of these features apply to the RenAM 500 Flex, with the features not applicable indicated in the table below.



1	Powder fill and large SafeChange filter left-hand door open (shown removed)	8	Load hopper filling point isolation valve (not present on RenAM 500 Flex)
2	Ultrasonic sieve system (not present on RenAM 500 Flex)	9	Load hopper filling point (not present on RenAM 500 Flex)
3	Powder system isolation valves (not present on RenAM 500 Flex)	10	Large SafeChange filter lower isolation valves
4	Powder metering screw feeder (not present on RenAM 500 Flex)	11	Large SafeChange filter number 1 (left-hand) and large SafeChange filter number 2 (right-hand)
5	Load hopper level load cells (not present on RenAM 500 Flex)	12	Large SafeChange filter status indicator
6	Load hopper (not present on RenAM 500 Flex)	13	Large SafeChange filter upper isolation valves
7	Powder return pipe	14	Oversized particle collection point

Figure 12 RenAM 500 front view with powder fill and large SafeChange filter door open

4.3.5 RenAM 500 Flex front view with overflow and large SafeChange™ filter door open

NOTE: The features shown apply to the RenAM 500 Flex only. These features do not apply to the RenAM 500 or RenAM 500 Ultra.

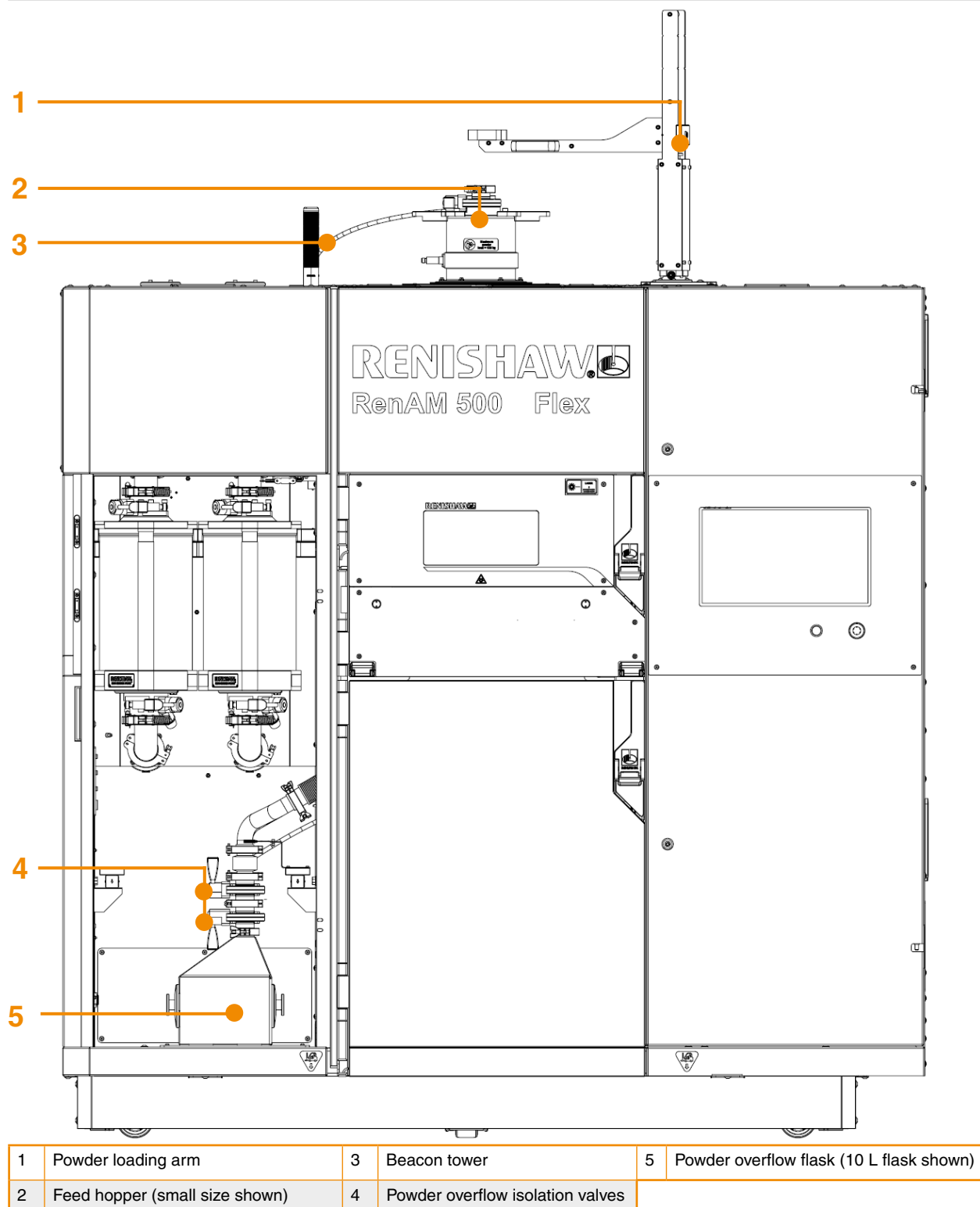
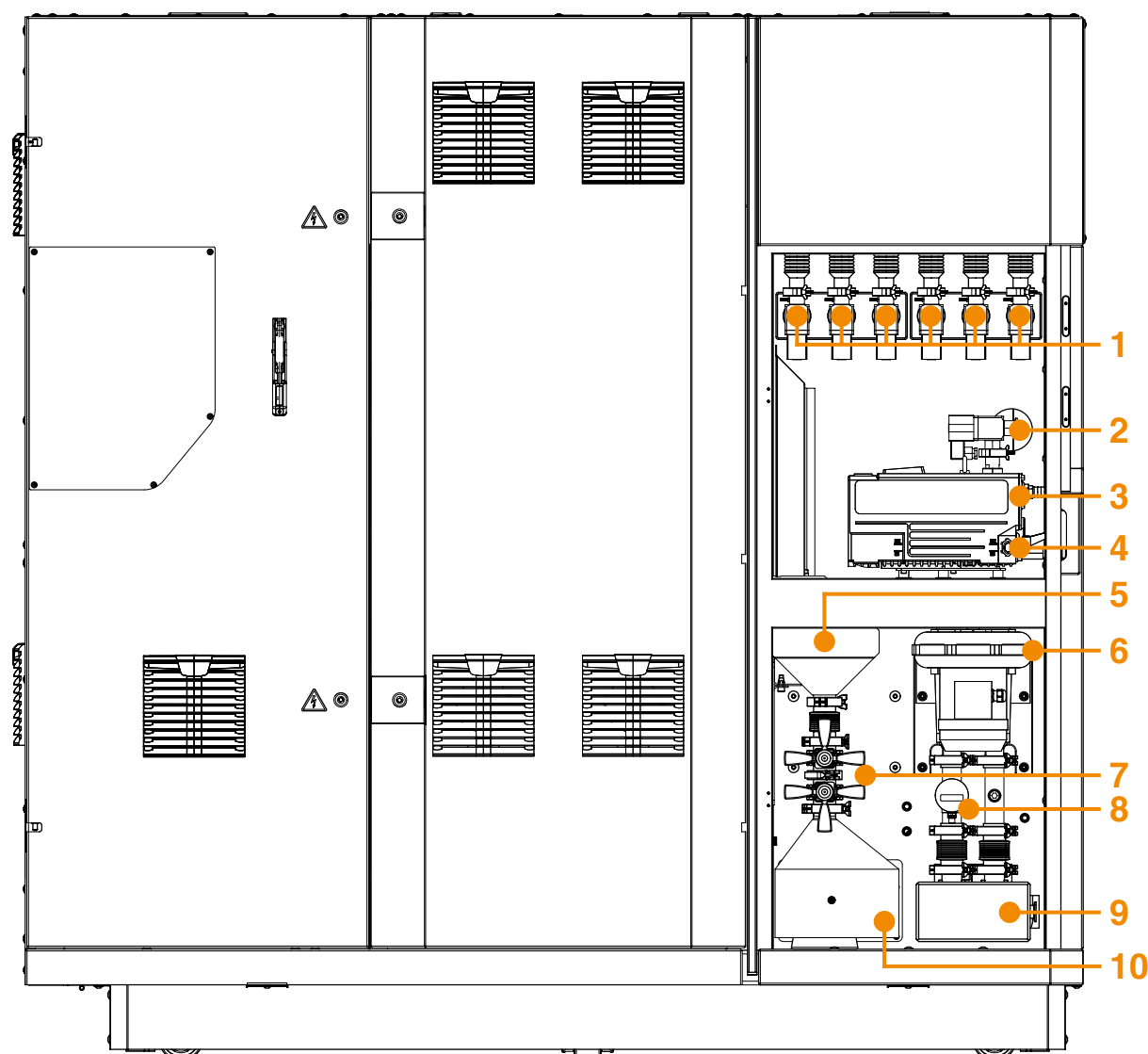


Figure 13 RenAM 500 Flex front view with overflow and large SafeChange filter door open

4.3.6 RenAM 500 rear view with rear right-hand cupboard door open

NOTE: The features shown apply to RenAM 500 and RenAM 500 Ultra models. Some of these features apply to the RenAM 500 Flex, with the features not applicable indicated in the table below.

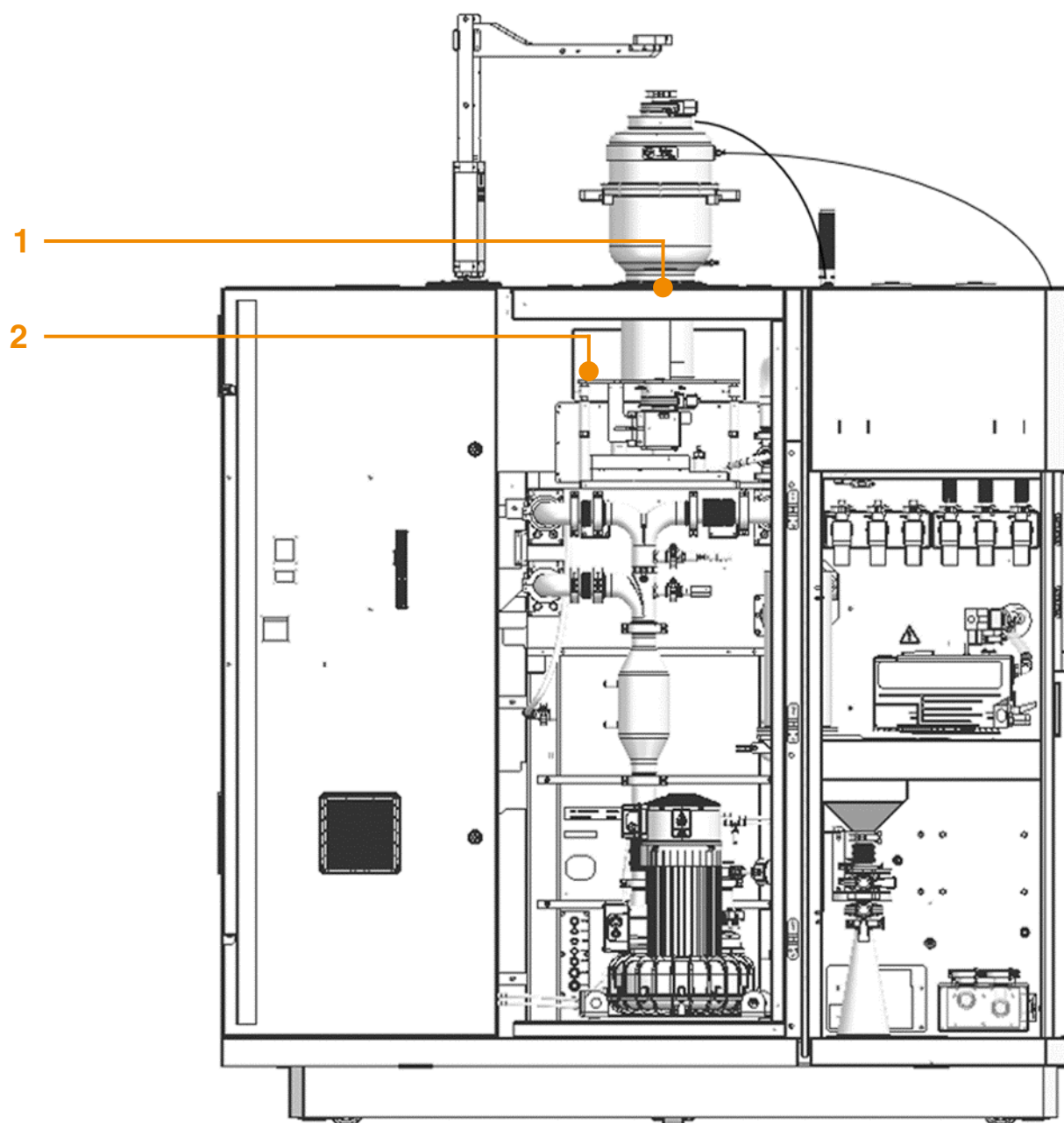


1	Solenoid valves	6	Powder recirculation pump (not present on RenAM 500 Flex)
2	Solenoid valves	7	Cyclone separator isolation valves
3	Vacuum pump	8	Flow switch (not present on RenAM 500 Flex)
4	Vacuum pump oil level viewing window	9	Right-hand manifold
5	Cyclone separator (lower section)	10	Cyclone separator collection flask

Figure 14 RenAM 500 rear view with rear right-hand cupboard door open

4.3.7 RenAM 500 Flex rear view with rear right-hand and middle cupboard doors open

NOTE: The features shown apply to the RenAM 500 Flex only. These features do not apply to the RenAM 500 or RenAM 500 Ultra.



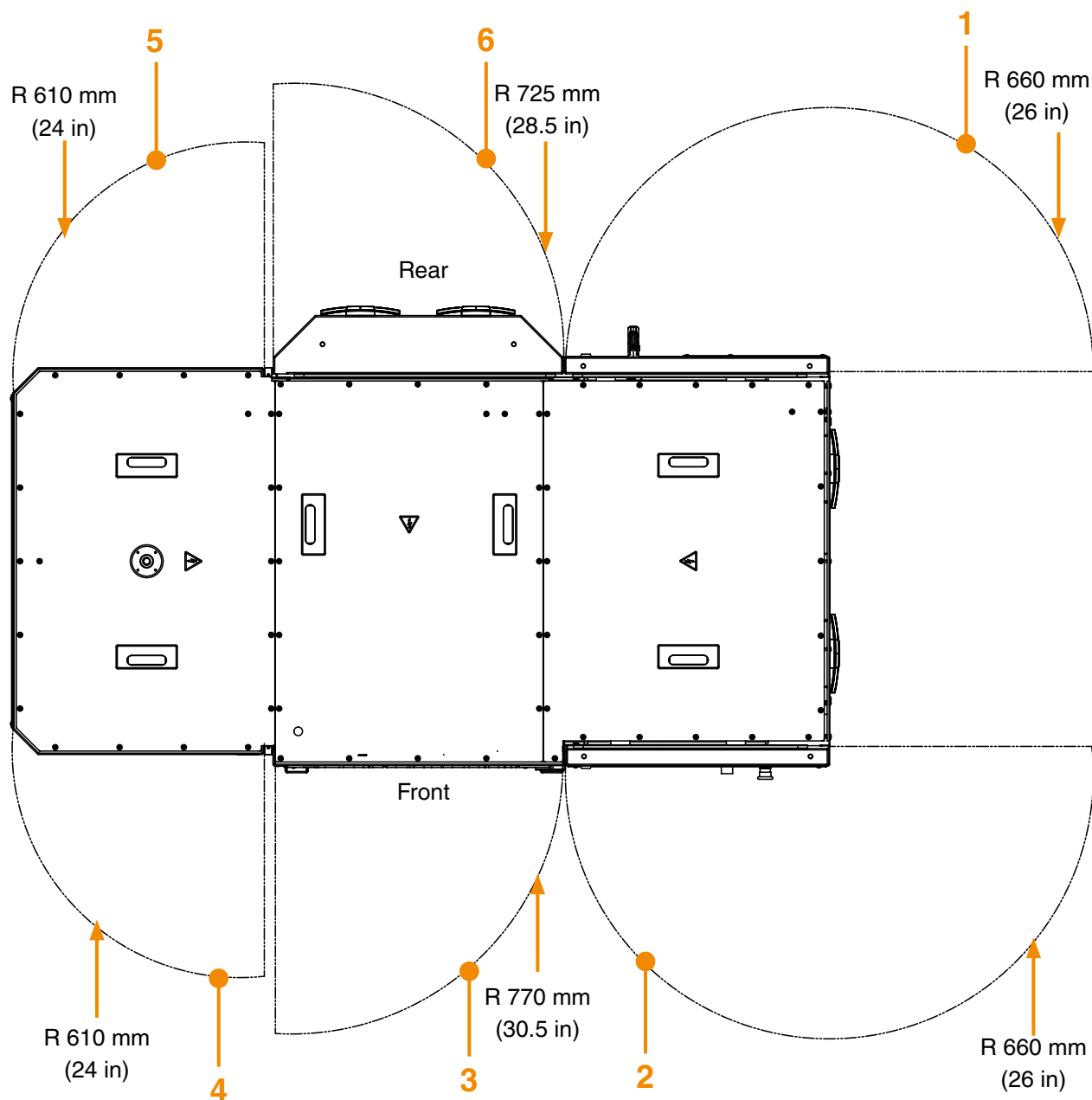
1 Feed hopper skirt

2 Feed hopper level load cells

Figure 15 RenAM 500 Flex rear view with rear right-hand and middle cupboard doors open

4.3.8 RenAM 500 plan view

NOTE: The measurements shown apply to the RenAM 500, RenAM 500 Flex and RenAM 500 Ultra.



1	Service access – rear left-hand electrical cupboard door	4	Operator access – front left-hand cupboard door
2	Service access – front right-hand electrical cupboard door	5	Operator access – rear right-hand cupboard door
3	Operator access – top and bottom doors	6	Service/Technician access – rear centre equipment cupboard door

Figure 16 RenAM 500 plan view

5. Ancillary equipment

The RenAM 500 series requires the use of supplementary or ancillary equipment to simplify and facilitate the process of operating the machine and producing builds. The equipment described in this section plays a crucial role in streamlining and supporting the overall AM process.

WARNING: Read the manufacturer's instructions before operating and/or maintaining the ancillary equipment. If the instructions are not followed, you may injure yourselves or others, or cause damage to the equipment.

WARNING: Before operating the ancillary equipment, ensure that an earthing connection is properly established. Failure to do so can result in severe injury or damage to the equipment.

The Renishaw RenAM 500 series system actively supports the use of the additional ancillary equipment listed in the table below for its operation.

Equipment name	Function	Availability
ATEX vacuum cleaner	Used to safely remove small amounts of metal powder that may become lodged in difficult-to-access areas of the system.	Mandatory
Chiller	A cooling system that efficiently removes heat from the RenAM 500 series system by circulating a refrigerant through its components, including the optical system.	Mandatory
Bead blaster and extractor	A blaster is used to modify the surface finish of AM parts. The extractor filters the dust-filled air from the blast cabinet.	Optional
Furnace	Used for heat treating AM parts.	Optional
Universal lifter	Enables you to lift and transport heavy items. It is particularly useful when loading powder into the machine, as well as carrying out service tasks, which include both maintenance and repair.	Recommended (mandatory for RenAM 500 Flex)
Hopper trolley	Aids you in transporting the hopper to and from the RenAM 500 and RenAM 500 Ultra systems.	Recommended for RenAM 500 and RenAM 500 Ultra
Powder recovery system (sieve)	Used to remove oversized particles from metal powder before it is loaded into the RenAM 500 series system.	Recommended (mandatory for RenAM 500 Flex)
Working platform	Used to carry out general tasks that require elevated access around the machine.	Recommended (mandatory for RenAM 500 Flex)
Optical System Verification (OSV)	This toolset is required for measuring and calibrating the laser power, focal point and positional accuracy.	Recommended

5.1 ATEX vacuum cleaner (mandatory)

WARNING: Do not store the ATEX vacuum cleaner in a closed unventilated space.

WARNING: Read the manufacturer's instructions before operating and/or maintaining the ancillary equipment. If the instructions are not followed, you may injure yourselves or others, or cause damage to the equipment.

CAUTION: Always use the manufacturer's genuine parts. Using parts other than those provided by the manufacturer may result in damage to the equipment. Contact Renishaw for replacement parts.

The Renishaw RenAM 500 series system mandates the use of an ATEX vacuum cleaner. The Renishaw recommended ATEX vacuum cleaner is a Ruwac model NA7. This vacuum cleaner is used to clean small residues of material and waste process emissions. These materials are potentially dangerous and the appropriate procedures as detailed in the manufacturer's instructions must be observed. For more details, refer to the manufacturer's website (www.ruwac.de).

NOTE: Contact your local Customer Service Center (CSC) for the electrical specifications of the ATEX vacuum cleaner.



Figure 17 Ruwac model NA7 ATEX vacuum cleaner

5.1.1 Technical specification

Equipment	Ruwac ATEX vacuum cleaner – model NA7
Electrical requirements EU/US	230 V, 50 Hz, single phase, 16 A (7.6 A consumption) 115 V, 60 Hz, single phase (21.3 A consumption)
Size: depth × width × height	705 mm × 480 mm × 755 mm (28 in × 19 in × 30 in)
Weight, gross	95 kg (210 lb)
Liquid capacity	7 L (15 US pt)
ATEX rating	 II 3D

5.1.2 ATEX vacuum cleaner safety

WARNING: Never use an unapproved vacuum cleaner to clean away powder or waste product.

Two main hazards exist:

1. The potential for powder explosion due to static charge caused by powder in suspension. To control and mitigate this hazard, an ATEX vacuum cleaner is used to extinguish any potential ignition while vacuuming the material. Renishaw recommends fitting an earth bond between the ATEX vacuum cleaner and the earthing point on the RenAM 500 series system when using the ATEX vacuum cleaner.
2. The use of water potentially causes a secondary hazard with some materials, where the reaction between the material and water causes a chemical reaction that can lead to the generation of hydrogen gas, which is flammable.
 - To control and mitigate this hazard, the ATEX vacuum cleaner features a ventilation valve which remains normally open when the cleaner is not being used.
 - For the ventilation valve to function effectively, it is essential to store the ATEX vacuum cleaner in a well-ventilated area.
 - When processing aluminium, use of a 5% solution of Hydra-Sol-MAG additive (Renishaw part no. P-LU08-0004) will help to inhibit the generation of hydrogen.

NOTE: For information about Hydra-Sol-MAG additive, refer to the Hydra-Sol-MAG additive Safety data sheet (Renishaw part no. H-5800-4019).

5.1.3 ATEX vacuum cleaner operation

WARNING: You must complete the appropriate Renishaw training course before handling oxygen-reactive metals. Among other recommendations, this will specify the need to add a 5% solution of Hydra-Sol-MAG additive (part no. P-LU08-0004) to the Ruwac ATEX vacuum cleaner when processing aluminium.

WARNING: Depending on the metal powder (particularly aluminium alloy) and local water hardness, it may also be necessary to add 0.1% by volume of anti-foaming agent (part no. 792322000). It is essential that foam is not allowed to build up, as it will be drawn into the cleaner, resulting in corrosion.

There are essential tasks that must be completed before and after the ATEX vacuum cleaner is operated. These include but are not restricted to the following:

- Carry out the safety checks in accordance with the manufacturer's instructions.
- Ensure the ATEX vacuum cleaner is electrically earthed – < 1 megohm between plug and components.
- Ensure the earth bond is fitted between the ATEX vacuum cleaner and the earthing point on the RenAM 500 series system.
- Ensure the fluid level is checked before every start-up and top up as necessary.
- Ensure the correct additives are used, if required.
- Check the hydrogen ventilation valves work before start-up by pressing them and ensuring they spring back (open).
- Ensure the ATEX vacuum cleaner is emptied and cleaned after every shift. Ensure any waste water is stored in a ventilated drum in a well-ventilated area (preferably outdoors) until it can be recycled.

NOTE: For information about Hydra-Sol-MAG additive, refer to the Safety data sheet.

5.2 Chiller (mandatory)

WARNING: Read the manufacturer's instructions before operating and/or maintaining the ancillary equipment. If the instructions are not followed, you may injure yourselves or others, or cause damage to the equipment.

CAUTION: Always use the manufacturer's genuine parts. Using parts other than those provided by the manufacturer may result in damage to the equipment. Contact Renishaw for replacement parts.

The RenAM 500 series requires a chiller to supply temperature-controlled water to keep the lasers and optical components at a stable temperature. The SMC Pneumatics air-cooled and water-cooled chillers are approved and supplied by Renishaw. Both the chillers operate on a closed-loop cooling circuit and are directly connected to the RenAM 500 series system, enabling the viewing of status updates and warnings via the touch screen control panel. For more details, refer to the manufacturer's website (www.smcpneumatics.com).

NOTE: Install the SMC chiller in accordance with the instructions supplied by SMC with the chiller.

NOTE: Contact your local Customer Service Center (CSC) for the electrical specifications of the SMC Pneumatics HRSH090-AF-40 chiller.

NOTE: Alternative chillers are available for use with the RenAM 500 series. Contact Renishaw for guidance on selecting an appropriate chiller.

NOTE: The inlet and exhaust vents of the cooling unit must not be obstructed. There must be a minimum distance of 500 mm (19 in) (front), 300 mm (12 in) (back) and 800 mm (31.5 in) (both sides) from walls or other equipment.

NOTE: The chiller is not supplied with a power cable or secondary earth cable. A suitably skilled and locally qualified electrician should select a suitable power cable and secondary earth cable. A power cable of 3 × 5.5 mm² CSA and a secondary earth with a total CSA of 14 mm² must be fitted.

NOTE: The chiller must be installed at the same floor level as the AM machine, and the piping length between the SMC chiller and the RenAM 500 series system must be limited to 20 m (66 ft).

5.2.1 Air-cooled chiller – technical specification



Figure 18 SMC Pneumatics model HRSH090-AF-40 chiller

Equipment	SMC Pneumatics – model HRSH090-AF-40
Electrical requirements	380 V to 415 V, 50 Hz to 60 Hz, three phase, 20 A
Chiller fluid	Nalco 460-TFS200 (supplied pre-mixed)
Size: depth × width × height	970 mm × 377 mm × 1 080 mm (38 in × 15 in × 42.5 in)
Weight	130 kg (287 lb) net
Pump capacity	20 L/min (0.7 cfm) to 60 L/min (2.11 cfm)
Heat output	8.5 kW
Noise	66 dB to 68 dB

5.2.2 Water-cooled chiller – technical specification



Figure 19 SMC Pneumatics model HRSH090-W-40 chiller

Equipment	SMC Pneumatics – model HRSH090-WF-40
Electrical requirements	380 V to 415 V, 50 Hz to 60 Hz, three phase, 20 A
Chiller fluid	Nalco 460-TFS200 (supplied pre-mixed)
Size: depth × width × height	970 mm × 377 mm × 1 080 mm (38 in × 15 in × 42.5 in)
Weight	121 kg (266 lb) net
Pump capacity	20 L/min (0.7 cfm) to 60 L/min (2.11 cfm)
Heat output	< 2.5 kW
Noise	66 dB to 68 dB

5.3 Bead blaster and extractor (optional)

WARNING: Read the manufacturer's instructions before operating and/or maintaining the ancillary equipment. If the instructions are not followed, you may injure yourselves or others, or cause damage to the equipment.

CAUTION: Always use the manufacturer's genuine parts. Using parts other than those provided by the manufacturer may result in damage to the equipment. Contact Renishaw for replacement parts.

An optional bead blaster and extractor can be supplied with the RenAM 500 series system to quickly modify the surface finish of parts after the build is complete. The optional bead blaster is a Guyson model Euroblast 4AM. The optional extractor is a Guyson model C400. For more details, refer to the manufacturer's website (www.guyson.co.uk).

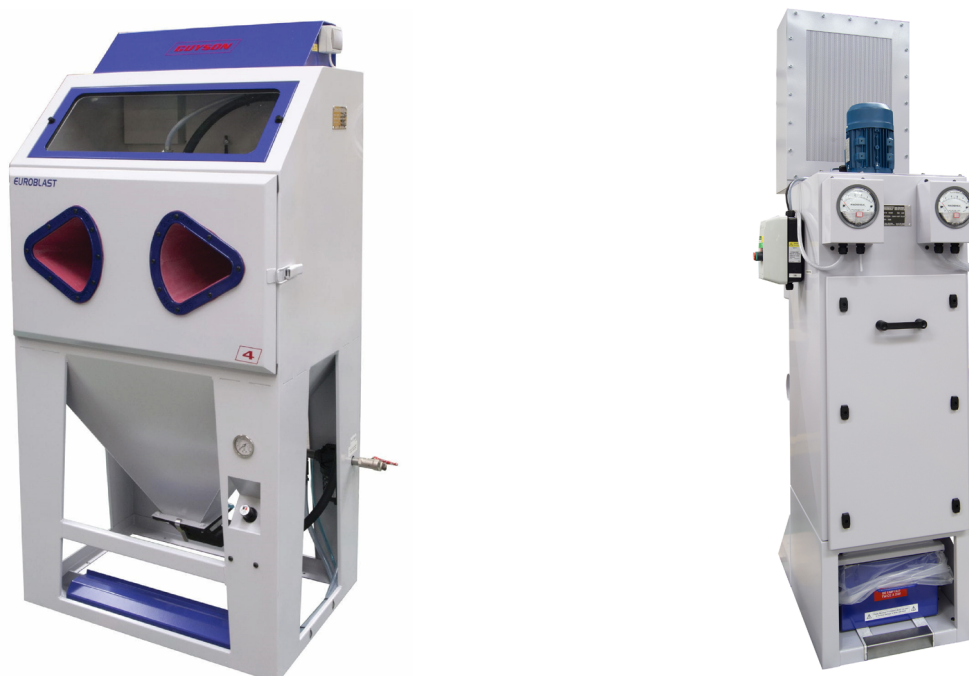


Figure 20 Guyson Euroblast 4AM bead blaster (left) and C400 extractor (right)

NOTE: Contact your local Customer Service Center (CSC) for the electrical specifications of the Guyson Euroblast 4AM and C400 bead blaster and extractor.

5.3.1 Technical specification

Equipment	Guyson Euroblast 4AM and C400 cartridge filter dust collector with HEPA
Electrical requirements	230 V, 50 Hz, single phase, 13 A
Gas supply	Compressed air – dry and oil free 5.5 bar (80 psi) pressure (max) Flow rate 27.2 m³/hour (960 ft³/hour) (max)
Footprint (blaster)	815 mm × 560 mm (32 in × 22 in)
Footprint (dust collector)	770 mm × 460 mm (30 in × 18 in)
Weight	140 kg (309 lb)

5.4 Furnace (optional)

WARNING: Read the manufacturer's instructions before operating and/or maintaining the ancillary equipment. If the instructions are not followed, you may injure yourselves or others, or cause damage to the equipment.

CAUTION: Always use the manufacturer's genuine parts. Using parts other than those provided by the manufacturer may result in damage to the equipment. Contact Renishaw for replacement parts.

An optional furnace can be supplied with the RenAM 500 series system to enable parts to be rapidly and easily heat-treated after the build is complete. The recommended furnace is a Nabertherm model N41/H. For more details, refer to the manufacturer's website (www.nabertherm.com).



Figure 21 Nabertherm N41/H furnace

NOTE: Contact your local Customer Service Center (CSC) for the electrical specifications of the Nabertherm N41/H furnace.

5.4.1 Technical specification

Equipment	Nabertherm furnace – model N41/H
Electrical requirements	400 V, 50 Hz to 60 Hz, three phase, 32 A
Gas supply	Argon – typically < 20 L/min (42 ft ³ /hr) – max 40 L/min (85 ft ³ /hr) Flow regulator or meter to suit 0 L/min to 40 L/min (0 ft ³ /hr to 85 ft ³ /hr) (Suitable suppliers; BOC 6000 series, Weldability AU300)
Flooring	Non-flammable surface (fire safety Class A EN 4102) Example: concrete, tiles, glass, aluminium or steel, so that any hot material falling from the furnace cannot ignite it
Footprint	1 150 mm x 950 mm (45 in x 38 in) NOTE: The controller can be removed for delivery. Width is then 840 mm (33 in). No combustible materials within perimeter of at least 500 mm. Dependent on application, a greater distance may be required.
Weight	260 kg (573 lb)

5.4.2 Furnace argon gas consumption

Argon gas usage is primarily dependent on the material and heat cycle; see the following table for estimates. Gas usage can be minimised by wrapping the part in heat treatment foil (part number P-HT01-0001).

Material	Approximate cycle length (hrs)	Approximate gas usage L (ft ³)
Aluminium	20	12 000 (424) full cylinder (w type)
Inconel	21	12 600 (444) full cylinder
Stainless steel	6	3 600 (127)
Titanium	5	6 000 (212)

5.5 Universal lifter (recommended for RenAM 500 and RenAM 500 Ultra) (mandatory for RenAM 500 Flex)

WARNING: Read the manufacturer's instructions before operating and/or maintaining the ancillary equipment. If the instructions are not followed, you may injure yourselves or others, or cause damage to the equipment.

A Renishaw universal lifter is mandatory equipment for the RenAM 500 Flex and is included with the first machine installation. The Wilmomat 207/S universal lifter is a general hydraulic lifting and transportation device used to move heavy items to and from the RenAM 500 series system. It is a pedestrian propelled lifter with a lifting mast, without tilt, with load-bearing outriggers, equipped with fork arms, a platform, or other load-handling device. The universal lifter is designed to be manually pushed, pulled and steered by one pedestrian operator. It is supplied with a lifting attachment and can be used to move a variety of items such as completed builds, 10 L powder flasks, RenAM 500 Flex feed hoppers, or a large SafeChange filter. For more details, refer to the Wilmomat 207/S universal lifter operation and maintenance manual.

NOTE: It is recommended to fully service and inspect any lifting equipment at regular intervals. Regularly maintaining your lifting equipment will prevent failures and thus reduce operating costs.

NOTE: The Renishaw universal lifter replaces the previously available silo lift. All tasks previously performed by the silo lift can also be performed by the universal lifter. Operation and maintenance of the silo lift is described in the silo lift user guide (Renishaw part no. H-5800-4480).



Figure 22 Universal lifter with lifting attachment fitted

5.6 Hopper trolley (recommended for RenAM 500 and RenAM 500 Ultra)

WARNING: Read the user guide (Renishaw part no. H-5800-4481) before operating and/or maintaining the hopper trolley. If the instructions are not followed, you may injure yourselves or others, or cause damage to the equipment.

The hopper trolley is a metal framed trolley used for transporting the hopper to and from the RenAM 500 or RenAM Ultra system.

It is fitted with the following items for ease of use:

- Four castors for ease of positioning.
- Two latches to secure the hopper trolley to the Renishaw AM system.
- One latch to secure the batch control hopper to the trolley.
- Eight rollers to ease loading of the hopper onto the trolley.



Figure 23 Hopper trolley

5.6.1 Technical specification

Equipment	Renishaw hopper trolley
Size (depth × width × height)	810 mm × 500 mm × 1070 mm (32 in × 19.5 in × 42 in)
Maximum rated capacity	320 kg (705 lb)
Unladen weight	30 kg (66 lb)

5.7 Powder recovery system (sieve) (recommended for RenAM 500 and RenAM 500 Ultra) (mandatory for RenAM 500 Flex)

WARNING: Read the user guide (Renishaw part no. H-5800-4613) before operating and/or maintaining the Renishaw powder recovery system (PRS). If the instructions are not followed, you may injure yourselves or others, or cause damage to the sieve.

WARNING: Before you begin any operational procedure with the powder recovery system, ensure you are wearing the correct PPE: eye protection, full face respirator (to EN143 Type P3 + A1), protective gloves and full-length clothing made from non-static-generating fabric such as cotton (avoid wool and man-made fabrics), and avoid turn-ups or pockets that may trap powder. Refer to NFPA 484 for details.

WARNING: Always keep body parts away, while the sieve is in operation. When in operation, the body of the powder recovery system (sieve) moves relative to the support frame. There is a possibility of body parts getting trapped between the sieve body and support frame.

A powder recovery system is required to remove oversized particles from powder that has been used in the chamber. The RenAM 500 Flex does not have a powder recovery system integrated into the machine, hence an external sieve is mandatory for operation. A stand-alone sieve is recommended if the user wants to re-use powder that is entrained in the chamber gas flow and ends up in the prefilter cyclone on all models of the RenAM 500 series.

CAUTION: Always use the manufacturer's genuine parts. Using parts other than those provided by the manufacturer may result in damage to the equipment. Contact Renishaw for replacement parts.



Figure 24 Powder recovery system

NOTE: To minimise the risk from argon leakage, Renishaw recommends using a small argon gas cylinder of approximately 1,000 L (35 cu/ft). It is also recommended to use a trigger-type gas valve to prevent the gas supply being accidentally left on.

5.7.1 Technical specification

Equipment	Russell Finex Powder Recovery System
Size (depth × width × height)	850 mm × 450 mm × 1450 mm (33.5 in × 18 in × 55 in)
Weight	70 kg (154 lb)
Electrical requirements	415 V, 50 Hz, three phase, 6 A

5.8 Working platform (recommended for RenAM 500 and RenAM 500 Ultra) (mandatory for RenAM 500 Flex)

WARNING: Failing to exercise caution while climbing, dismounting, or standing on the working platform can lead to injury and/or death.

WARNING: Special care should be taken while manoeuvring any mobile safety steps or working platforms. Always make sure that the pathways are free of obstacles or other people before moving any equipment.

The 1.3 m working platform can be used for general tasks that require elevated access around the machine. For the RenAM 500 Flex, it is required to safely complete powder-loading activities, and can be used throughout the material change process if necessary.



Figure 25 1.3 m working platform

NOTE: It is recommended that any mobile safety steps or platforms are fully serviced and inspected at regular intervals as specified in the manufacturer's instructions. By maintaining your equipment regularly, you will prevent failures and thus reduce operating costs.

5.8.1 Technical specification

Equipment	1.3 m working platform
Size (depth × width × height)	1358 mm × 850 mm × 2250 mm (53.5 in × 33.5 in × 88.5 in)
Unladen weight	59 kg (130 lb)

5.9 Optical System Verification (OSV) (recommended)

OSV is a process designed to measure and calibrate the lasers in the RenAM 500 series system. The OSV toolset includes everything needed to check laser power output, focal point and positional accuracy across the entire powder bed surface.

CAUTION: OSV is only compatible with RenAM 500 series machines running Machine Software Suite (MSS) 1.6.2 or later, with a V5 controller and three-slot kinematic heater plate installed. RenAM 500 machines purchased after July 2022 will have these prerequisites installed as standard. Contact Renishaw for more information.

NOTE: OSV is required for many of the system optical tests.

NOTE: OSV is highly recommended when using material files optimised for multiple lasers per part.

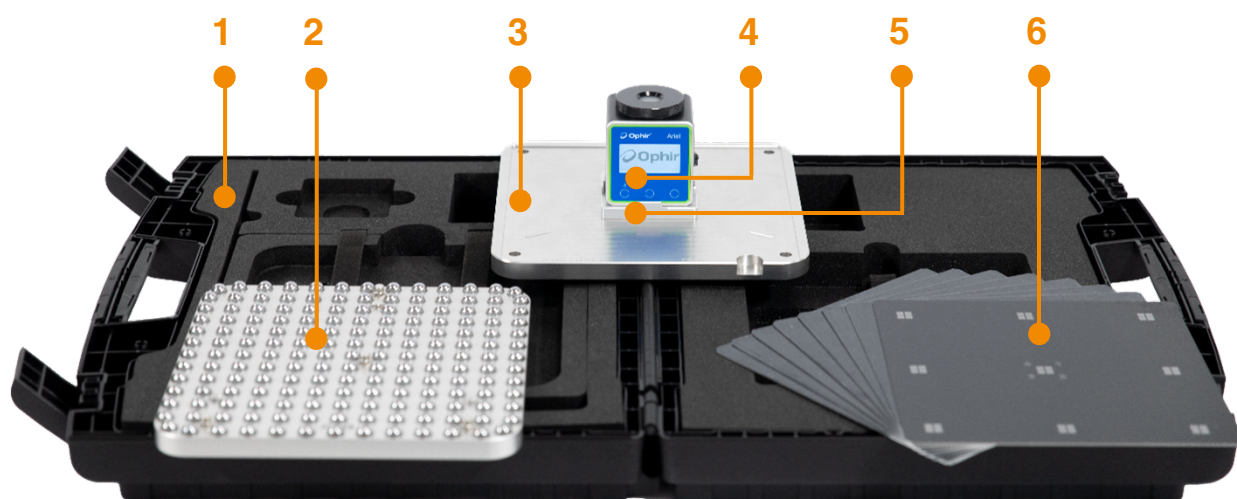


Figure 26 OSV toolset with included equipment displayed

The equipment included in the OSV toolset includes:

1. Protective case
2. Sphere array
3. Commissioning plate
4. Ophir Ariel (sold separately)
5. Ophir Ariel tooling plate
6. Eight marking plates

For more information on OSV, visit www.renishaw.com/osv.

6. Site and facilities preparation

This section provides all the necessary information to prepare the site and facilities before the arrival of your RenAM 500 system. It also describes the environment parameters that must be met for successful system installation at your site. Although you hold the primary responsibility for the activities listed in this guide, you can always contact Renishaw for advice and support.

6.1 Process room requirements

WARNING: Make sure that operator work areas are designed and built to prevent incidents such as slips, trips and falls.

WARNING: Follow your local fire safety regulations to ensure adequate fire escape routes are planned, and that the correct type of fire extinguishers are strategically placed to aid escape.

When designing the process room layout, it is essential to allocate sufficient space for operating the RenAM 500 series system and its ancillaries. The RenAM 500 series system has a small footprint of just 2.5 m² (27 ft²). Additionally, your process room layout must contain emergency escape routes and sufficient space for operating and maintaining the AM system and its ancillaries.

A standard process room layout in CAD format can be provided upon request; for more information, please contact your Renishaw representative. Should you need help with planning your process room layout, contact the Renishaw service team as outlined in section 13, “Customer support”.

To ensure ease of access for the operation and maintenance of the RenAM 500 system, the following requirements are recommended.

Process room dimensions		
Minimum recommended size(length × width)	RenAM 500 series (excluding Flex)	8000 mm × 5000 mm (26 ft 3 in × 15 ft 5 in)
	RenAM 500 series (Flex only)	9000 mm × 7000 mm (29 ft 6 in × 22 ft 12 in)
Minimum recommended height	RenAM 500 series (excluding Flex)	3000 mm (10 ft)
	RenAM 500 series (Flex only)	3500mm (11.5 ft)

NOTE: The RenAM 500 series system must not be installed in a room where significant sources of air-borne contamination are present. Examples of such sources include but are not restricted to the following; welding, grinding, fabrication activities, laser cutting and machining.

6.1.1 Machine room space requirement

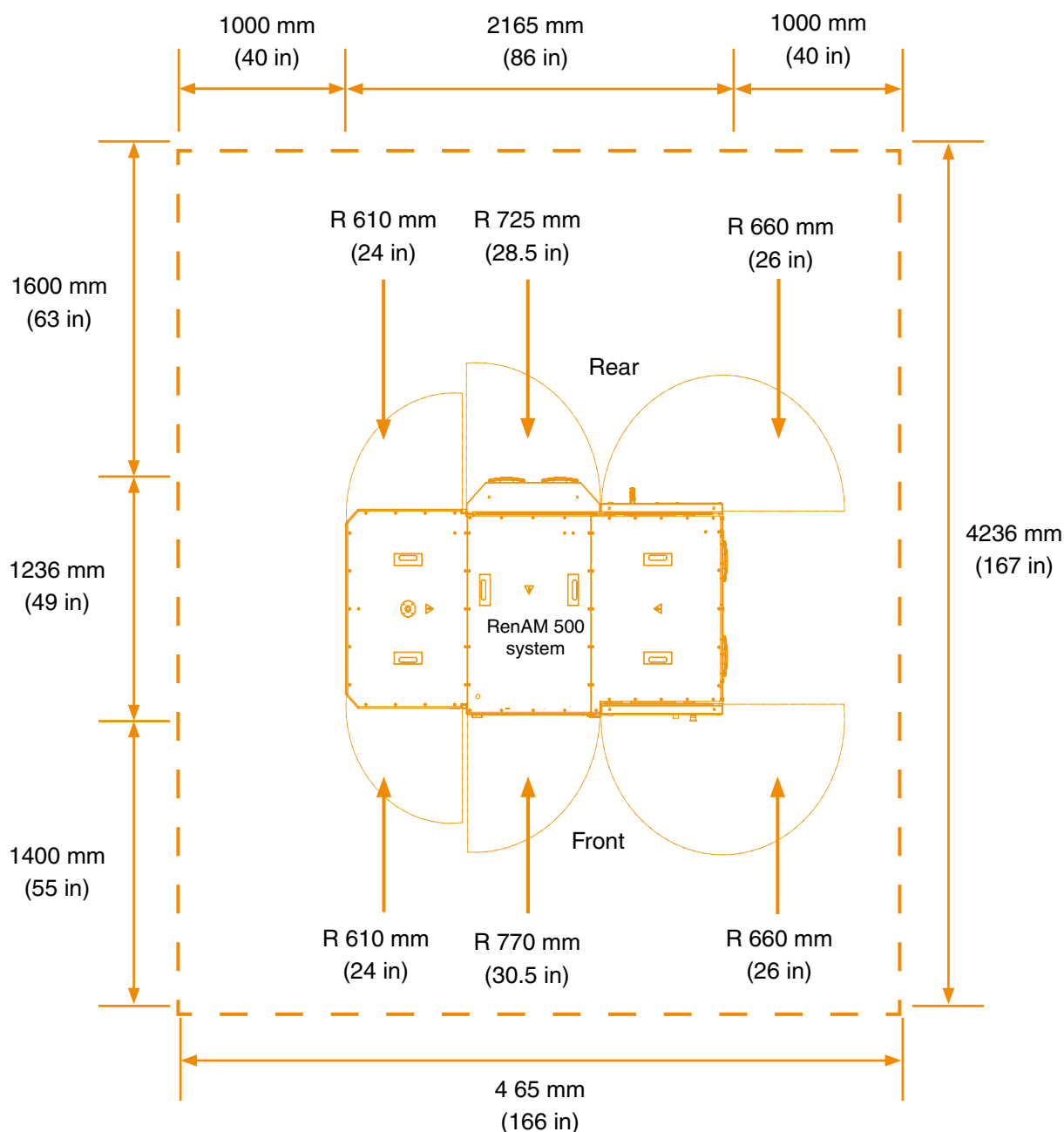


Figure 27 RenAM 500 system floor space requirements (excluding Flex)

NOTE: It is acceptable for the position of the SMC chiller to overlap with the floor space requirement for the RenAM 500 series system at one end only. It is acceptable to overlap the operating space of adjacent RenAM 500 series machines.

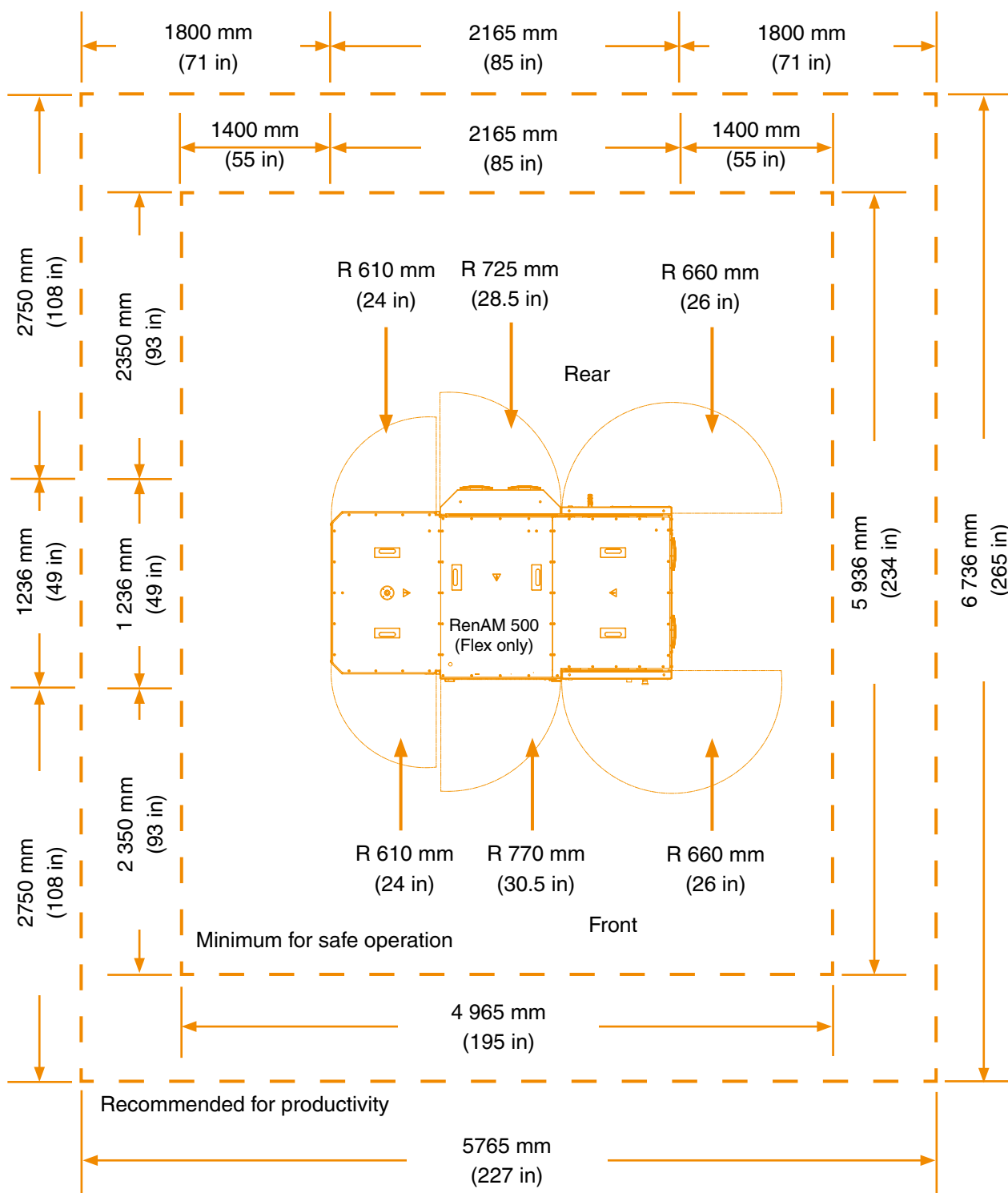


Figure 28 RenAM 500 system floor space requirements (Flex only)

6.1.2 Ancillary equipment floor space requirement

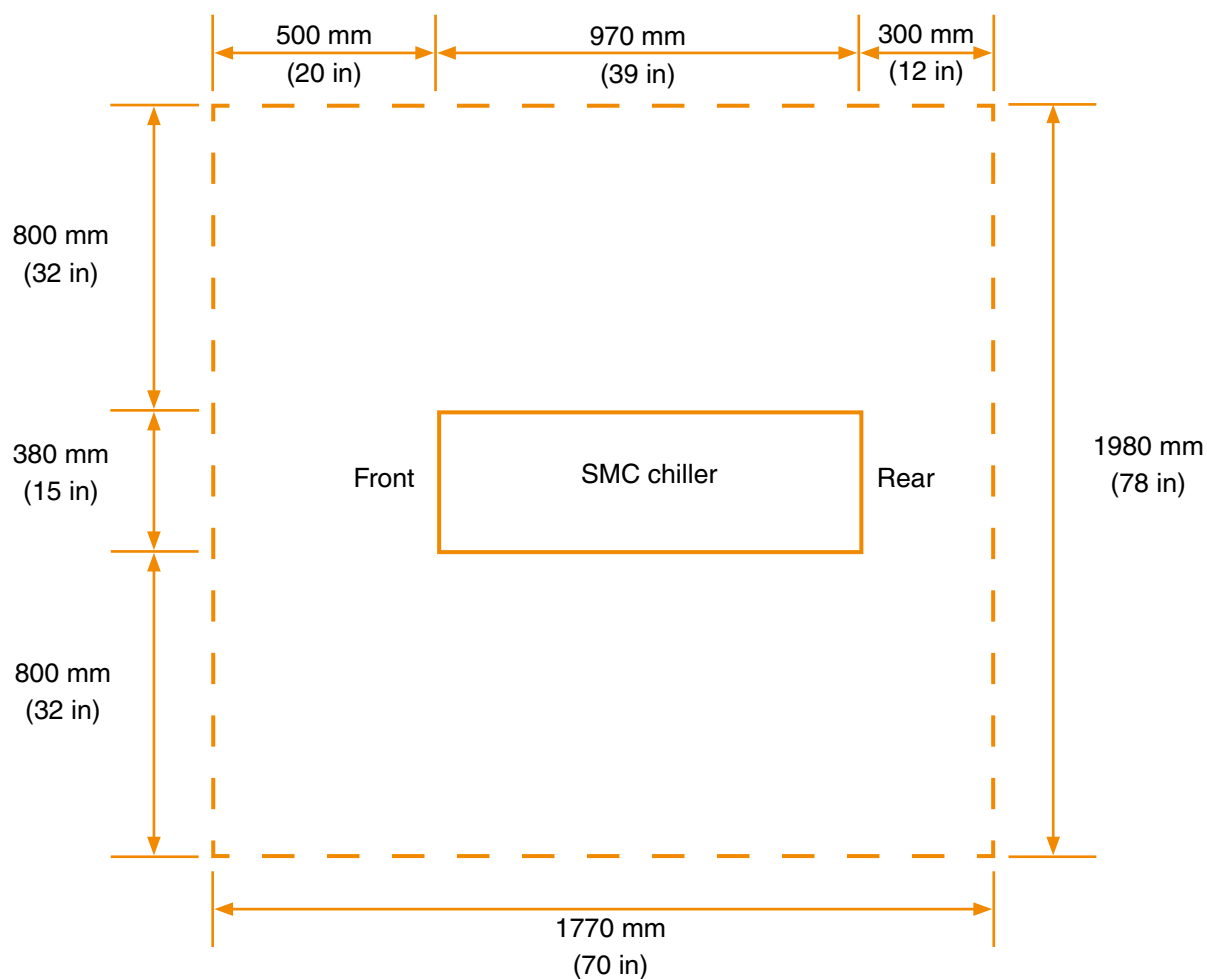


Figure 29 SMC chiller floor space requirements

NOTE: The maximum recommended length of piping between the SMC chiller and the RenAM 500 series system is 20 m (66 ft).

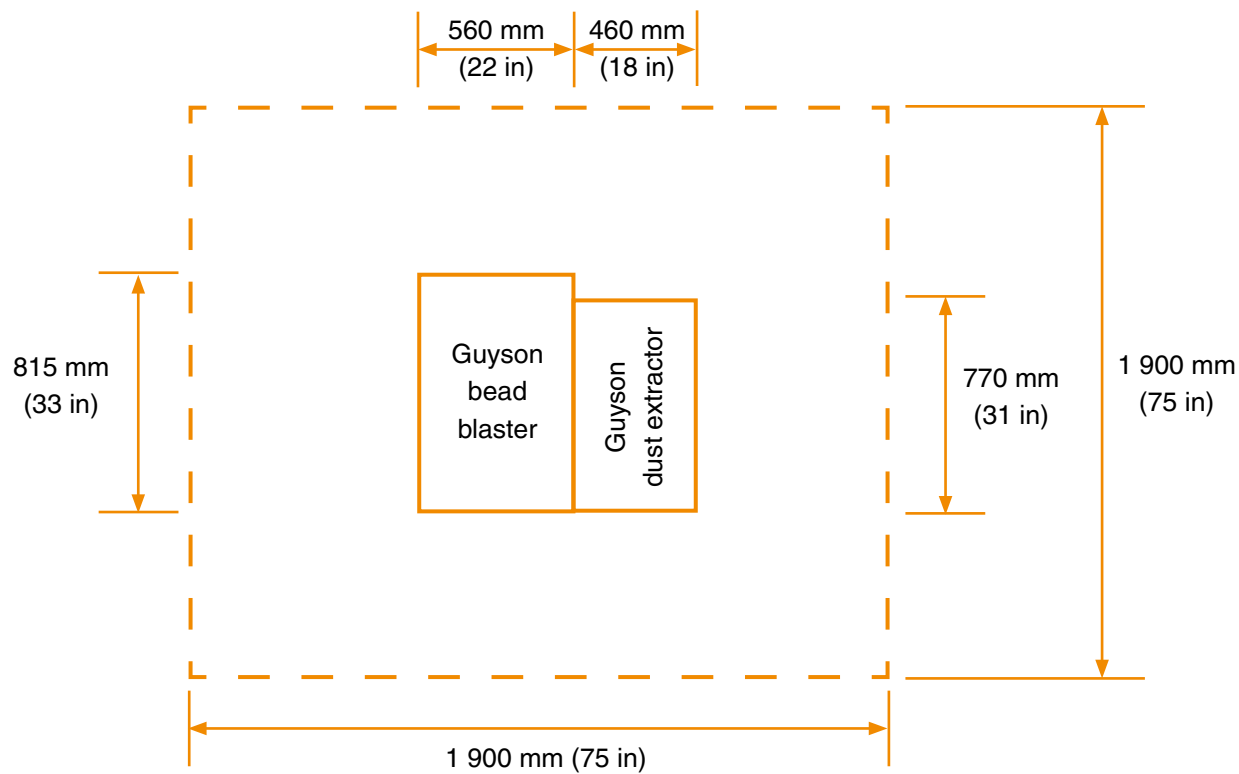


Figure 30 Guyson bead blaster and extractor floor space requirements

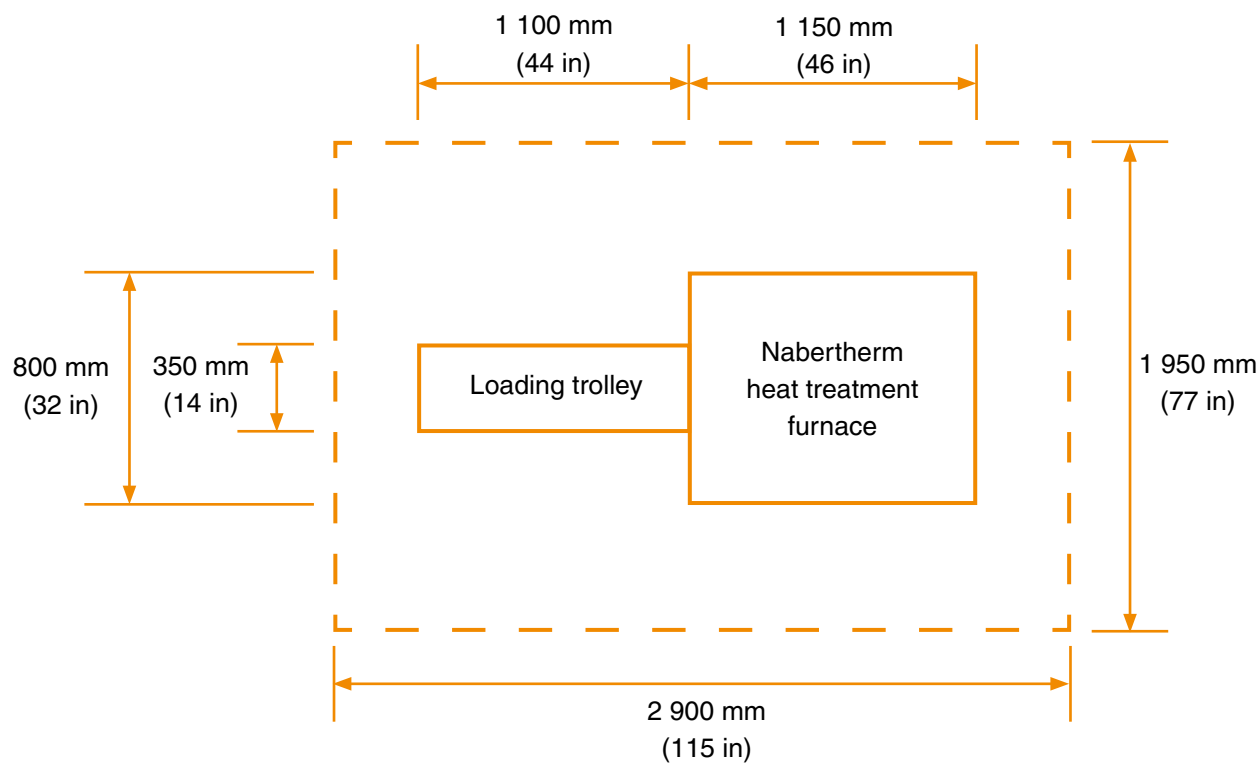


Figure 31 Nabertherm heat treatment furnace floor space requirements

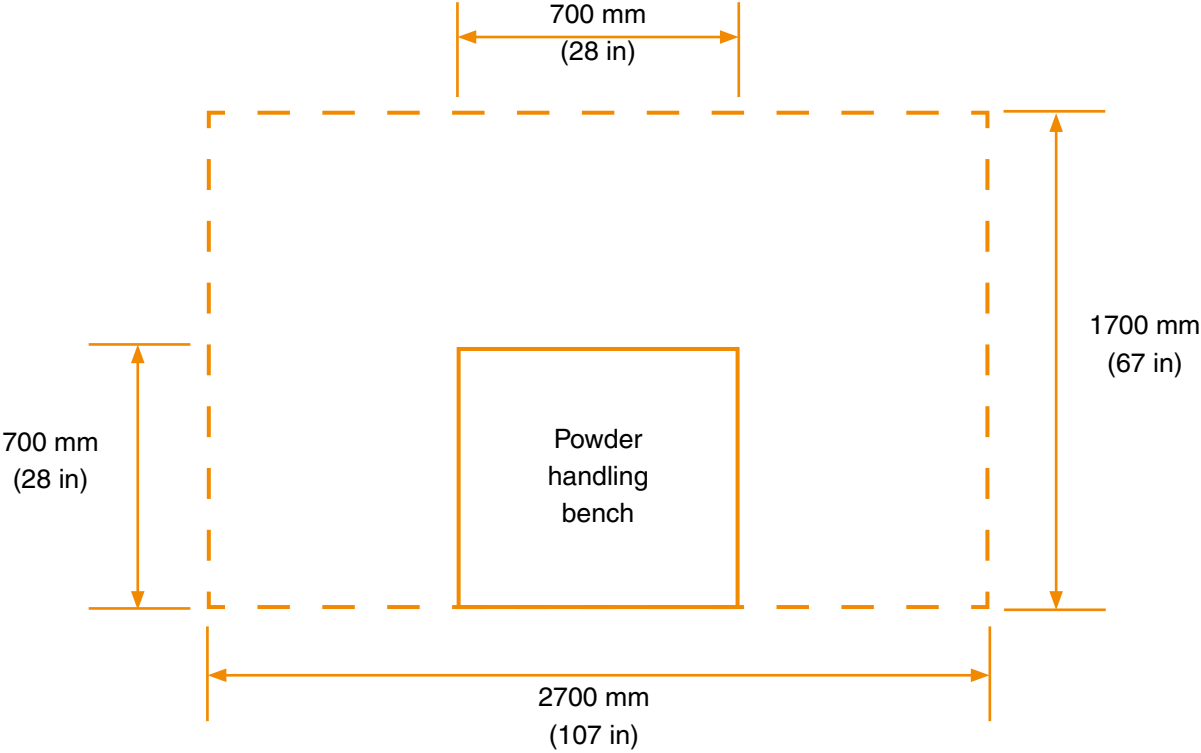


Figure 32 Powder handling bench floor space requirements

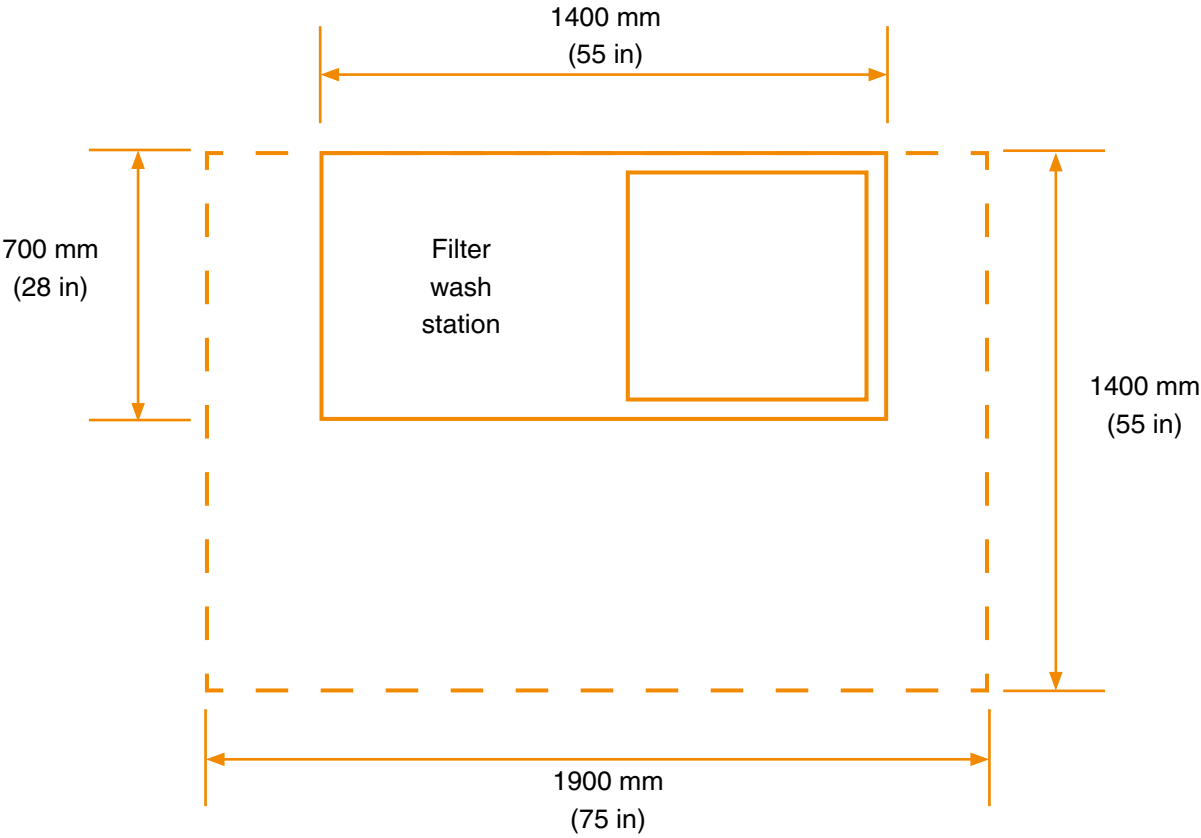
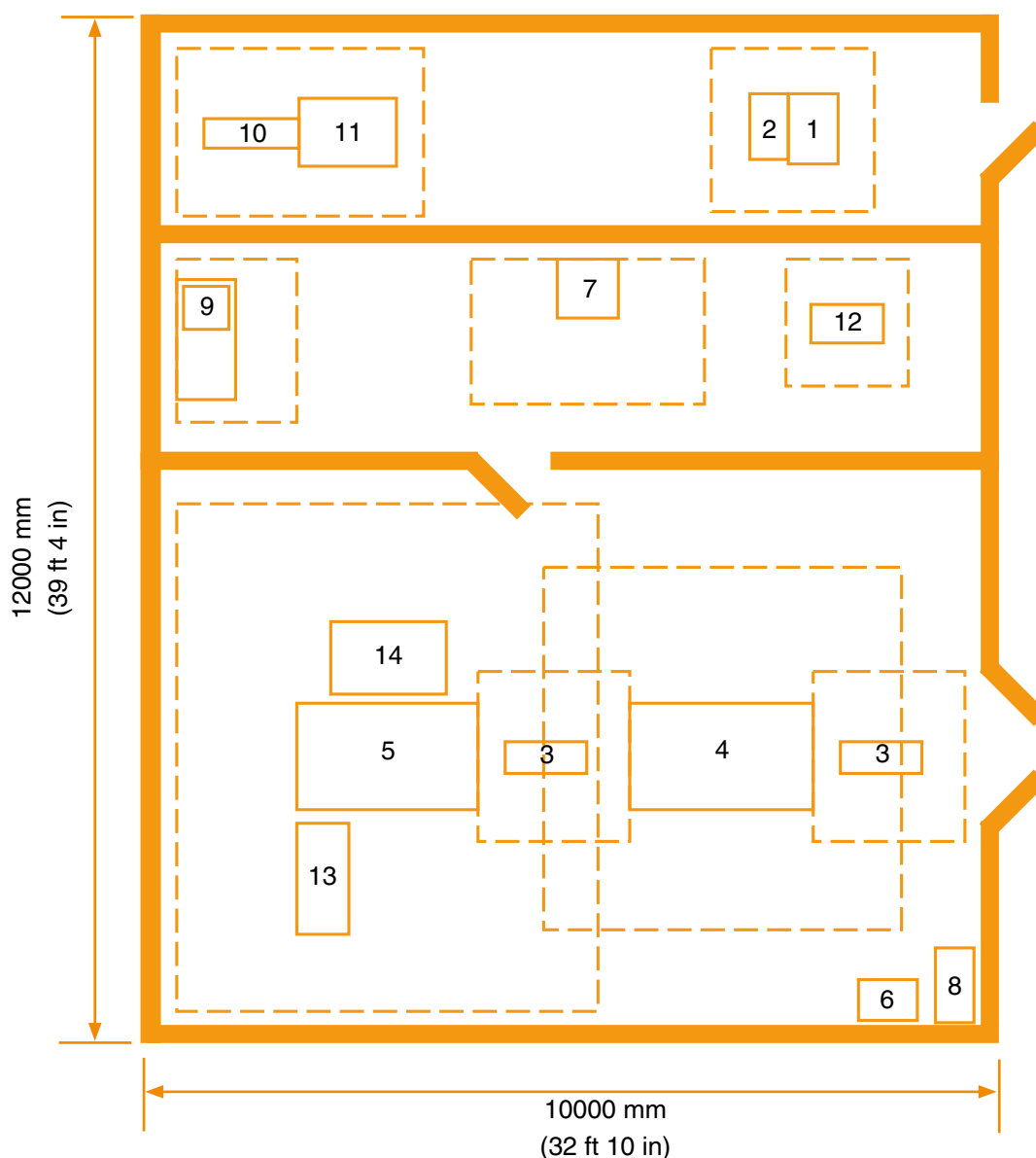


Figure 33 Filter wash station floor space requirements

6.1.3 Sample process room layout

The following illustration shows an example of process room layout for the RenAM 500 series system.

NOTE: It is recommended to install the furnace and bead blaster in a separate area located away from the powder handling area. The PRS and powder handling bench must be installed in a separate room, constructed to ATEX classification zone 22 (dusts).



1	Guyson bead blast unit	8	Material safe storage cabinet
2	Guyson bead blast extractor unit	9	Filter wash station
3	SMC chiller	10	Furnace loading trolley
4	RenAM 500 series system (excluding Flex)	11	Nabertherm heat treatment furnace
5	RenAM 500 series system (Flex only)	12	Renishaw Powder Recovery System (PRS) station
6	Ruwac NA7 ATEX vacuum cleaner	13	Universal lifter
7	Powder handling bench	14	Working platform

Figure 34 Sample process room layout

6.2 Process room construction requirements

WARNING: All gas and electrical connections must be carried out by a suitable locally-qualified tradesperson. Attempting to handle these connections without proper expertise can lead to serious accidents or damage to the equipment.

If you intend to construct a new process room for the RenAM 500 system, the design and layout of the room must facilitate efficient workflow, ensure operator safety, and accommodate the specific requirements of the machines. When considering the location of the process room, preference should be given to a location close to an outside wall to minimise the length of the extraction duct.

The key considerations and details involved in constructing a process room is listed in table given below.

Construction		Type	Details
Process room size		N/A	Dependent upon the equipment installed
Walls		Metal stud partition	12.5 mm (0.5 in) plasterboard to each side, finished with plaster skim
Ceiling	RenAM 500 series (excluding Flex)	At least 3 000 mm (10 ft) above fixed floor level	12.5 mm (0.5 in) plasterboard, finished with plaster skim
	RenAM 500 series (Flex only)	At least 3500 mm (11.5 ft) above fixed floor level	12.5 mm (0.5 in) plasterboard, finished with plaster skim
Flooring		WARNING: All gaps and cracks which are permeable should be avoided to prevent powder ingress and accumulation.	
		ESD floor covering with resistance of $\leq 1 \times 10^6$ ohms	GerFlor Mipolam Elegance EL5 2 mm vinyl or equivalent
		Electrical bonding	Terminate floor bonding outside of process room
		Coving to cover any gap between floor and walls	Coving at least 100 mm (4 in) tall
Decoration		WARNING: Flooring which is permeable should be avoided to prevent powder ingress and accumulation.	
		All gaps and cracks sealed with caulking before painting with washable paint	
		WARNING: All gaps and cracks which are permeable should be avoided to prevent powder ingress and accumulation.	

Construction	Type	Details
Entrance doors	Two 30-minute fire doors with brush seal on three sides (not bottom) and viewing window or panel. A minimum of 2300 mm × 838 mm (7 ft 7 in × 2 ft 9 in) × 2 doors. If a lock or latch is fitted it will slow egress through the door and prevent hands-free operation	Open outwards to enable quick egress.
	NOTE: Consider the ventilation requirements of the process room. It may be necessary to cut the door 20 mm (1 in) short to allow air pressure to keep the door closed.	
	Auto-door closer	DORMA TS 73 or equivalent
Entrance door (PRS only)	30 minute fire door with brush seal on three sides (not bottom) and viewing window or panel. 1981 mm × 838 mm (6.5 ft × 2.75 ft)	Cut 20 mm (1 in) short to allow negative air pressure pull.
Ducting	Constructed from spark-resistant metal, not plastic or non-conductive duct/liner. Electrically bonded and grounded to minimise accumulation of static charge. Fabricated with smooth interior surfaces, with internal lap joints facing direction of flow. Avoid capped outlets or other spaces that might allow accumulation of dust. Must have a minimum airspeed to prevent stagnation and accumulation of dust within the duct. Use fans/blowers of spark-resistant design (interlocked so that operation is ensured when equipment/area is in use). Free of moisture and humidity during operation. Fan/blower should be located outside, in a position that minimises dust from the fan exhaust re-entering the building. If in doubt, consult a qualified ventilation engineer	Designed to permit regular inspection and cleaning to avoid dust build-up
Fan	Bifurcated in-line fan	Located outside the process room
PRS light	PRS station light fitting must be zone 22 ATEX rated. Consider emergency lighting (in case of power failure)	Tamlite Cyclone X2 luminaire or similar
Electrical supply	Minimise number of supplies where possible. Lighting and, if fitted, fire alarm sensors	Minimise supply penetrations

Construction	Type	Details
Electrical cable and glands	All cables must be double insulated. For PRS station, use an ATEX or zone 22 rated gland	
Electrical sockets	Consider IP rated sockets	
PRS electrical supply ratings	Depending on PRS model	See section 6.4, "Power requirements"
PRS electrical switch gear	Rotary isolator and DOL (Direct On Line) starter, both external to the room	All switchgear must be fitted outside the room and conform to machinery directive EN60204
PRS emergency stop	Fitting an emergency stop button to the PRS is recommended	Must be ATEX or zone 22 rated and conform to machinery directive EN60204
PRS electrical bonding	Both the PRS body and frame must be electrically earth bonded	
Electrical switchgear – PRS lighting and fan	Light switch installed outside the room must also start the extraction fan (contactor set-up)	If the extractor fan is common to more than one room, all light switches must start it
Electrical supply – ATEX vacuum cleaner	Install an ATEX vacuum cleaner supply externally to the process room	See section 6.4, "Power requirements"
Argon supply (where used)	Depends upon gas supply method selected. Store gas outside the PRS station and run copper pipework within wall voids	All pipework must be electrically earth bonded prior to entry into the PRS station
Low oxygen sensors (if argon is used)	Mains powered, with battery back-up and audible alarm	Situated not more than 300 mm (12 in) from floor level
Signage	Various safety signs	See section 6.15, "Safety signs and labels" for examples
Powder handling bench (users need ATEX zone 22 rated powder handling facility)	Metal frame and work surface electrically earth bonded	Non-sparking metal work surface. Typically 700 mm × 700 mm (28 in × 28 in)
Electrical bonding – powder handling bench	The metal frame and work surface must be electrically earth bonded	
Additional equipment	ANY and ALL electrical equipment used in the PRS station must be ATEX zone 22 rated	For example, powered respirators, oxygen alarms, fire alarms, ATEX vacuum cleaner, etc

NOTE: PRS is only required for RenAM 500 series system, Flex variant installations. It is optional for the other variants excluding Flex.

6.3 Floor requirements

The RenAM 500 series machine cabinet is supported on five combined castors and adjustable jacking feet located behind the plinth. These enable you to adjust the height of the system for levelling purposes. The stability of the system can only be guaranteed if the floor meets the required standard detailed in the table below.

NOTE: During normal use the RenAM 500 series system is stable and should not topple over.

Loading capacity	Minimum 10 kN/m ² (209 lb/ft ²)
Levelling	5 mm/m ² (0.2 in per 10 ft ²)
Finish	Anti-slip, easy to clean, free of dust traps and expansion joints
Resistance	Solvent resistant and waterproof
Static dissipative	ESD anti-static coating – less than 1 × 10 ⁶ ohm earth leakage. For more information, see section 6.2, “Process room construction requirements”.
Vibration	Vibration free. For more information, see section 6.12, “Vibration”.

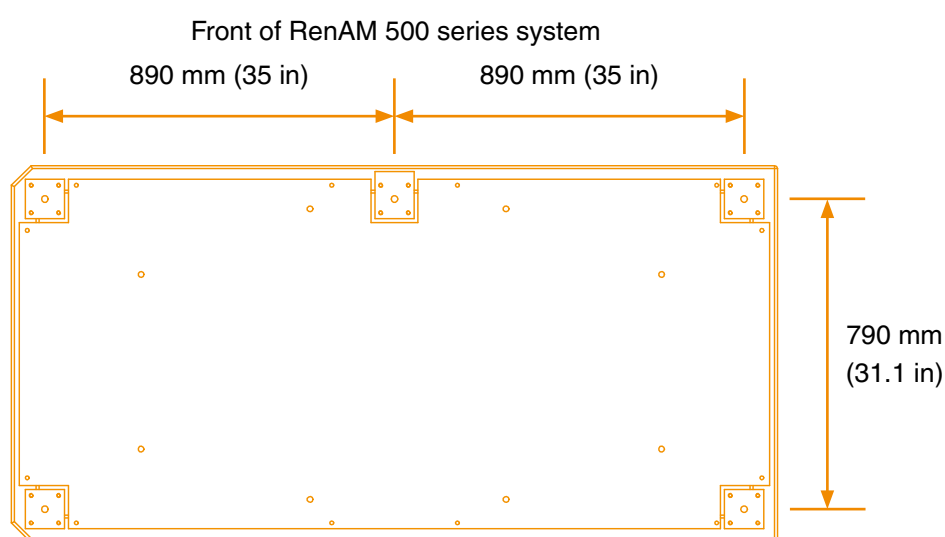


Figure 35 RenAM 500 plan view of combined castor and jacking feet positions

6.4 Power requirements

WARNING: A locally qualified electrician must be available to make all machine connections. Failure to comply may result in serious injury or damage to the equipment.

The RenAM 500 series system must have a dedicated circuit protected by either time-delay fuses or a moulded case circuit breaker (MCCB) which must be a maximum of 50 A “D-curve” rated. This is to be supplied by the customer. Do not use an RCD type breaker.

Interruption of the electrical supply is likely to result in a machine shutdown and incomplete build. Depending on electrical supply reliability, you may wish to consider an uninterrupted power supply (UPS) unit, see section 6.4.2, “Uninterrupted power supply”.

The RenAM 500 series system is not supplied with a power cable. The power cable for the RenAM 500 series system must be TC-ER type (Tray Cable Exposed Run). The power cable must be protected by a dedicated circuit protection device, either time-delay fuses or a moulded case circuit breaker (MCCB) which must be a maximum of 50 A “D-curve” rated. This is to be supplied by the customer. Do not use an RCD type breaker. The specification for the power cable is in the table below.

Power cable size	Terminal block diameter	Crimp terminal on the RenAM 500 series system side
4 × 10 mm ² (4 × AWG8)	0.2 mm ² to 16 mm ² AWG	Bootlace ferrule size: 10-12 (AWG8) For example: JST FWE10-12

NOTE: The RenAM 500 series system is not supplied with a secondary earth cable. Renishaw recommends a cable of 10 mm CSA (1 × AWG8) is fitted. This is to prevent high touch current in the event of a mains earth failure. Renishaw recommends that the secondary earth cable is connected to the local ground earth.

NOTE: The Renishaw PRS is shipped with conductive structural parts and exposed conductive parts of the electrical equipment bonded back to the protective earth (PE) stud. The Renishaw PRS PE stud must be connected back to the installation earth point with a minimum of 4 mm CSA copper conductor. Where an installation conductor material other than copper is used, its electrical resistance per unit length shall not exceed that of the allowable copper conductor.

It is recommended to install the ATEX vacuum cleaner socket at ceiling height to avoid trailing cables.

For the health and safety of operators and third parties, services must be planned in order to eliminate trip hazards such as trailing leads and service pipes.

6.4.1 RenAM 500 series system and ancillary equipment power ratings

Equipment	Voltage, V	Frequency, Hz	Current supply, A	No. of phases	Isolator / switch	Emergency Stop	Plug	Socket	Hardwire	Supply cable	Secondary earth	Accessory	Option
RenAM 500 series system	380 to 480	50 to 60	50 * **	3 + E	Opt	Yes	Opt	Opt	Yes	Req	Req		
Chiller HRS090-AF-40	380 to 415	50 to 60	20	3	Opt	No	Opt	Opt	Yes	Req	Req		
Chiller HRS090-W-40	380 to 415	50 to 60	20	3	Opt	No	Opt	Opt	Yes	Req	Req		
PRS station mechanical PRS400-M	400	50	6	3	Req	Opt	Hardwire only			Req			Yes
PRS station mechanical PRS100-M (US)	115	60	13	1	Req	Opt	Hardwire only			Req			Yes
PRS station vibrasonic PRS400-V	230	50	13	1	Req	Opt	Hardwire only			Req			Yes
	400	50	6	3	Req	Opt	Hardwire only						Yes
PRS station vibrasonic PRS100-V (US)	115 × 2	60	13	1	Req	Opt	Hardwire only			Req			Yes
Vacuum – Ruwac NA7	230	50	16	1	Req	No	IEC 3 pin Req	Req	No	No		Yes	
Furnace N/41	400	50 to 60	32	3	Req	No	No	No	Yes	Req			Yes
Bead blaster 4AM	230	50	13	1	Req	No	Opt	Opt	Opt	Yes			Yes
Bead blaster extractor C400	230	50	13	1	Req	No	Opt	Opt	Opt	Yes			Yes

* The RenAM 500 series system supply cable must be connected to a dedicated fused (by either time-delay fuses or a “D-curve” moulded case circuit breaker) three phase circuit capable of supplying at least 32 A (nominal operating current).

** Maximum calculated load of machine is 50 A, nominal operating current is 32 A.

Req – Required (customer to supply)

Opt – Optional (customer may fit if they wish)

NOTE: The PRS must be hard-wired using armoured cable and in accordance with the Renishaw PRS User guide (Renishaw part no. H-5800-4613). An isolator will need to be supplied by the customer.

6.4.2 Uninterrupted power supply

CAUTION: If in doubt, consult expert advice. Incorrect handling or decision-making could damage the equipment.

If you decide to install a UPS for your RenAM 500 series system, please consult a local expert in UPS and consider the following:

1. A UPS should be from a reputable manufacturer.
2. Depending upon the location, significant variation in power supply, frequency, voltage and power outages should be considered by the potential suppliers.
3. A UPS should be provided with a bypass control panel allowing switching from mains UPS power to direct mains power, and completely off.
4. A UPS shall be a full on-line unit giving the additional benefits of surge protection etc.
5. UPS units shall only be located in an area that does not rise above 28 °C in order to maximise battery life. If required in hot and humid climates, the use of a split system with a cooling capacity of 20% of the UPS rated output may be required. This will maintain temperature and % relative humidity within design operational parameters.
6. UPS costs are significantly increased when the battery back-up time increases above the standard 15 mins. UPS with 5 mins and 10 mins battery capacities are available, reducing cost further.
7. Where there is a history of electrical power outages lasting longer than 15 mins, the justification of a standby generator set starts to become financially viable.
8. Generator sets should be enclosed in an acoustic canopy or enclosure and be equipped with an integrated day tank (diesel storage) and an electronic speed governor.
9. Where there may be a possibility of a power outage lasting more than 24 hrs, the installation of a separate, secured and banded diesel storage tank should be considered, with a possible seven days' or greater storage capacity (local legislation may apply to the storage of fuel).
10. If a generator set is a requirement, it should be installed with an Automatic Mains Changeover (AMC) panel.
11. A generator shall be maintained at regular intervals and load-tested at suitable intervals. A generator should not be run with no load, other than for maintenance testing etc, as engine damage (cylinder bore glazing) can result from no load conditions.
12. A UPS will still be required in conjunction with a generator as the power outage time from mains failure to generator supplying power is normally between 20 s and 30 s.
13. Generator ratings are in kVA. Power factor (PF) is nominally 0.8. The sweet spot for a generator is at 75% of their maximum rating. For example, a 100 kVA generator set applying a PF of 0.8 produces 80 kW. A generator's normal run load should be at 75% of maximum power, thus the generator is sized at a continuous power rating of 60 kW.

14. You should consider all the electrical items of equipment that must run during an AM build:
- HVAC
 - Extraction
 - Lighting
 - Chillers or heat exchanger
 - Low-level oxygen sensors and control systems
 - AM machines (number in concurrent operation etc)
 - ATEX vacuum cleaner (wet separator)
 - Air compressor and drier units
 - Machining centres, EDM, etc
 - Computers, printers etc
 - PRS
 - IT, data services, etc
15. Power coverage to other facilities, areas and equipment as deemed appropriate will impact on the choice of generator and how electrical utilities within the building will be allocated, ie back-up or no back-up.
16. Potential losses of additive manufacturing in process, in terms of financial cost as well as customer dissatisfaction etc. may require the consideration of a secondary back-up power generator.
17. Where a large battery capacity is installed, e.g. 100 kW for 15 mins, the batteries start recharging as soon as the UPS is relieved of its auxiliary battery duty. The recharge current can be significant, so the load should be treated like a machine tool, for example, for the time taken to fully recharge the batteries.

6.5 Requirements for heat removal devices

CAUTION: The heat removal device must be installed in accordance with the manufacturer's instructions to ensure correct operation and enable adequate cooling. Failure to comply could result in loss of cooling of the RenAM 500 series system.

There are three heat removal device options available for use with the machine. The first two are Renishaw supplied chillers, which use Nalco-treated water as the process coolant supplied to the RenAM 500 series system. As a third option, you may source an alternative heat exchanger, provided it conforms to the machine heat removal requirements. The selection of the heat removal device will depend on the availability of a facility water supply, and the air handling available in the environment. For installations of multiple machines, it is recommended that the customer uses a facility water supply in conjunction with water-cooled chillers or heat exchangers to reduce the required air handling capacity.

NOTE: The chiller is not supplied with a power cable or secondary earth cable. A suitably skilled and locally qualified electrician should select a suitable power cable and secondary earth cable. A power cable of 3 × 5.5 mm² CSA and a secondary earth with a total CSA of 14 mm² must be fitted.

Heat removed by the Renishaw air-cooled chiller is exhausted into the environment using a refrigerant loop. The air handling system in the facility must be adequately equipped to deal with this heat. Heat removed by the water-cooled chiller is exhausted to a suitable facility water circuit using a refrigerant circuit.

NOTE: The inlet and exhaust vents of the cooling unit must not be obstructed. There must be a minimum distance of 500 mm (19 in) (front), 300 mm (12 in) (back) and 800 mm (31.5 in) (both sides) from walls or other equipment.

Piping length should be minimised where possible to reduce the required pump load on the heat removal device. The maximum allowable pipe length between the AM machine and heat removal device should not exceed 20 m (chiller) or 10 m (heat exchanger).

NOTE: The maximum recommended length of piping between the chiller and the RenAM 500 series system is 20 m (66 ft).

It is advised to install the heat removal device at the same floor level as the AM machine. If it is installed at a height above the floor level of the AM machine, the pressure cut-off limit should be reduced by 0.05 MPa to compensate for the increased hydrostatic head at the RenAM 500 series system.

If you are considering installing fixed pipework, for example, to position the chiller in an adjacent room, it should maintain the same 19 mm internal diameter as the pipework included in the chiller fitting kit. If possible, install the filter on the flow side, situated between the customer's pipework and the AM machine, to filter out any potential contamination from the fixed pipework.

NOTE: If the chiller is not situated adjacent to the machine and the pipework for the secondary internal heat removal circuit needs to be extended, additional local isolation valves will be required.

NOTE: HRS090 chillers are not recommended for outdoor use.

6.5.1 Customer-supplied heat exchanger

Heat removed by a heat exchanger is exchanged directly with an external facility water circuit. This must be at a stable temperature at least 5 °C below the process water temperature. Instability in the facility water supply will impair the performance of the heat exchanger.

The heat exchanger should only be specified for a facility water circuit at a steady temperature between 10 °C and 15 °C, otherwise the water-cooled chiller should be used.

NOTE: The maximum recommended length of piping between a heat exchanger and the RenAM 500 series system is 10 m (33 ft).

NOTE: Install the heat exchanger in accordance with the instructions provided by the supplier.

6.6 Plumbing and water requirements

6.6.1 Large SafeChange™ filter requirements

It is necessary to fill the large SafeChange filters with water to inert the fine particulate before disassembly. A tap, sink, workbench, and waste water storage will be required for filling, disassembly, and cleaning of the filter housing.

Two filter housings are supplied with each system. Additional spare housings can be supplied if required. Drying time will depend on ambient humidity and temperature – it is important that moisture is not introduced into the RenAM 500 series system. Recommended drying times (following a dry wipe) is 4 hours for the large SafeChange filter housings.

6.6.2 Waste water

An external area is recommended to store drums of waste water (both from the filter wash and ATEX vacuum cleaner). Drums must be in a well-ventilated area, as small quantities of hydrogen gas may be released. An external tap and hose is also recommended, and a bund or a tray should be considered, as contaminated water must not be allowed to run off into soil or drains.

6.6.3 Facility water requirements for chiller / heat exchanger

The customer will be responsible for the connection of a heat exchanger or water-cooled chiller to the facility water supply. As this may be at a temperature below the process coolant, pipe lagging/insulation may be required to reduce the formation of condensation on these pipes. If a water-cooled chiller is used, the facility water outlet temperature could reach up to 60 °C as indicated in the SMC user guide.

The customer is responsible for piping to connect the water-cooled chiller or heat exchanger to the facility water supply. The heat load on the facility water supply for the water-cooled chiller or heat exchanger under typical operating conditions is 8.5 kW. The cooling capacity of the facility water system should be specified to suit.

NOTE: To comply with health and safety regulations, ensure that local isolation valves are fitted to the compressed air, argon supply and primary water supply.

6.6.4 Water-cooled chiller

For flow rate, temperature and pressure requirements, refer to the latest issue of the SMC manual on the SMC website.

The coolant in the facility supplied water should conform to the specification below. Failure to do so may result in a reduction of the cooling or premature failure of the chiller, as minerals and debris block the cooling circuit through corrosion or scale. The following information applies to an SMC supplied chiller; however, it is to be taken into consideration for a customer's own sourced chiller.

NOTE: It is mandatory to add a filter between the chiller and the facility water cooled circuit. Ensure this is placed to the supply circuit of the chiller and not the return circuit. The filtration is recommended to be between 20 µm and 30 µm.

Facility water				
Minimum requirement*	Unit	Value	Influence	
			Corrosion	Scale
pH (at 25 °C)	-	6.5 to 8.2	✓	✓
Electric conductance (at 25 °C)	µS/cm	100 to 800	✓	✓
Chloride ion	mg/L	≤ 200	✓	
Sulfuric acid ion	mg/L	≤ 200	✓	
Acid consumption (at pH 4.8)	mg/L	≤ 100		✓
Total hardness	mg/L	≤ 200		✓
Calcium hardness	mg/L	≤ 150		✓
Ion silica	mg/L	≤ 50		✓

* A filter is installed between the chiller and the facility's water-cooled circuit

Facility water				
Components	Unit	Value	Influence	
			Corrosion	Scale
Iron	mg/L	≤ 1.0	✓	✓
Copper	mg/L	≤ 0.3	✓	✓
Sulphide ion	mg/L	Not detected	✓	
Ammonium ion	mg/L	≤ 1.0	✓	
Residual chlorine	mg/L	≤ 0.3	✓	
Free carbon	mg/L	≤ 4.0	✓	

6.6.5 Heat exchanger

Recommended 25 L/min at 15 °C (5 °C below process coolant), at supply pressure of 2 bar across primary connections. Temperature or pressure oscillation should not be present in the facility water supply, as this could lead to unstable operation of the heat exchanger. The properties of the facility supply must meet the heat exchanger supplier's specification.

Operation of the facility water circuit at lower temperatures is possible; this also allows reduced flow rates. It is not recommended to run the facility water circuit below 10 °C, as this may cause temperature instability in the process water circuit and poor machine performance.

6.7 Pneumatic supply

Compressed air is required for the bead blaster and for optical module replacement.

NOTE: To comply with health and safety regulations, ensure that local isolation valves are fitted to the compressed air, argon supply and primary water supply.

6.7.1 Bead blaster air requirements

The bead blaster requires compressed air which is clean, dry, oil free at 6 bar (87 psi) pressure and a flow rate of 500 L/min (18 ft³/min).

NOTE: To comply with health and safety regulations, ensure that local isolation valves are fitted to the compressed air, argon supply and primary water supply.

6.8 Operating environment

In most countries there is no need for a temperature and/or humidity-controlled environment to safely operate the RenAM 500 series system. However, in particularly hot or humid locations, conditions must be monitored and kept within the safe working limits to protect the components of the system.

CAUTION: As temperature and humidity rise, the dew point of ambient air increases. A high dew point can cause unwanted condensation on chiller-cooled components, which may lead to component failure. To avoid this, Renishaw recommends maintaining the target operating temperature between 18 °C (64 °F) and 22 °C (72 °F), and a target relative humidity of less than 60%.

The process room must be sufficiently ventilated to avoid the build-up of heat and gas emissions (argon from the machine purge and potential hydrogen from the ATEX vacuum cleaner). To achieve this, heating and an air extraction system should be installed in the process room. A volume flow rate should be determined by a heating and ventilation engineer, as this will vary depending on the overall process room volume and equipment installed.

Heat output (under typical operating conditions)	RenAM 500 series system	8 kW (single laser) 9 kW (dual laser) 12 kW (quad laser)
	Air-cooled chiller	8.5 kW
	Heat exchanger / water-cooled chiller	< 2.5 kW
Ideal operating temperature		18 °C to 22 °C (64 °F to 72 °F)
Safe operating temperature limits		15 °C to 28 °C * (60 °F to 82 °F) CAUTION: In an environment where the temperature and/or humidity approaches the maximum operating limit, the chiller set temperature may need to be adjusted. This adjustment helps to prevent potential component failures and ensure optimal performance.
Ideal relative humidity		< 60%
Maximum relative humidity		< 80% CAUTION: In an environment where the temperature and/or humidity approaches the maximum operating limit, the chiller set temperature may need to be adjusted. This adjustment helps to prevent potential component failures and ensure optimal performance.
Recommended maximum altitude*		1 000 m (3280 ft)

* Contact Renishaw for advice on installations at higher altitudes.

To keep the cooled components at a temperature above the ambient air's dew point, the chiller set temperature can be adjusted between 20 °C (68 °F) and 25 °C (77 °F) within the machine's safe operating limits. Use the table below to find the recommended chiller set temperature for environments within the safe operating limits:

CAUTION: Do not operate the machine in conditions marked as "X" in the table. If your operating environment regularly exceeds the maximum temperature and humidity limits, Renishaw recommends installing temperature and humidity controlling systems, such as HVAC, to ensure safe operation.

		Air temperature (°C)													
		15	16	17	18	19	20	21	22	23	24	25	26	27	28
Relative humidity (%)	80	20	20	20	20	20	21	22	23	24	25	X	X	X	X
	75	20	20	20	20	20	20	21	22	23	24	25	X	X	X
	70	20	20	20	20	20	20	20	21	22	23	24	25	X	X
	65	20	20	20	20	20	20	20	20	21	22	23	23	24	25
	60	20	20	20	20	20	20	20	20	20	20	21	22	23	24
	55	20	20	20	20	20	20	20	20	20	20	20	21	22	23
	50	20	20	20	20	20	20	20	20	20	20	20	20	20	21
	45	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	40	20	20	20	20	20	20	20	20	20	20	20	20	20	20

6.8.1 Electrical and thermal loads

Equipment		Fuse rating	Typical running current	Maximum power	Typical power rating	Cooling capacity
RenAM 500 series system		50 A	20 A to 32 A *	26 kVA to 33 kVA *	13 kVA to 26 kVA *	N/A
Chiller HRSH090-AF-40		20 A	8 A	No data	5.0 kW	Up to 9.5 kW **
Chiller HRSH090-W-40		20 A	8 A	No data	5.0 kW	11 kW
PRS station – mechanical	PRS400-M	6 A (400 V)	< 2 A	2.4 kW	0.8 kW	N/A
	PRS100M (US)	13 A (115 V)	< 2 A	4.8 kW	1.6 kW	N/A
PRS station – vibrasonic	PRS400-V	6 A (400 V)	No data	No data	No data	N/A
	PRS100V (US)	13 A (115 V)	No data	2.8 kW	No data	N/A
Furnace N/41		32 A	No data	12.8 kW	No data	N/A
ATEX vacuum cleaner NA7		16 A	7.6 A	2.8 kW	1.7 kW	N/A
Bead blaster 4AM		13 A	No data	2.8 kW	No data	N/A
Bead blaster extractor C400		13 A	No data	2.8 kW	No data	N/A

* Depending upon supply voltage.

** For details, refer to the equipment manufacturer's user manual.

NOTE: If you are using an air-cooled chiller, consider placing it in a separate well-ventilated room to reduce heat.

6.8.2 Equipment emissions

Equipment	Gas	Powder	Vapour
RenAM 500 series system	Argon, maximum 1 L/min (1.8 ft ³ /hr) running Up to 900 L (32 ft ³) during purge and 600 L (21 ft ³) at end of build	Only in the event of a spill	None
ATEX vacuum cleaner	Small quantities of hydrogen gas	None	None
Small/large SafeChange filter (when wet)	Hydrogen	Only in the event of a spill	None
Furnace N/41 (optional)	Argon, typically < 20 L/min (42 ft ³ /hr) Max 40 L/min (85 ft ³ /hr)	None	None, provided only clean AM parts are treated
Bead blaster 4AM (optional)	Compressed air	Blast media, abraded material (extractor provided)	None
Bead blaster extractor C400 (optional)	None	Filtration for above	None
PRS station PRS400-M/PRS100M/ PRS400-V/PRS100V	A negligible amount of argon	Only in the event of a spill	None

6.9 Electro-magnetic compatibility

The RenAM 500 series system has been tested to European standards to ensure electro-magnetic compatibility (EMC), however devices that emit high-frequency radiation should not be operated in the vicinity of the RenAM 500 series systems.

Electro-magnetic compatibility (EMC)

RenAM 500 series system
BS EN 61000

NOTE: The RenAM 500 series laser melting system is industrial in design and not intended for use at any time in a residential environment or to be powered from the public low-voltage mains.

6.10 Argon supply

Due to the varied and differing international standards the RenAM 500 series system is not supplied with a gas regulator. The correct regulators will need to be purchased before installation. The RenAM 500 series system regulator should be suitable for argon and supply approximately 400 L/min (14 ft³/min) at up to 7 bar (102 psi) (BOC 8000 series or similar are suitable).

NOTE: For sieving under argon (for processing titanium) an additional 0.1 bar (1.5 psi) regulator and hose will be required for the PRS supply.

The customer will also need to specify how they are going to supply argon to their machine.

- Cylinder – if used, the customer should ensure the argon cylinders are correctly secured in the storage area and at the system location
- Bank
- Cryospeed (liquid)

Argon supply from regulator	Gas hose (supplied) *	RenAM 500 series system gas connection
3/8 in BSP male cone fitting (right-hand thread). Argon compatible regulator with 4.5 bar to 7 bar (65 psi to 102 psi) outlet pressure.	3/8 in BSP female cone fittings on both ends (right-hand). 5 m (16 ft) long.	3/8 in BSP male cone fitting (right-hand). Flow rate – 400 L/min (14 ft³/min).

* Shipment will include 5 m (16 ft) of hose for the connection between the argon regulator and the inlet connection of the RenAM 500 series system. The hose is specified to allow initial gas fill to be executed in under 12 minutes. Substituting this hose may result in a loss of performance – if situated a long way from the system, a higher pressure feed may be required before regulating to operating pressure to ensure sufficient flow.

NOTE: For information on furnace gas consumption, see section 5.4, “Furnace (optional)”.

Insert gas type	Argon (Ar)
Consumption (average after fill)	10 L/hr to 50 L/hr (0.4 ft³/hr to 1.8 ft³/hr)
RenAM 500 series system line pressure regulator setting	1.5 bar ±0.5 bar (22 psi ±4 psi) – chamber line 2.5 bar ±0.5 bar (36 psi ±4 psi) – powder recirculation (Failure to observe this will result in machine error)
Cylinder regulator setting	4.5 bar to 7 bar (65 psi to 102 psi)
Minimum flow rate	400 L/min (14 ft³/min)
Recommended pre-regulated cylinder pressure before build start	50 bar (725 psi)
Quality (greatest permissible impurities)	20 ppm or better (99.998% pure)

NOTE: To comply with health and safety regulations, ensure that local isolation valves are fitted to the compressed air, argon supply and primary water supply.

6.11 ATEX zoning

WARNING: If in doubt, consult expert advice. Incorrect handling or decision-making could result in severe injury and/or damage to the equipment.

When using an ATEX rated PRS station, powder sieving presents a low combustion risk. However, volumes of powder are manually handled and, as such, the risks of a dust explosion need to be correctly managed.

The recommendation by Renishaw is to install the sieving equipment and powder handling bench in a separate room, constructed to ATEX classification zone 22 (dusts).

European and IEC classification	Definition of zone or division	North American classification
Zone 20 (dusts)	An area in which an explosive mixture is continuously present or present for long periods	Class II Division 1 (dusts)
Zone 21 (dusts)	An area in which an explosive mixture is likely to occur in normal operation	Class II Division 1 (dusts)
Zone 22 (dusts)	An area in which an explosive mixture is not likely to occur in normal operation and if it occurs it will exist only for a short time	Class II Division 2 (dusts)

This document outlines the main considerations for constructing a suitable zone. Renishaw recommends that the latest standard relevant to your territory is referred to (for example DSEAR or ATEX/IEC in Europe or CEC/NEC in North America).

6.12 Vibration

The RenAM 500 series system must be installed in a location away from known sources of vibration.

6.12.1 Vibration impact

The reliability of the components within the AM system is not affected by typical workshop levels of vibration (up to 0.8 mm/s), however accuracy and performance may be.

6.12.2 Mitigating vibration

Vibration is undesirable for the AM optical system because it can affect the performance and positional accuracy of mirrors. The impact may vary depending on the amplitude and frequency of the vibration, as resonance can occur at certain frequencies.

As a general rule, installations should aim for a maximum of 0.1 mm/s vibration (8 Hz to 80 Hz). In practical terms, installation on a ground floor concrete foundation of at least 200 mm should be sufficient. Machines that generate vibration should be located sufficiently far away or isolated to prevent transmission of vibration (refer to ISO 10816 for vibration severity). A Class 1 (best case) machine will generate up to 0.28 mm/s).

NOTE: If vibration is a concern at your installation site, a specialist must conduct a vibration measurement survey. Using vibration isolation mounts in such cases could be an effective solution.

6.13 Data

6.13.1 Network requirements

The Renishaw RenAM 500 series system requires a connection to the file preparation computer. In cases where the machine cannot be connected to the network, a separate dedicated network card should be installed in the file preparation PC. This allows the computer to communicate directly with the machine for file transfer, whilst communicating to the network via the other network card. The machine's network interface has the specifications shown in the table below.

The PC requirements for running the RenAM 500 series system are relatively modest, however build preparation and slicing software is processor-intensive and a high-specification computer will result in faster offline build preparation. Refer to the QuantAM or Magics software documentation for PC specification.

The network connection should be in close proximity to the rear of the machine. If this is not possible, a network cable of sufficient length should be provided.

Refer to the RenAM 500 series system User guide (Renishaw part no. H-5800-3693) for details of setting up a file transfer.

Network type	Ethernet
Protocol	TCP / IP (Transmission Control Protocol / Internet Protocol)
Connection cable	RJ45, LAN (Local Area Network)



Figure 36 RJ45 LAN connector

6.13.2 Network connection

If connecting to a company network, Renishaw can supply the MAC address of the purchased PC upon request and in addition would require:

- Static IP address
- Subnet mask
- Default gateway address
- First and second domain name server address – optional

6.13.3 Connection to a single computer

When connecting the RenAM 500 series system directly to a single computer, the Renishaw installation staff will require someone with administration rights on that computer to set up the connections.

6.13.4 Firewall

CAUTION: If the RenAM 500 series system is connected to a company network, a suitable firewall must be installed to prevent open access to the system controls from the internet.

It is recommended to have a robust firewall in place when connecting the RenAM 500 series system to a company network. This firewall should be configured correctly to allow necessary communications while blocking potential threats. Regular updates and maintenance of the firewall are also crucial to keep up with evolving cyber threats that could compromise the system's performance.

6.14 Handling considerations

Care should be taken when the system is in operation, when closing doors, handling powder flasks and generally avoiding gross mechanical impacts. As well as potential optical effects, this could cause the powder bed to settle – resulting in a powder shortage on that layer.

ISO standard	Maximum vibration level mm/s rms	Detail size for optical equipment μm	Human perception of vibration	Applicable for
Workshop	0.8	–	Distinctly detectable	–
Office	0.4	–	Detectable	–
Residential	0.2	75	Barely detectable	×20 microscopes
Operating theatre	0.1	25	Not detectable	×100 microscopes
VC-A	0.05	8	Not detectable	×400 microscopes

6.15 Safety signs and labels

Appropriate workplace signage should be displayed to inform personnel of the necessary requirements.



WEAR PROTECTIVE EYEWEAR, DUST MASKS, AND PROTECTIVE CLOTHING

Figure 37 PPE Safety sign



DO NOT ALLOW THE METALLIC POWDER OR WASTE PRODUCTS TO FORM A DUST CLOUD

Figure 38 Dust safety sign



NEVER EAT, DRINK OR SMOKE IN THE VICINITY OF THE RENISHAW AM SYSTEM OR COMPONENTS PRODUCED BY THE PROCESS THAT HAVE NOT BEEN PROPERLY CLEANED

Figure 39 Fire safety sign



WASH HANDS THOROUGHLY WITH SOAP AND WATER AFTER HANDLING

Figure 40 Personal cleanliness safety sign



EX – POTENTIALLY EXPLOSIVE ATMOSPHERE

Figure 41 Explosive atmosphere safety sign



ESD – AVOID STATIC DISCHARGE, WEAR ESD FOOTWEAR

Figure 42 ESD footwear safety sign

7. Receiving the RenAM 500 series system

This section outlines the procedures and responsibilities involved in receiving the AM system on site. It provides detailed information about the size and weight of the equipment in its packaging. It also includes the guidelines for safe handling and storing the equipment to maintain its integrity.

7.1 Scope of supply

Renishaw supplies certain equipment as standard when you purchase a RenAM 500 series system. The following section list the equipment included with each variant of the RenAM 500 series machine.

NOTE: In addition to the supplied equipment, the customer needs to procure some mandatory materials and equipment to execute the AM build on the procured RenAM system after installation and commissioning by a Renishaw representative. For details on mandatory equipment, see section 10, “Essential materials and equipment”.

7.1.1 Standard equipment for RenAM 500 Flex

The following equipment and services are supplied as standard when you purchase a RenAM 500 Flex system from Renishaw. This does not apply to RenAM 500 or RenAM 500 Ultra models.

- Renishaw RenAM 500 Flex AM system, referred to as either RenAM 500S Flex or RenAM 500Q Flex.
- Welcome pack
- RenAM 500 series User guide (Renishaw part no. H-5800-3693)
- Operator training course
- Sign-off kit – to suit the material being processed
- Powder flask kit – one powder flask, complete with isolating valve
- Chiller – to supply cooled water to the system optical equipment
- Filter passivation kit (Renishaw part no. A-6521-5060)
- Renishaw universal lifter ¹
- 1.4 m working platform ¹
- Overflow flask kit – two 1.7 L or 10 L overflow flasks complete with isolating valve
- Feed hopper – one small, medium or large RenAM 500 Flex feed hopper
- 1 T, 2 m long, lifting sling ¹

¹ Included as standard on first machine installation only; optional accessory on subsequent installations

7.1.2 Standard equipment for RenAM 500

The following equipment and services are supplied as standard when you purchase a RenAM 500 system from Renishaw. This does not apply to RenAM 500 Flex or RenAM 500 Ultra models.

- Renishaw RenAM 500 AM system, referred to as either RenAM 500S or RenAM 500Q.
- Welcome pack
- RenAM 500 series Site preparation and installation guide (Renishaw part no. H-5800-3692)
- RenAM 500 series User guide (Renishaw part no. H-5800-3693)
- Operator training course
- Sign-off kit – to suit the material being processed
- Powder flask kit – one powder flask, complete with isolating valve
- Chiller – to supply cooled water to the system optical equipment
- Filter passivation kit (Renishaw part no. A-6521-5060)

7.1.3 Standard equipment for RenAM 500 Ultra

The following equipment and services are supplied as standard when you purchase a RenAM 500 Ultra system from Renishaw. This does not apply to RenAM 500 Flex or RenAM 500 models.

- Renishaw RenAM 500 Ultra AM system, referred to as either RenAM 500S Ultra or RenAM 500Q Ultra.
- Welcome pack
- RenAM 500 series Site preparation and installation guide (Renishaw part no. H-5800-3692)
- RenAM 500 series User guide (Renishaw part no. H-5800-3693)
- Operator training course
- Sign-off kit – to suit the material being processed
- Powder flask kit – one powder flask, complete with isolating valve
- Chiller – to supply cooled water to the system optical equipment
- Filter passivation kit (Renishaw part no. A-6521-5060)
- 12-month licence for InfiniAM Camera software
- 12-month licence for InfiniAM Spectral software
- Renishaw Central AM connector

7.2 Installation plan

You must have an installation plan in place and it should be followed. In addition to the installation plan, risk assessments and method statements must be prepared before the commencement of the installation process. These documents are crucial for identifying potential hazards, outlining safety procedures, and ensuring that all work is carried out in a controlled and safe manner.

NOTE: You must follow the instructions detailed in this guide, it will assist you in the installation process. Additionally, complete and return the questionnaire found in section 11, “Installation and commissioning” on page 127.

WARNING: During shipping and handling, precautions must be taken to prevent shocks or drops. Make sure that the shock watches fitted to the crates are intact upon the receipt of your system.

It is the your responsibility to unload and position the AM machine and any ancillaries at the location where they will be operated.

7.3 Exterior requirements

For unloading purposes, the access to the building entrance should be clear and free from obstacles. There should be adequate parking for a lorry and ample time for unloading. A risk assessment for this activity should be conducted.

NOTE: The emergency stop button on the front of the machine protrudes approximately 40 mm (1.5 in) from the system. This addition to the spatial envelope should be considered when moving the system through tight spaces.

7.4 Lifting requirements

WARNING: The task of safely unloading the AM system and any ancillaries from the delivery vehicle and crates is your responsibility, not Renishaw's.

To safely unload the RenAM 500 series system from the delivery vehicle and crate, a forklift truck is required. It should have a minimum lifting capacity of 3000 kg (6614 lb).

NOTE: Renishaw will not supply handling equipment unless it is agreed upon in a prior written agreement. You must arrange for this before receiving the system.

When lifting the RenAM 500 series system, the centre of gravity aligns approximately with the system's centre line. Specifically, the centre of gravity is 1162 mm (45.8 in) in from the front left wheel (x), -398 mm (-15.7 in) in from the front (y) and 623 mm (24.5 in) up from the floor (z).

NOTE: When lifting the RenAM 500 series system, the minimum distance between the inside edges of the forks should be 865 mm (34 in), and the length of the fork must be at least 1600 mm (63 in).

7.5 Crate sizes and weights

The RenAM 500 series system will arrive in crates and pallets. The size and weight are dependent on the amount of equipment you have ordered. The largest crate will contain the RenAM 500 series system.

Item	Height mm (in)	Width mm (in)	Depth mm (in)	Gross weight kg (lb)
RenAM 500 series system	2370 (94)	2300 (91)	1500 (60)	2260 (4982) - 2450 (5402)
Chiller	1139 (45)	1058 (42)	460 (18)	141 (311)
Furnace 1	940 (37)	1200 (47)	900 (35)	226 (498)
Furnace 2	1100 (43)	900 (35)	1200 (47)	91 (201)
Bead blaster	1950 (78)	1380 (54)	1330 (52)	140 (308)
Universal lifter	1875 (74)	1462 (57.5)	877 (34.5)	365 (805)
Working platform	1453 (57.5)	2350 (92.5)	950 (37.5)	132 (291)
ATEX vacuum cleaner	1020 (40)	730 (29)	1200 (40)	155 (342)
PRS	1 600 (63)	880 (34.5)	930 (36.5)	141 (311)

7.6 Inspection

CAUTION: If storing the RenAM 500 series system, do not remove it from its packing crate.

The crate will be equipped with tip-and-tell and shock watch indicators. Upon receiving the shipment, inspect the packaging for any signs of transport damage.

NOTE: If there are any shipping concerns, it must be communicated to Renishaw and the shipping company immediately.

7.7 Storage requirements

The RenAM 500 series system and ancillaries must be stored in a safe indoor environment, protected from frost under the conditions detailed in the table below.

Temperature	> 5 °C (41 °F)
Relative humidity	< 60%

NOTE: If the AM system is stored in a cool environment, allow it at least 24 hours to reach the ambient temperature before use.

7.8 Site transportation requirements

The route that the system will take to its final location should be free from any obstacles, with sufficient clearance through doorways and corridors. The floor must be smooth to facilitate easy transportation, and sturdy enough to support the weight of the equipment and any transportation device.

It is recommended to maintain a clearance of at least 50 mm (2 in) on all sides of the system when measuring and planning the delivery route within the site facility. This will ensure a smooth and safe delivery process.

8. Unloading and unpacking

This section describes the process of unloading and unpacking the RenAM 500 series system. It includes detailed instructions for unloading the AM system from the delivery vehicle and removing it from its transportation crate. Some of the information in this section is written in a generic way, as it is impossible to know the exact facilities and equipment available at every location where the AM system will be installed.

8.1 Unloading RenAM 500 series machine crate

This section outlines the procedure for safely unloading the AM system from the delivery vehicle. It ensures that the system is handled with care to prevent any damage that could affect its performance.

8.1.1 Tools and equipment required

- a. Forklift (minimum lifting capacity of 3000 kg (6614 lb))

NOTE: Renishaw will not supply handling equipment unless it is agreed upon in a prior written agreement. You must arrange for this before receiving the system.

8.1.2 General safety advice

WARNING: The task of safely unloading the AM system and any ancillaries from the delivery vehicle and crates is your responsibility, not Renishaw's.

WARNING: Carry out a risk assessment of the unloading process. Use this risk assessment to identify any unacceptable risks, and implement mitigation actions to reduce these risks to an acceptable level. Non-compliance with the risk assessment could lead to damage to the AM system or potential safety hazards.

WARNING: Ensure that all required Personal Protective Equipment (PPE) is worn at all times. Depending on the results of the risk assessment, it may be necessary to wear high-visibility clothing, protective footwear, and eye protection. Failure to comply with these safety measures could result in serious injury.

WARNING: Renishaw strongly recommends the use of a forklift to unload the AM system from the delivery vehicle. The use of lifting straps, lifting frames, or ropes is strictly prohibited. Non-compliance with these guidelines could result in damage to the equipment or serious injury.

CAUTION: Ensure that the unloading area for the AM system is level, has a solid surface, and is free of obstacles. Only personnel involved in the unloading process should be present in the area. Consider the use of temporary fences or barriers to maintain a safe distance for other personnel during the unloading process. Non-compliance with these safety measures could lead to accidents or damage to the equipment.

CAUTION: Renishaw recommends the use of a forklift, capable of safely lifting 3,000 kg (6,614 lb), for unloading the AM system from the delivery vehicle. Using a forklift with insufficient lifting capacity could lead to equipment damage or personal injury.

8.1.3 Procedure

1. Remove any straps or rope securing the crate of the AM system to the delivery vehicle.
2. Align the forklift with the lifting points, which are marked as “FORK HERE” and located on the front and rear of the RenAM 500 series system crate.

NOTE: The lifting points on the crate, marked “FORK HERE”, are spaced 865 mm (34 in) apart. Adjust the fork spacing on the forklift as required.



Figure 43 Lifting points on the crate

3. Ensure that the forklift's forks are long enough to fully support the weight of the crate and its contents. The forks must extend completely under the crate and protrude from the other side.

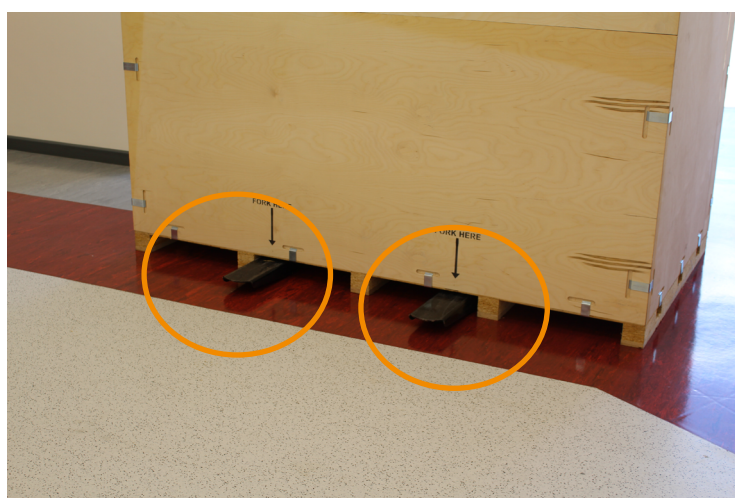


Figure 44 Suitable forks

4. Use the forklift to remove the crate from the delivery vehicle, and position it on level ground in a location with sufficient free space around it to ensure easy access.
5. Make sure that the tip-and-tell and shock watch indicators are still fitted to the crate and are not activated. If they are activated, report to your local Renishaw office. For more information, see section 13, “Customer support”.
6. Inspect the crate’s exterior for any damage. If you find any damage, report it to your local Renishaw office. For more information, see section 13, “Customer support”.

8.2 Removing RenAM 500 series machine from the crate

This section provides detailed instructions on safely removing the AM system from the crate.

NOTE: The crate consists of seven wooden panels, which are fastened together at the edges with metal spring clips. Due to the size of these panels, the task of removing the AM system from its crate requires two persons.

8.2.1 Tools and equipment required

- a. Forklift (minimum lifting capacity of 3000 kg (6614 lb))
- b. Powered pallet truck (minimum lifting capacity of 3000 kg (6614 lb))
- c. Suitable crowbar
- d. Working platforms (movable)

NOTE: The crate is 2370 mm high. Suitable working platforms for two persons will be needed to reach the top of the crate.

8.2.2 Procedure

1. Make sure that the crate is positioned in a location with sufficient free space around it to facilitate easy access.
2. The sequence for removing the crate panels is as follows: start with the top panel, then the front upper panel, front lower panel, end panel 01, back upper panel, back lower panel, and finally, end panel 02.
3. Position the working platform in front of the crate (where the delivery note is attached).
4. Use a suitable crowbar to remove the four metal spring clips that fasten the top lid to the front upper panel of the crate.



Figure 45 Removing the clips that secure the lid

5. Similarly, remove all the metal springs from all sides of the crate that fasten the top lid to the sides of the crate. There are a total of 14 metal springs: four on the front, four on the back, and three on each end of the crate.
6. Using the working platforms, two people must lift the top lid off the crate and keep it aside for future use.



Figure 46 Removing the lid of the crate

7. Support the weight of the front upper panel and remove the four clips that secure the front upper panel to the end panels. Two clips are located on the left end and two on the right end.



Figure 47 Remove the four clips that secure the front upper panel

8. Two people must lift the front upper panel and keep it aside for future use.



Figure 48 Removing the front upper panel

9. Support the weight of the front lower panel and remove the eight clips that fasten the front lower panel. There are two on the left end, two on the right end and four along the bottom edge.



Figure 49 Supporting and removing front lower panel clips

10. Two people must lift the front lower panel and keep it aside for future use.
11. Remove the four clips attaching the end panel 01 to the back panel.
12. Support the weight of end panel 01 and remove the three clips that fasten the bottom of the end panel to the base of the crate.



Figure 50 Supporting and removing end panel clips

13. Two people must lift the end panel 01 and keep it aside for future use.

14. Support the weight of the back upper panel and remove the two clips that secure the back upper panel to the end panel 02.



Figure 51 Supporting and removing back upper panel clips

15. Two people must lift the back upper panel and keep it aside for future use.



Figure 52 Removing the back upper panel

16. Remove the two clips that secure the back lower panel to the end panel 02.

17. Support the weight of the back lower panel and remove the four clips that secure the bottom of the back lower panel to the base of the crate.



Figure 53 Supporting and removing back lower panel clips

18. Two people must lift the back lower panel and keep it aside for future use.



Figure 54 Removing the back lower panel

19. Support the weight of end panel 02 and remove the three clips that fasten the bottom of the end panel to the base of the crate.



Figure 55 Supporting and removing end panel clips

20. Two people must lift the end panel 02 and keep it aside for future use.



Figure 56 Removing end panel

21. Remove the two packs of plinth parts and keep them aside so they can be fitted to the AM system when it is installed in its final location.



Figure 57 Removing two pack of plinth parts

22. Remove the corner foam pieces and keep them aside for future use.



Figure 58 Remove the foam corner packing pieces

23. Use the working platform and remove the foil bag covering the AM system.



Figure 59 Removing the foil bag fitted over the system

24. Fold the foil bag and keep it aside for future use.
25. The RenAM 500 series system sits on five jacking castors/feet, three at the front and two in the rear corners.

NOTE: When the system is in the crate, the feet are lowered to prevent it from moving on its castors.



Figure 60 Jacking castor/foot

26. Rotate the red thumbwheel to raise the foot and lower the system on to its castors/feet.

NOTE: The feet must be raised to allow easy movement of the system into its final location on its castors.

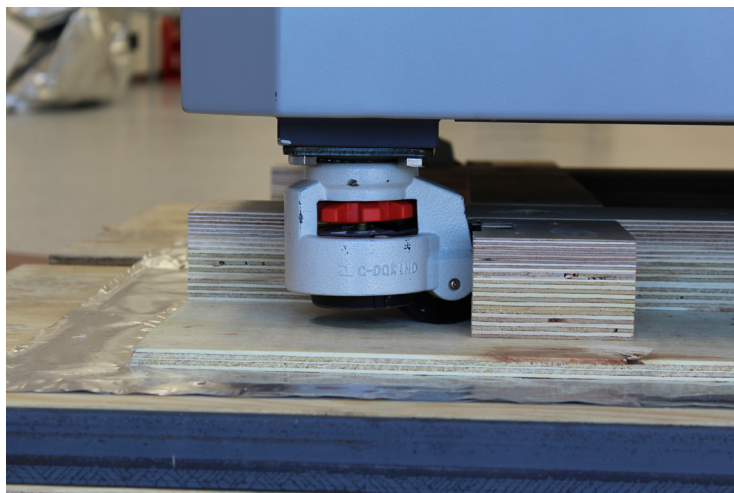


Figure 61 Red thumbwheel to raise the foot

27. Align the forklift with the lifting symbols on the front of the AM system.

NOTE: The RenAM 500 series system should always be lifted with the front of the system nearest the forklift.



Figure 62 Align forks with forklift lifting point symbols

28. Before lifting the AM system, make sure that the forks extend completely under the system and protrude from the other side.
29. Lift the AM system clear of the base of the crate.



Figure 63 Lifting the system clear of the base of the crate

30. Use a forklift, pallet truck or similar to remove the base of the crate and set it aside for future use.

NOTE: The base of the crate weighs 300 kg.



Figure 64 Moving the base of the crate

31. Place the AM system on a level ground.

8.3 Moving RenAM 500 series machine to the process room

After unpacking the RenAM 500 series system, the next step is to move it to the process room, which has been prepared according to the specifications given in this guide. The following procedure provides instructions for transporting your AM system to the process room.

8.3.1 Tools and equipment required

- a. Powered pallet truck (minimum lifting capacity of 3000 kg (6614 lb))

8.3.2 General safety advice

WARNING: Make sure that the pallet truck has sufficient lifting capacity to lift the weight of the RenAM 500 system. Using a pallet truck with insufficient lifting capacity could lead to equipment damage or personal injury.

WARNING: The use of a powered lifting device is strongly recommended for handling these machines. Failure to adhere to this recommendation may lead to personal injury or damage to the equipment.

8.3.3 Procedure

1. Align the powered pallet truck under the end of the system. Then, raise the pallet truck so that the wheels at the end are just off the floor.



Figure 65 Moving the system using a powered pallet truck

2. Use the pallet truck to move the AM system to the process room.
3. Once the system has been moved to the process room and positioned where it will be used, turn the red thumbwheel on all the five jacking castors/feet to lower the foot.

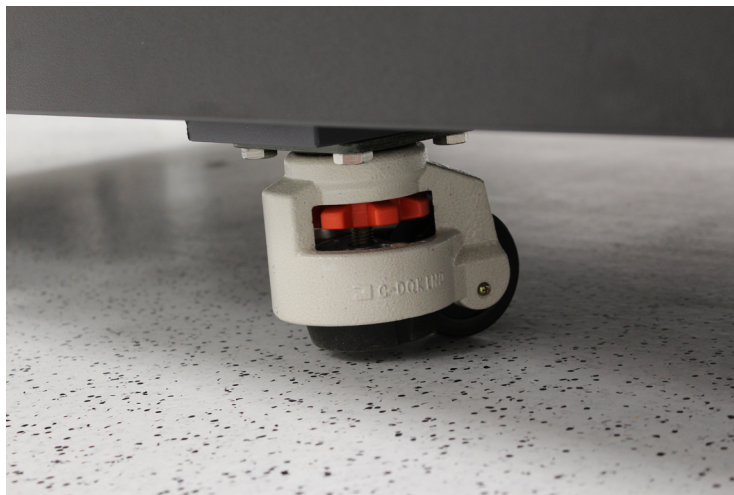


Figure 66 Red thumbwheel on the machine castor/foot

4. Locate the two packs of plinth parts removed from the crate during the unpacking of the AM system. Place them near the AM system so that they can be installed when the system is commissioned by Renishaw service engineers.

9. System configuration

This section describes your responsibilities for supporting the installation and commissioning of the RenAM 500 series system. The tasks you are required to perform include:

- a. Installing the power cable
- b. Connecting to the transformer terminals

NOTE: A Renishaw representative will complete the remaining installation and commission the RenAM 500 series system. Assistance will be required from a specified local tradesperson. This will be followed by comprehensive training.

9.1 General safety advice

WARNING: Ensure that all required Personal Protective Equipment (PPE) is worn at all times. Depending on the results of the risk assessment, it may be necessary to wear high-visibility clothing, protective footwear, and eye protection. Failure to comply with these safety measures could result in serious injury.

9.2 Installing the power cable

The RenAM 500 series machine is not supplied with a plug or power cable. It is recommended to hard-wire the AM system to a dedicated three-phase circuit, which is fused either by time-delay fuses or a “D-curve” moulded case circuit breaker. However, based on local wiring regulations, the RenAM 500 series system can be connected using an appropriate plug and socket.

NOTE: It is recommended to use a 4 × 10 mm² power cable capable of providing a supply of at least 32 A, up to a maximum of 50 A. Depending on local wiring regulations, a power cable smaller than 4 × 10 mm² could also be used.

NOTE: The supply cable for the RenAM 500 series system should be connected to a dedicated three-phase circuit, which is fused either by time-delay fuses or a “D-curve” moulded case circuit breaker. This circuit must be capable of supplying a nominal operating current of at least 32 A.

Follow the instructions below to connect a three-phase power cable to the RenAM 500 series system.

1. Before fitting the power cable to the RenAM 500 series system, pass it through the cable gland at the end of the system.

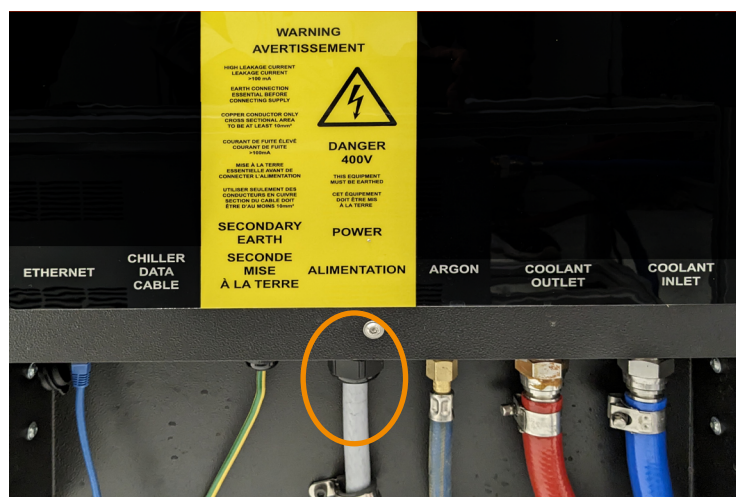


Figure 67 Incoming power cable fed through cable gland on end of system

2. Pull sufficient cable through the gland to reach the terminal block.

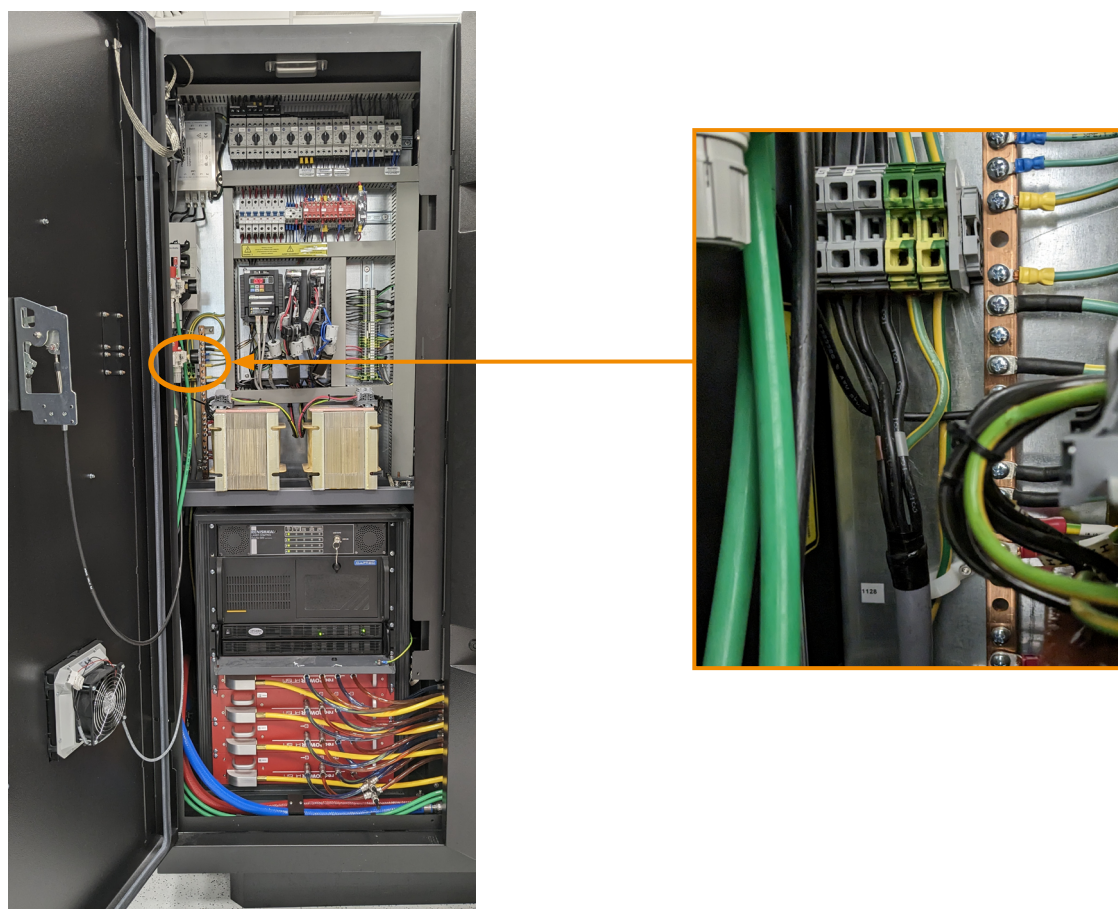


Figure 68 Terminal block inside rear left-hand electrical cupboard door

3. Secure the cable gland in accordance with applicable local wiring regulations.
4. Attach the bootlace ferrules to the terminals of the power cable and crimp it.
5. Attach the crimped terminals to the terminal block according to the wiring diagram.



Figure 69 Wiring diagram (left) and terminal block (right) of RenAM series system

9.3 Connecting to the transformer input terminal

The selection of transformer input terminals is a region-specific requirement designed to convert the 3-phase input supply voltage into an output voltage range between 200 Vac and 230 Vac. Before powering up the RenAM 500 series system, after its power cable has been installed, it is necessary to make sure that wires 1129 and 1140 are correctly connected to the transformer's input terminal. The two transformers are located inside the rear left-hand electrical cupboard door.

NOTE: A transformer is a converter for increasing or reducing the supply voltage. The model of transformer used in the RenAM 500 series system has multiple voltage taps on its input terminal. Increasing the primary voltage tap on the input terminal of the transformer reduces the secondary output voltage.



Figure 70 Two transformers in the rear left-hand electrical cupboard

To connect the correct wires to the transformer terminal, follow the instructions listed below:

WARNING: Make sure that the appropriate safety procedures and practices are followed when handling high voltage electricity to prevent serious injuries.

1. Switch off circuit breakers 11Q12 and 11Q14.
1. Use a suitable voltage measuring equipment and, in accordance with applicable local legislation, measure and record the voltage of the mains supply to which the RenAM 500 is connected.
2. Compare the voltage measured and recorded in the previous step with the input values printed on the label next to the transformer input terminals.

NOTE: The values printed on the transformer label are 380 V, 400 V and 480 V.

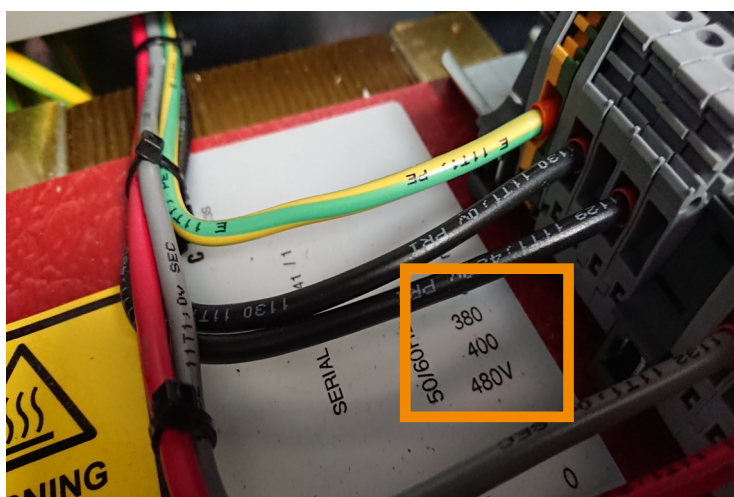


Figure 71 Transformer inputs of 380 V, 400 V and 480 V, wired to the 480 V terminal in this example

3. Select the input voltage on the transformer label that most closely matches the value previously measured and recorded, within a tolerance of $\pm 10\%$.

CAUTION: Make sure to select the correct transformer input terminals that correspond with the same input voltage value. If the input voltage exceeds the recommended limit for the transformer terminal, it could result in electrical component failure.

4. Connect the wire number 1129 to the terminal next to the selected input voltage of the left-hand transformer. Similarly, connect the wire number 1140 to the terminal next to the selected input voltage of the right-hand transformer.

NOTE: If the wires are already connected to the correct input terminals, no further action is required. However, if the wires are not connected to the correct input terminal, remove the wire from the transformer input terminal and connect it to the correct terminal.

5. Use a suitable voltage measuring equipment and, in accordance with applicable local legislation, measure the voltage on wires 1131 and 1142.
6. Ensure that the voltage measurement on wires 1131 and 1142 is within the range of 200 V to 230 V.

NOTE: If the measured voltage exceeds 230 V, connect wires 1129 (pertaining to the left-hand transformer) and 1140 (pertaining to the right-hand transformer) to the input terminals corresponding to the next highest voltage value on each respective transformer. Conversely, if the measured voltage falls below 200 V, connect wires 1129 and 1140 to the input terminals corresponding to the next lowest voltage value on each respective transformer. For additional guidance, contact the Renishaw AM support team.

7. If wires 1129 and 1140 are reconnected, make sure that the voltage on wires 1131 and 1142 falls within the range of 200 V to 230 V.
8. Switch on the circuit breakers 11Q12 and 11Q14.

NOTE: Before powering up the RenAM 500 series system, make sure that both wires are connected to the correct transformer terminals that have the same input voltage value.

10. Essential materials and equipment

This section outline the materials and equipment that you will need to purchase, in addition to the RenAM 500 series system, to fully equip your process room for successful execution of metal powder builds on the AM machine.

NOTE: Due to varying national regulations and standards it is not practical to supply every foreseeable combination of equipment. Therefore, you must procure the following equipment before initiating the installation process.

10.1 Fire extinguishers

As determined by your risk assessment, procure a suitable fire extinguisher. Class D fire extinguishers are suitable for a process room environment. For more information, see section 3.4.2, “Fire-fighting”.

10.2 Argon regulators and cylinders

The RenAM 500 series system, Renishaw PRS, and furnace do not come equipped with argon cylinder fittings or pressure regulators. Therefore, you must procure a suitable argon gas supply, suitable argon gas fittings and regulators for the RenAM 500 series system, Renishaw PRS (if processing titanium) and furnace. For more information, see section 5.7, “Powder recovery system (sieve) (recommended for RenAM 500 and RenAM 500 Ultra) (mandatory for RenAM 500 Flex)”.

NOTE: If you are processing titanium in the Renishaw PRS, you will need an additional supply of argon to the PRS.

10.3 Low-level oxygen sensors

Renishaw recommends the use of an oxygen monitoring system with an audible alarm wherever there is a risk of a significant argon leak. It is your responsibility to assess this risk and take appropriate action. For more information, see section 6.8, “Operating environment”.

NOTE: In an ATEX Zone 22, if an oxygen monitoring system with an audible alarm is installed, the sensor must be of Category 3.

10.4 Personal protective equipment (PPE)

Renishaw recommends wearing full PPE when handling metal powder, which should include at least the following:

- a. Gloves/gauntlets – heat-resistant gauntlets are required if a furnace has been specified.
- b. Eye protection.
- c. A full-face respirator that conforms to EN143 Type P3 for dust protection and A1 for gas/vapour protection when using IPA or solvent cleaners.
- d. ESD dissipative safety footwear with toe protection, which is essential for ATEX zones and recommended for all areas.
- e. Full-length clothing made from non-static-generating fabric such as cotton. Avoid wool and synthetic fabrics, as well as turn-ups or pockets that may trap powder. For more details, refer to NFPA 484.



Figure 72 Example of suitable PPE

10.5 Electrical components

WARNING: A locally qualified electrician must be available to make all machine connections. Failure to comply may result in serious injury or damage to the equipment.

Items such as armoured cable, isolators, plugs and sockets are outside of the scope of supply. Therefore, you must procure these components.

NOTE: Renishaw recommends using an ATEX-rated plug for the chiller.

10.6 IPA and cleaning items

It is necessary to clean the machine between commissioning builds. Supplies of IPA, general-purpose cleaning fluid, and cleaning cloths must be procured. Disposable cleaning cloths are ideal, although paper products should be avoided in preference for a non-linting material.

10.7 Waste storage

Ventilated drums must be used for storing used filters, cleaning cloths, and ATEX vacuum cleaner fluid. These drums should contain a 5% solution of Hydra-Sol MAG additive (Renishaw part no. P-LU08-0004) when used for storing aluminium or oxygen-reactive metal waste.

10.8 Powder storage

Metal powder must be stored in a cool, dry place within hermetically sealed non-flammable containers away from any ignition sources. Powder must not be stored in non-approved containers which may present the risk of electrostatic accumulation.

Bulk storage must comply with local building and fire codes. Consider using zone-classified storage cabinets.

10.9 Workbenches

An area should be designated for placing completed builds, storing build plates, drying filter housings, finished or removed components, decanting powder, etc. A mobile tool chest and trolley could also be useful.

Consider using an ATEX/ESD workbench for powder decanting and maintenance.

10.10 Mobile safety steps

Mobile safety steps can be used to improve access for ergonomically difficult tasks that require slightly elevated access around the machine.

10.11 PPE storage

Lockers to store items of PPE.

10.12 First aid and eye wash

Suitably qualified first aiders, first aid equipment and eye wash, as determined by your risk assessment.

10.13 File preparation PC

A PC located in a separate office equipped with Renishaw QuantAM or Materialise Magics build preparation software.

11. Installation and commissioning

This section provides you with the instructions for facilitating the installation and commissioning of the RenAM 500 series system, which is carried out by a Renishaw representative. It also includes a questionnaire that you must complete and send to Renishaw. This process ensures that you have all the necessary resources, skills, facilities, equipment, services, systems and processes for the successful installation and commissioning of your RenAM 500 series system at your facility.

NOTE: You must email the completed questionnaire to **am.support@renishaw.com** or mail the completed form to the service address provided in section 13, “Customer support”.

NOTE: You must complete and return the questionnaire to Renishaw at least four weeks before the installation date of your AM system.

NOTE: If you are unable to meet any of these requirements, you must inform Renishaw at least 14 days before the installation date. If you fail to inform Renishaw in time, or if issues arise during installation, this may result in a delay in the installation and commissioning of your AM system.

11.1 Pre-installation questionnaire

11.1.1 Contact details

1	Company name	
2	Address	
3	City	
4	Postcode (or ZIP code)	
5	Country	
6	Name and phone number of the safety officer or person responsible for occupational safety within the customer's organisation (1)	
7	Name and phone number of the manager responsible for the operation of the AM system within the customer's organisation (2)	
8	Name and phone number of the supervisor/operator responsible for the AM System within the customer's organisation (3)	

11.1.2 System details

1	System type	
---	-------------	--

11.1.3 Pre-preparation and safety documentation

For information on safety recommendations, see section 3, "Safety".

		Customer confirmation	Renishaw reviewed
1	Responsibilities section read	☐ Yes	☐ Yes
2	Risk assessment complete	☐ Yes, Date:	☐ Yes, Date:
3	Explosion prevention document created	☐ Yes	☐ Yes
4	Explosion and fire risks evaluated and approved	☐ Yes	☐ Yes
5	Waste disposal arranged	☐ Yes	☐ Yes
6	Toxicity and personnel exposure evaluated and approved	☐ Yes	☐ Yes
7	Annual spirometry testing complete	☐ Yes ☐ Not applicable	☐ Yes vvv ☐ Not applicable
8	Low oxygen risks evaluated and approved	☐ Yes	☐ Yes
9	Safety data sheets evaluated and approved	☐ Yes	☐ Yes

11.1.4 Site facilities and preparation

Site facility preparation must be confirmed by a Renishaw representative before machine commissioning can be scheduled. For more information, see section 6, “Site and facilities preparation”.

		Customer confirmation	Renishaw reviewed
1	Process room size (length x width)		
2	Minimum clearances adhered to	☐ Yes	☐ Yes
3	Process room height		
4	Floor loading acceptable for machine and chiller	☐ Yes	☐ Yes
5	Floor level	☐ Yes	☐ Yes
6	Anti-slip solvent resistant coating	☐ Yes	☐ Yes
7	Floor electrostatic discharge	☐ ESD coating	☐ ESD coating
8	Floor vibration free to 0.8 mm/s	☐ Yes	☐ Yes
9	Ventilation in place (Ensure the ventilation does not obstruct any service access to the machine.)	☐ Yes	☐ Yes
10	Air temperature and humidity control	☐ Yes	☐ Yes
11	EMC from other equipment checked	☐ Yes	☐ Yes
12	Suitable Type D fire extinguishers installed	☐ Yes	☐ Yes
13	Powder storage considered	☐ Yes	☐ Yes
14	Argon supply at minimum 4.5 bar regulated	☐ Cylinder Bank ☐ Cryospeed (liquid)	☐ Cylinder Bank ☐ Cryospeed (liquid)
15	2 stage/ dual argon regulators (400 L/min (14 ft ³ /min)) purchased Ensure Hose connection is 3/8 BSP	☐ Yes (please state brand and model of regulator):	☐ Yes
16	Electrical installation planned (see section 6.4, “Power requirements”)	☐ Yes	☐ Yes
17	Dedicated 50 A supply for RenAM 500 series system (380 V to 480 V AC, 50 A 50 Hz to 60 Hz 3-phase “D” rated MCB (socket 63 A optional) (cable required))	☐ Yes	☐ Yes
18	Dedicated 16 A supply for Ruwac NA7 (230 V AC 16 A 50 Hz 1-phase power for wet separator) (socket required)	☐ Yes	☐ Yes
19	Dedicated 20 A supply for SMC chiller (if applicable) (380 V to 480 V 20 A 50 Hz to 60 Hz 3-phase for chiller (socket optional) (cable required))	☐ Yes	☐ Yes
20	Dedicated supply for heat exchanger (if applicable)	☐ Yes	☐ Yes
21	Dedicated 6 A to 13 A supply for Renishaw PRS (cable required)	☐ Yes	☐ Yes

		Customer confirmation	Renishaw reviewed
22	13A socket for engineer service equipment.	☐ Yes	☐ Yes
23	Secondary earth cable (10 mm CSA) for RenAM 500 series system	☐ Yes	☐ Yes
24	Secondary earth cable (14 mm CSA in total) for SMC chiller (if applicable)	☐ Yes	☐ Yes
25	Electrician wired machine and chiller prior to installation date (chiller must be located within 20 m of the machine on the same level)	☐ Yes	☐ Yes
26	Pneumatic supply (compressed air) with 10 mm push fitting	☐ Yes	☐ Yes
27	Plumbing and facility water supply for SafeChange filter passivation	☐ Yes	☐ Yes
28	Primary water system in place with sufficient filter (if using a water cooled chiller)	☐ Yes	☐ Yes
29	Local isolation valves fitted to the compressed air, argon supply and primary water supply. This will apply to the secondary internal heat removal circuit, if the pipework is extended.	☐ Yes	☐ Yes
30	Appropriate signage	☐ Yes ☐ Not applicable	☐ Yes ☐ Not applicable
31	Data port installed and cable of sufficient length to reach RenAM 500 series system, along with static IP address, known default gateway and subnet	☐ Yes	☐ Yes
32	Computer available to minimum specification	☐ Yes	☐ Yes
33	Suitable lifting equipment for operation and maintenance of the RenAM 500 series system available for Renishaw service engineer use – including universal/silo lifter and working at height platform. A specification can be supplied upon request.	☐ Yes	☐ Yes
34	DataCollector PC available if InfiniAM Spectral purchased	☐ Yes	☐ Yes

11.1.5 Receipt of goods

For information on safety recommendations, see section 7, “Receiving the RenAM 500 series system”.

		Customer confirmation	Renishaw reviewed
1	Installation plan, risk and method statements complete by customer	☐ Yes	☐ Yes
2	Exterior access booked and map sent to Renishaw	☐ Yes	☐ Yes
3	Forklift booked for delivery and installation (min 3000 kg / 6614 lb)	☐ Yes	☐ Yes
4	Suitable storage space and environment	☐ Yes	☐ Yes
5	Store above freezing	☐ Yes	☐ Yes
6	Delivery route and clearances adhered to (door heights, floor condition, steps, etc.)	☐ Yes, note any obstacles and delivery address:	☐ Yes

11.1.6 Installation and commissioning

		Customer confirmation	Renishaw reviewed
1	Laser safety during commissioning considered	☐ Yes	☐ Yes
2	Personnel available for training	☐ Yes	☐ Yes

11.1.7 Ancillary equipment

For information on ancillary equipment, see section 5, “Ancillary equipment”.

		Customer confirmation	Renishaw reviewed
1	Equipment requirements considered	☐ Yes	☐ Yes

11.1.8 Additional equipment supplied by the customer

For information on additional equipment, see section 10, “Essential materials and equipment”.

		Customer confirmation	Renishaw reviewed
1	PPE for every operator, including anti-static coats and anti-static safety boots/shoes	☐ Yes	☐ Yes
2	ATEX rated PPE (for example, battery-fed respirator)	☐ Yes	☐ Yes
3	Electrical components – local plugs and sockets	☐ Yes	☐ Yes

4	IPA and cleaning materials	☐ Yes	☐ Yes
5	Waste fluid storage	☐ Yes	☐ Yes
6	Powder storage	☐ Yes	☐ Yes
7	Work benches	☐ Yes	☐ Yes
8	PPE storage	☐ Yes	☐ Yes
9	Eye wash and first aid	☐ Yes	☐ Yes

11.1.9 Confirmation

I confirm that the information supplied is correct and that the preparations for the RenAM 500 series machine and ancillaries are complete, including a comprehensive risk assessment.

The potential risks when handling metal powders have been considered, and the installation follows the guidelines contained in DSEAR, ATEX, or the local equivalent standard.

I confirm that I understand that, if the installation environment and facilities are not of an acceptable standard in accordance with this site preparation and installation guide, or are potentially unsafe, Renishaw reserves the right to discontinue the installation and postpone to a later date. I also agree that any additional costs that are incurred that are the result of such events are the sole responsibility of the customer and that Renishaw will invoice for the additional costs.

Print name

Signature

Date

NOTE: You must email the completed questionnaire to am.support@renishaw.com or mail the completed form to the service address provided in section 13, "Customer Support". After review, the installation can be scheduled with a minimum lead time of 4 weeks.

For Renishaw office use only

Reviewed by	
Date	
Notes	

12. Training

After completing and submitting the checklist contained in this guide to Renishaw, a Renishaw representative will install and commission the RenAM 500 series system, and training will be provided after the installation. For more details, see section 11, “Installation and commissioning” on page 127.

The syllabus covers an introduction to the software required to prepare and slice a CAD file, and full training on the practical aspects of running the RenAM 500 series system.

Further training on advanced applications engineering is available on request from Renishaw. For more information see section 13, “Customer support”.

13. Customer support

If you experience an issue with your system or software, or if you need advice, contact Renishaw.

13.1 Contact details

Contact details for Renishaw are below:

Phone number:		+44 (0) 1453 524524 Hours of work: Monday to Friday 08:00 to 1700 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 license issues or queries	quantam.support@renishaw.com
Service address:		Renishaw plc New Mills Wotton-under-Edge Gloucestershire GL12 8JR United Kingdom

1. System type	
2. System serial number	

Please quote the details above.

The system serial number plate can be found on the rear of the system.

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

www.renishaw.com/contact

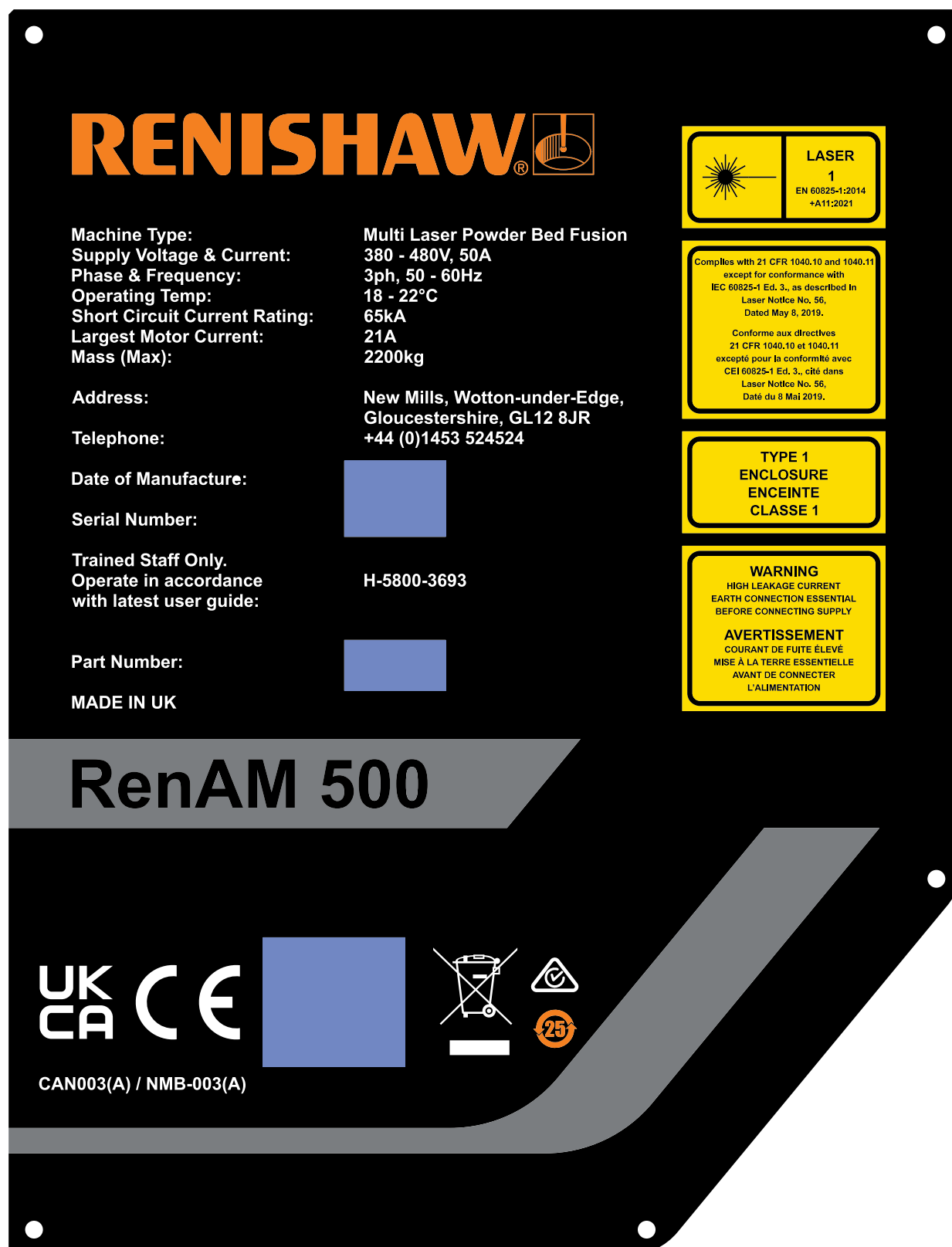


Figure 73 System build information

14. Glossary

14.1 Definitions

The following definitions are used throughout this guide:

Term	Definition
Client or end user	The organisation responsible for purchasing or using the equipment.
Supervisor	An individual who is ultimately responsible for ensuring the safe operation and maintenance of the equipment.
Trained operator	An individual working for the customer or end user who is competent to operate, maintain and clean the equipment safely. This is because they have been formally trained and assessed in the individual tasks required.
Technician	An operator who is trained to change material parameters, fault-find and change material types.
Service engineer	A Renishaw Service engineer or Renishaw trained person who is qualified and experienced to the highest level in repairing the RenAM 500 series system.
Equipment	The scope of supply from Renishaw that the client has purchased.
Ancillary equipment	Any item which is required for manufacture that is not included in the scope of supply.
Manufacture or manufacturing	Any process where the equipment is commissioned, trialled, operated, maintained or cleaned.
Must	Tasks, actions or activities that are essential for the safe operation of the system.
Should	Tasks, actions or activities that are recommended for the safe operation of the system.

14.2 Abbreviations

The following abbreviations are used throughout this guide:

Term	Definition
AM	Additive Manufacturing
AMPM	Additive Manufacturing Process Monitoring
ANSI	American National Standards Institute
ATEX	ATmosphères EXplosives (explosive atmospheres)
BDO	Beam Delivery Optic
BSP	British Standard Pipe (thread type)
COSHH	Control of Substances Hazardous to Health
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
EMC	Electro-Magnetic Compatibility
ESD	Electrostatic Discharge
FSE	Field Service Engineer
FTP	File Transfer Protocol
GFO	Global Focus Offset
HMI	Human Machine Interface
IEC	International Electrotechnical Commission

Term	Definition
IP	Internet Protocol
IPA	Isopropanol
LED	Light Emitting Diode
LPBF	Laser Powder Bed Fusion
MCB	Miniature Circuit Breaker
MIE	Minimum Ignition Energy
MSS	Machine Software Suite
NFPA	National Fire Protection Association
OSV	Optical System Verification
PC	Personal Computer
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
PPM	Parts Per Million
PV	Present Value
RenAM 500 series	Renishaw's multiple-laser digital AM machine platform. This term refers to all the following models: • RenAM 500S Flex • RenAM 500D Flex • RenAM 500Q Flex • RenAM 500S • RenAM 500D • RenAM 500Q • RenAM 500S Ultra • RenAM 500D Ultra • RenAM 500Q Ultra
RenAM 500 Flex	This term refers to models within the RenAM 500 series with a flexible total-loss powder management system, such as: • RenAM 500S Flex • RenAM 500D Flex • RenAM 500Q Flex This does not include the RenAM 500 or RenAM 500 Ultra models.
RenAM 500	This term refers to models within the RenAM 500 series with on-board powder filtration and recirculation, but without TEMPUS technology, LaserVIEW and MeltVIEW hardware installed as standard, such as: • RenAM 500S • RenAM 500D • RenAM 500Q This term does not include the RenAM 500 Flex or RenAM 500 Ultra models.
RenAM 500 Ultra	This term refers to models within the RenAM 500 series with on-board powder filtration and recirculation, with TEMPUS technology and LaserVIEW and MeltVIEW hardware installed as standard, such as: • RenAM 500S Ultra • RenAM 500D Ultra • RenAM 500Q Ultra This term does not include the RenAM 500 Flex or RenAM 500 models.

Term	Definition
SIL	Safety Integrity Level
SMB	Server Message Block
UPS	Uninterruptible Power Supply
WAN	Wide Area Network

www.renishaw.com/contact



#renishaw



+44 (0) 1453 524524



uk@renishaw.com

© 2018–2024 Renishaw plc. All rights reserved. This document may not be copied or reproduced in whole or in part, or transferred to any other media or language by any means, without the prior written permission of Renishaw.

RENISHAW® and the probe symbol are registered trade marks of Renishaw plc. Renishaw product names, designations and the mark 'apply innovation' are trade marks of Renishaw plc or its subsidiaries. Other brand, product or company names are trade marks of their respective owners.

WHILE CONSIDERABLE EFFORT WAS MADE TO VERIFY THE ACCURACY OF THIS DOCUMENT AT PUBLICATION, ALL WARRANTIES, CONDITIONS, REPRESENTATIONS AND LIABILITY, HOWSOEVER ARISING, ARE EXCLUDED TO THE EXTENT PERMITTED BY LAW. RENISHAW RESERVES THE RIGHT TO MAKE CHANGES TO THIS DOCUMENT AND TO THE EQUIPMENT, AND/OR SOFTWARE AND THE SPECIFICATION DESCRIBED HEREIN WITHOUT OBLIGATION TO PROVIDE NOTICE OF SUCH CHANGES.

Renishaw plc. Registered in England and Wales. Company no: 1106260. Registered office: New Mills, Wotton-under-Edge, Glos, GL12 8JR, UK.

Part no.: H-5800-3692-03-B

Issued: 11.2024