User guide
H-5800-0704-05-B

Renishaw additive manufacturing: AM250 and AM400 laser melting systems

ORIGINAL INSTRUCTIONS

Renishaw part no: H-5800-0704-05-B

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Contents

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1 Before you begin

1.1 Disclaimer

RENISHAW HAS MADE CONSIDERABLE EFFORTS TO ENSURE THE CONTENT OF THIS DOCUMENT IS CORRECT AT THE DATE OF PUBLICATION BUT MAKES NO WARRANTIES OR REPRESENTATIONS REGARDING THE CONTENT. RENISHAW EXCLUDES LIABILITY, HOWSOEVER ARISING, FOR ANY INACCURACIES IN THIS DOCUMENT.

1.2 Trademarks

1.3 Warranty

Equipment requiring attention under warranty must be returned to your equipment supplier.

Unless otherwise specifically agreed in writing between you and Renishaw, if you purchased the equipment from a Renishaw company, the warranty provisions contained in Renishaw's CONDITIONS OF SALE apply. You should consult these conditions in order to find out the details of your warranty but, in summary, the main exclusions from the warranty are if the equipment has been:

- neglected, mishandled or inappropriately used; or
- modified or altered in any way except with the prior written agreement of Renishaw.

If you purchased the equipment from any other supplier, you should contact them to find out what repairs are covered by their warranty.

1.4 Changes to equipment

Renishaw reserves the right to change equipment specifications without notice.

1.5 Patents

Features of the AM250/AM400 additive manufacturing system, and other similar systems, are the subject of one or more of the following patents and/or patent applications:

CA 2010/007394	CN 102164696	EP 2323787	JP 5514210	US 2010/007396
CA 2010/007396	CN 102186554	EP 2318164		US 2010/026397
CA 2010/026396	CN 103357874	EP 2331232		US 2014/0287080
CA 2010/026397		EP 2342042		US 8753105
		EP 2620241		US 8794263
		EP 2687305		

1.6 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.

WEEE symbol

1.7 EC declaration of conformity

Renishaw plc declares that the AM250/AM400 complies with the applicable standards and regulations.

Renishaw plc hereby declares that the AM250/AM400 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

Contact Renishaw plc or visit www.renishaw.com/am400 for the full EC declaration of conformity.

1.8 FCC information to user (USA only)

1.8.1 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.

1.8.2 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 his own expense.

2 Scope of supply

The following section gives details of the equipment supplied with the system, and the equipment available as options.

2.1 Summary

The Renishaw additive manufacturing process creates homogeneous solid metal components, using high-powered laser energy to melt fine powder, manufacturing parts directly from 3D CAD data.

This manual covers basic system operation and the relevant safety procedures for many commercially available materials. Users should be aware that raw materials used by the system require tightly controlled safety and handling protocols to be adhered to.

Additionally, the system must only be operated by staff who have followed a Renishaw approved training course, and in accordance with the instructions and advice contained in this manual. If in doubt about the particular requirements of the Renishaw AM250/AM400 system for a specific material, please contact us for advice and guidance.

2.2 Equipment

Standard equipment

- Renishaw AM250/AM400 additive manufacturing system
- Chiller – two sizes depending upon AM system supplied
- Dehumidifier – AM400 only
- Chiller fitting kit
- AM250/AM400 User guide – H-5800-0704
- AM250/AM400 Site preparation guide – H-5800-0838
- Operator training documentation
- Starter kit
- Commissioning kit

- Powder bottle kit with three small powder bottles with valves (A1) and one large overflow bottle with valve (B1)
- Additional safe change filter assembly
- File preparation software (for example Renishaw QuantAM or Materialise Magics™)

Required accessories

- Powder conditioning system for material sieving
- ATEX vacuum cleaner (wet separator)
- Metal powder bottles
- Computer for offline file preparation
- Metal powder
- Argon gas supply (cylinder, bank or liquid)

Optional items

- Furnace
- Bead blast unit
- Replacement sieve mesh
- Additional material silo
- Additional material doser
- Additional safe change/large safe change filter assembly
- Additional material bottles and valves
- Additional software modules

3 Warranty and liability

Our equipment is sold subject to the terms and conditions of sale supplied with your purchase of the system; or available on request from your local Renishaw office.

www.renishaw.com/en/contact

3.1 Spare parts

All components and sub-assemblies are subject to rigorous quality control. Components purchased from sub-suppliers, such as ball bearings, electric motors or hydraulic cylinders, are supplied in accordance with Renishaw specifications. Renishaw will not honour any warranty claims where faults arise due to non-OEM replacement parts being fitted.

When ordering spare parts please quote the following:

- Description of the spare and its part number, if known
- Equipment name and model
- Serial number
- Year of manufacture

Details can be found on the serial plate on the rear of your system, see Section 5 "Contact details".

Spare parts should be ordered from your local Renishaw office. See:

www.renishaw.com/en/contact

For details of your nearest local Renishaw office.

See Section 35 Appendix B – "Part numbers of spares" for information about the most commonly used spare parts.

Caution: Renishaw strongly recommend that only Renishaw supplied parts are fitted to the AM250/AM400 system.

4 Introduction

The Renishaw AM250/AM400 is a complex piece of manufacturing equipment and must be used correctly to ensure optimum performance. It must not be used by untrained staff who have not completed a Renishaw approved training course.

4.1 Definitions

The following definitions are used throughout this manual:

Term	Definition
Client or end user	The company responsible for purchasing or using the equipment
Supervisor	An individual or individuals who is/are ultimately responsible for ensuring the safe operation and maintenance of the equipment
Operator	An individual or individuals working for the client or end user who is/are 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 qualified to carry out a particular aspect of maintenance. This is because they have been formally trained and assessed in the individual tasks required
Equipment	The scope of supply from Renishaw that the client has purchased
Ancillary equipment	Any item which is required to complete the installation that is not included in the scope of supply
Manufacture or manufacturing	Is 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

4.2 Abbreviations

Term	Definition
AM	Additive Manufacturing
ATEX	ATmosphères EXplosives (explosive atmospheres)
COSHH	Control of Substances Hazardous to Health
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
EMC	Electro-Magnetic Compatibility
HMI	Human Machine Interface (touch screen)
IEE	Institute of Electrical Engineers (or local governing body)
IPA	Isopropanol Alcohol
ISO	International Organisation for Standardisation
LED	Light Emitting Diode
MCB	Miniature Circuit Breaker
PC	Personal Computer
PLC	Programmable Logic Controller
PPM	Parts Per Million
PV	Present Value
SDS	Safety Data Sheet
SOP	Standard Operating Procedure
SP	Set Point

4.3 Text structure

The following structure has been used throughout this manual:

- The names of menus, buttons, options, icons, check boxes, functions, names of input fields and hot keys are written in **bold**.
- Program windows, parameters, settings for controls, system messages, signals, paths, file names, software names, areas of the screen and operating modes are written in *italics*.
- Controls and function keys are written between <angled brackets>.
- Wildcards for filenames are written in *<angled brackets>* and in italics.

4.4 Safety warnings in this manual

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

Example Warning:

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. A WARNING WILL BE IN UPPER CASE BOLD TEXT.

Example Caution:

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. A Caution will be in sentence case bold text

Example Note:

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. A Note will be in sentence case medium text.

The following Warning labels are fitted to the AM250/AM400 system:

WARNING

Danger by electrocution.

WARNING

Hot surface.

WARNING

Danger of asphyxiation.

DANGER 230 V

THIS EQUIPMENT MUST BE EARTHED

4.5 Training schedule

Renishaw provides a basic level of training to operate the equipment safely. Renishaw also offers extended training courses for operators and process engineers. Please refer to this manual and the training documentation supplied as part of the user training course that all users **must** complete before using the AM250/AM400 system.

5 Contact details

Phone number	+44 (0) 1785 285 000 Hours of work: Monday to Friday 08:00 to 17:00 hr BST (British summer time)
Email	am.support@renishaw.com
Service address	Renishaw plc Brooms Road, Stone Business Park, Stone Staffordshire, ST15 0SH United Kingdom

1. System type	
2. System serial number	
3. System part number	
4. Software version numbers	
HMI revision	
PLC revision	
PC revision	

Please quote the details above:

- The system serial number plate can be found on the rear of the system (Figure 1)
- The system part number:
  AM250 200 W A-5774-0001
  AM250 400 W A-5771-0100
  AM400 A-6252-0001
- The system software version on the start screen (Figure 2)

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

www.renishaw.com/contact

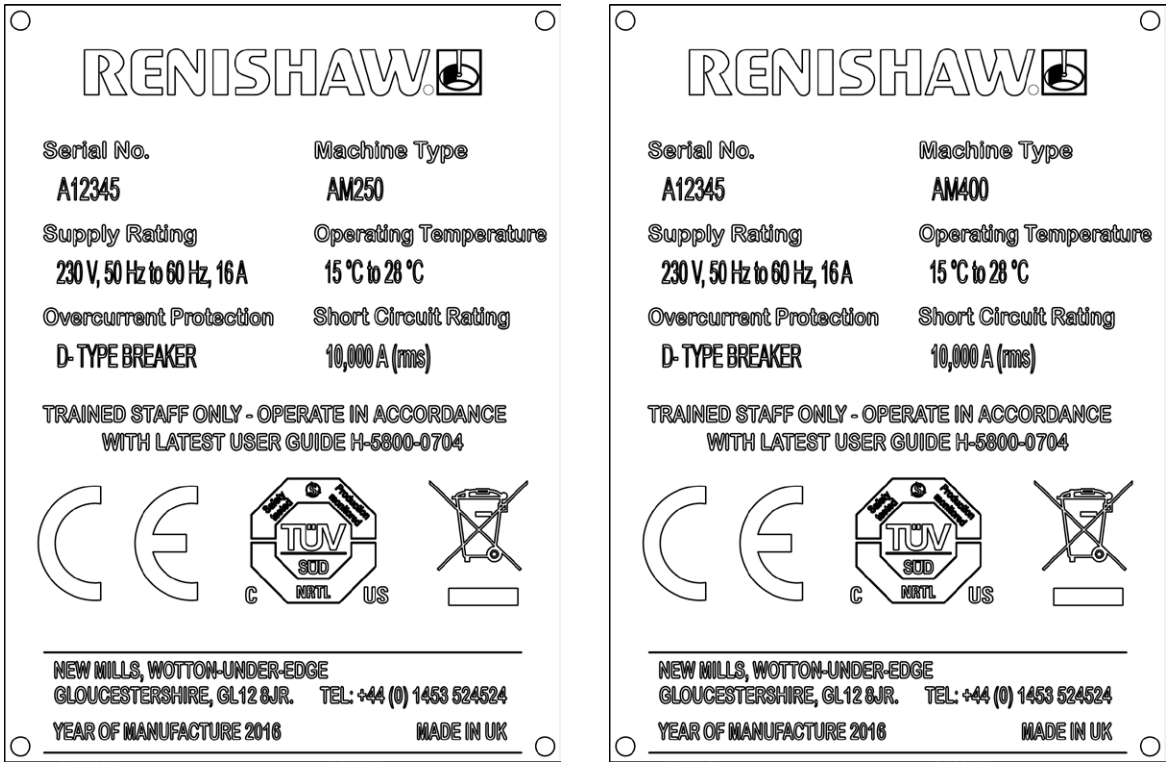


Figure 1 Build information – AM250 (l) and AM400 (r)

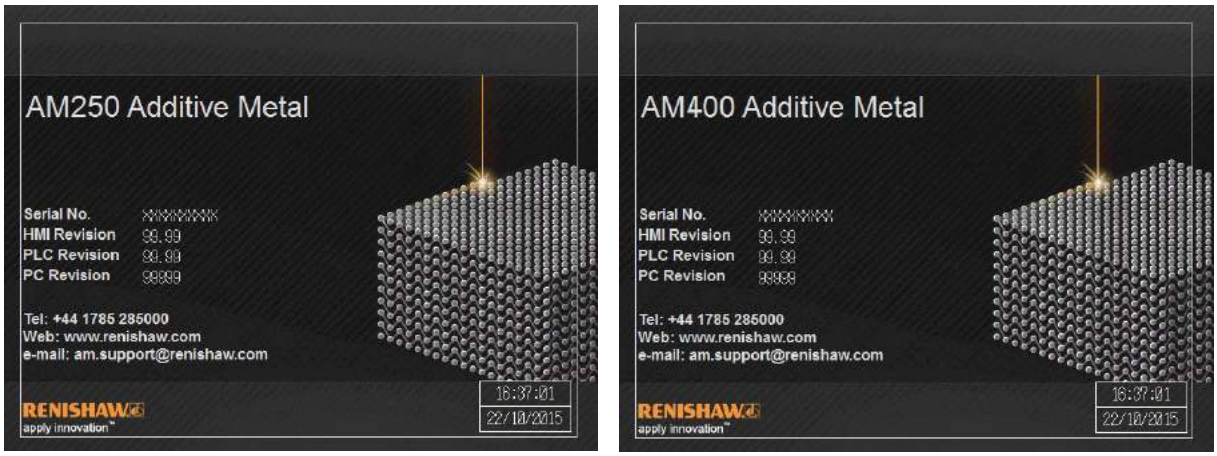


Figure 2 Software welcome screen – AM250 (l) and AM400 (r)

6 Safety

Relevant national legislation and internal company policies will dictate normal minimum requirements for health and safety.

WARNING: OPERATION OF THE RENISHAW AM250/AM400 IS ONLY PERMITTED BY OPERATORS WHO HAVE COMPLETED A RENISHAW APPROVED TRAINING PROGRAM.

WARNING: DO NOT OVERRIDE SAFETY INTERLOCKS AND CIRCUITS.

Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

6.1 Basic safety measures

Risk assessments for all foreseeable hazards 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 or DSEAR assessment (or the local equivalent). This will subsequently inform the provision of correct personal protective equipment 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 bodies will differ depending upon geographic location, and the appropriate governmental and regulatory bodies must be identified for each territory. Considerations need to include regulations governing:

- The use of lasers.
- Fine metallic powders below 45 µm (0.002 in) diameter.
- The use, storage and monitoring of inert gas.
- Small quantities of waste product including nano soot particles captured by the filter system.

Review all data sheets (especially Safety Data Sheets) containing information about the metal powder(s) being used in the AM250/AM400 system.

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 personal

protective equipment 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.

6.2 Safety signs

Various safety signs are fixed to the AM250/AM400. These are described below.

Safety sign	Description and location
	**Warning – ISOLATE SUPPLY BEFORE OPENING COVER.** **AM250 and AM250 with PlusPac – 3 stickers on each door of the electrical cabinet adjacent to the handles.** **AM400 – 4 stickers on each door of the electrical cabinet adjacent to the handles.**
	**Warning – DANGER OF HOT SURFACES.** **Sticker near the oxygen sensor inside the recirculation cabinet.**
	**WARNING – Danger of asphyxiation.** **Sticker near the argon gas exhaust on the rear of the system.**
	**DANGER 230 V** **THIS EQUIPMENT MUST BE EARTHED** **AM250 and AM400 – Sticker on the back of the system adjacent to the power cable**
	**RESIDUAL VOLTAGE DO NOT TOUCH TERMINALS FOR 6 MINUTES AFTER DISCONNECTION OR IF CHARGE LIGHT IS ILLUMINATED** **AM400 – Sticker inside electrical cabinet on rear of system.**
	**MAINS FILTER REMAINS LIVE AFTER MACHINE IS ISOLATED – DISCONNECT POWER SOURCE TO MACHINE BEFORE TOUCHING** **AM400 – Sticker inside electrical cabinet on right hand side of the system.**

Safety sign	Description and location
	**Mandatory personal protective equipment label** **AM400 – Sticker on left hand user access door on left hand side of the system.**
	**Mandatory read the manual label** **AM400 – two stickers on system. one in front of system above display screen and one near the silo.**

6.3 General note on eye protection

In normal use laser operation, the main chamber door is interlocked.

Potential for Class 4 laser emissions.

WARNING: DO NOT OVERRIDE SAFETY INTERLOCKS.

During any adjustment or maintenance with the laser on and the chamber door open, laser eyewear **MUST BE WORN**, as specified in EN 207 (EN 58215) which provides protection against laser beams with wavelengths of 1 000 µm to 1 100 µm. Failure to do so may result in permanent irreparable eye damage.

Any maintenance **MUST** be carried out by a suitably qualified person.

WARNING: ON AM250 FITTED WITH PLUSPAC AND AM400 THERE IS AN LED LIGHT ASSEMBLY FITTED TO THE TOP OF THE BUILD CHAMBER. DO NOT STARE AT THE LED LIGHT ASSEMBLY AS IT MAY BE HARMFUL TO THE EYES.

7 Laser warning labelling

In order to comply with international standards, the Renishaw AM250/AM400 carries various safety warning labels regarding the emission of laser light. These labels form part of the safety information and it is recommended that users regularly (we suggest weekly) check the condition and presence of the labels in the locations shown in the following images. Many labels are generic and fitted to both AM250 and AM400, but some labels are specific to AM250 and some are specific to AM400.

Replacement warning labels can be ordered from Renishaw.

Laser power is classified the higher the class number, the greater the laser radiation hazard. Refer to international standard IEC 60825 for details.

The Renishaw AM250/AM400 in normal operation with the build chamber door closed, 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 skin and may also present a fire hazard.

7.1 AM250 laser warning labels

On AM250 systems supplied prior to 2016 – Class 2 General classification label inside the chamber (Figure 3). To reference the targeting laser, this is not affected by the door interlock system.

M-5774-0680

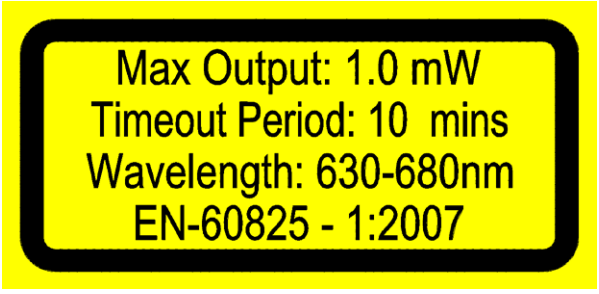
Figure 3 General classification label

On AM250 systems supplied from 2016 and retrofitted to systems supplied before 2016 – Class 3R Custom laser specific label positioned inside the chamber on the right hand side recoater cover (Figure 4).

M-5774-0691

Figure 4 General classification label

Class 2 Custom laser specific label detailing the Class 2 targeting laser positioned directly below the Class 2 label on the right hand side recoater cover inside the chamber (Figure 5).



M-5774-0425

Figure 5 Laser specific label

Laser warning triangle to be displayed on the top door (Figure 6).

M-5774-0684

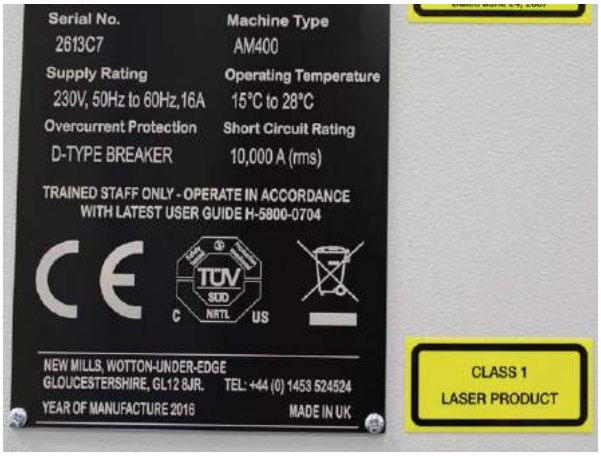
Figure 6 Laser warning triangle

Class 4 Interlocked housing label to be added to the header, placed in line with the outer edge of the top door (Figure 7).

M-5774-0682

Figure 7 Interlocked housing label

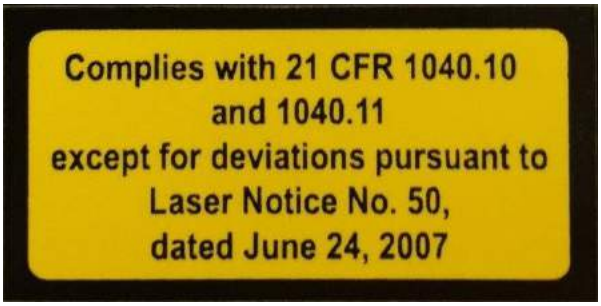
Class 1 general classification label, during normal operation with the system door closed. Fitted to the right of the serial plate, aligned with the bottom edge (Figure 8).



M-5774-0681

Figure 8 General classification label

Label detailing the conformance with 21 CFR 1040.10 and 1040.11. Fitted adjacent to rear serial plate aligned with tope edge (Figure 9).



M-5774-0424

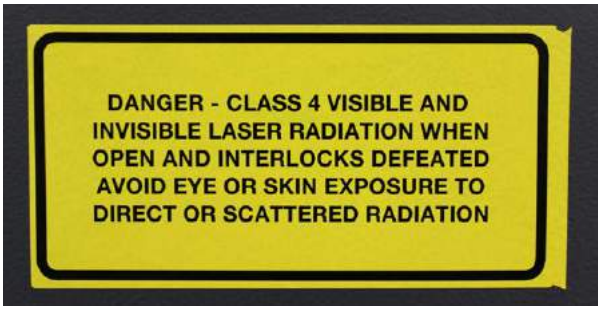
Figure 9 Compliance label

Class 4 Protective housing labels fitted to the right of the silo. Must be placed above the level of the silo flange to allow it to be seen before or after removing silo removal (Figure 10).

M-5774-0682

Figure 10 Protective housing label

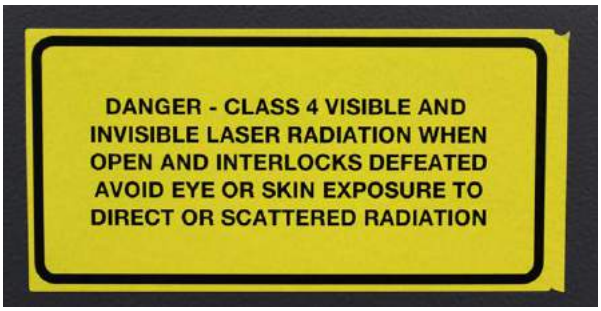
Class 4 Protective housing labels, displayed in line with the right edge of the silo seal plate (Figure 11).



M-5774-0682

Figure 11 Protective housing label

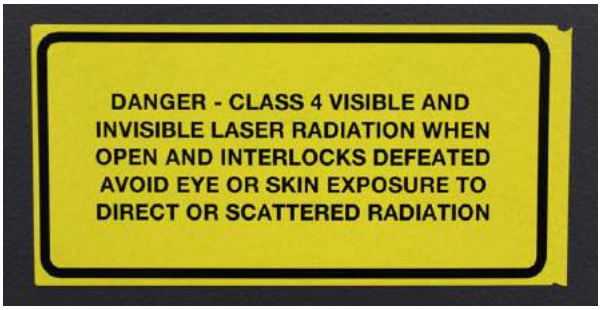
Class 4 Protective housing labels, fitted in between the two fans closest to the front of the system, directly on the top cover (Figure 12).



M-5774-0682

Figure 12 Protective housing label

Class 4 Protective housing labels, fitted by the light aperture under the top cover (Figure 13). In clear line of sight avoiding any cabling.



M-5774-0682

Figure 13 Protective housing label

7.2 AM400 laser warning labels

Class 3R General classification label inside the chamber (Figure 14). To reference the targeting laser, this is not affected by the door interlock system.

M-5774-0691

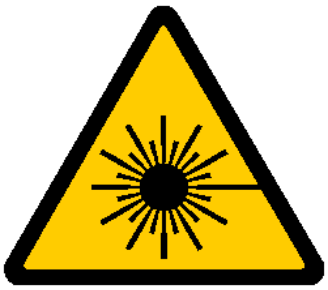
Figure 14 Protective housing label

Class 3R Custom laser specific label detailing the Class 3R targeting laser positioned directly adjacent to the Class 3R label on the right hand side recoater cover inside the chamber (Figure 15).

M-6252-0235

Figure 15 Protective housing label

Laser warning triangle to be displayed on the top door (Figure 16).



M-5774-0684

Figure 16 Laser warning triangle

Class 4 Interlocked housing label to be added to the right hand door surround, placed in line with the top edge of the build chamber door (Figure 17).

M-5774-0682

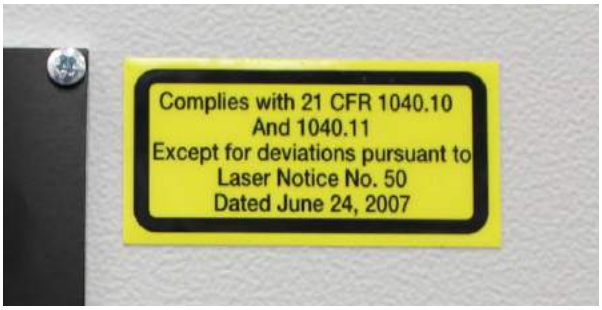
Figure 17 Interlocked housing label

Class 1 general classification label, during normal operation with the system door closed. Fitted to the right of the serial plate, aligned with the bottom edge (Figure 18).

M-5774-0681

Figure 18 General classification label

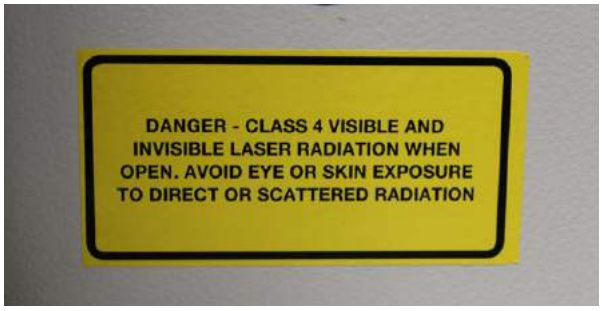
Label detailing the conformance with 21 CFR 1040.10 and 1040.11. Fitted adjacent to rear serial plate aligned with tope edge (Figure 19).



M-5774-0424

Figure 19 Compliance label

Class 4 Protective housing labels fitted to the right of the silo. Must be placed above the level of the silo flange to allow it to be seen before or after removing silo removal (Figure 20).



M-5774-0682

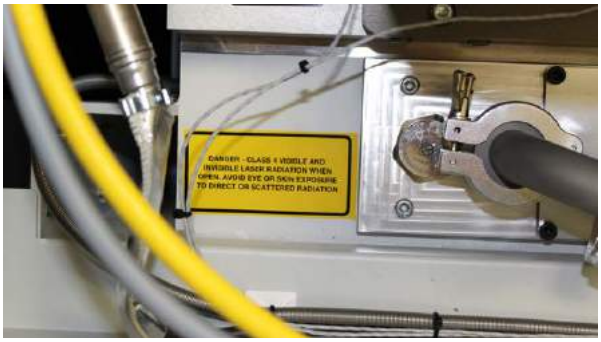
Figure 20 Protective housing label

Class 4 Protective housing labels, displayed in line with the right edge of the silo seal plate (Figure 21).

M-5774-0682

Figure 21 Protective housing label

Class 4 Protective housing labels, fitted on the left hand end of the optical module, underneath the top cover (Figure 22).



M-5774-0682

Figure 22 Protective housing label

Class 4 Protective housing label, fitted to the top of the of the optical module under the top cover (Figure 23).

M-5774-0682

Figure 23 Optical module housing label

Class 4 Protective housing label, fitted to the end of the of the optical module under the top cover (Figure 24).

M-5774-0682

Figure 24 Optical module housing label

Class 4 Protective housing label, fitted to the lower end of the of the optical module under the top cover (Figure 25)

M-5774-0682

Figure 25 Optical module housing label

8 General safety instructions

Risk assessments have been carried out to ensure that the Renishaw AM250/AM400 operates in a safe manner under normal defined operating conditions.

The Renishaw AM250/AM400 conforms to the relevant European standards and legislation in force at the time that the equipment was manufactured.

8.1 What to do in an emergency

In case of emergency, immediately press the Emergency Stop button located on the front panel of the system as shown, (Figure 26).

Figure 26 Emergency Stop button location on the front panel of the system

The Renishaw AM250/AM400 also conforms to UL 508A:2010 accredited by TÜV SÜD America Inc.

8.2 Normal operation

The Renishaw AM250/AM400 may only be started up from the area directly in front of the touch screen. Starting the system from any other location is unsafe.

During equipment and ancillary equipment operation, no safety devices may be removed or disabled.

The operating staff must ensure that no unauthorised persons enter the working area of the system, if it is unsafe to do so.

8.3 Training

Training is included in the scope of supply of the Renishaw AM250/AM400, unless the user indicates that no training is required, for instance where a local Renishaw approved trainer already exists.

WARNING: OPERATION OF THE RENISHAW AM250/AM400 IS ONLY PERMITTED BY OPERATORS WHO HAVE COMPLETED A RENISHAW APPROVED TRAINING PROGRAM.

8.4 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 and filters, must be done in accordance with the relevant Safety Data Sheets and 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 ATEX, DSEAR or the equivalent local guidelines. Disposal of waste product, including process emissions and unused waste powder, must be in accordance with local regulations for hazardous waste. See Section 13.19 "Disposal of waste material".

8.5 Personal Protective Equipment

Renishaw recommends that full personal protective equipment is worn when handling metal powder, a minimum of:

- Gloves/gauntlets
- Eye protection
- Full face respirator (conforming to EN143 Type P3+A1)
- Toe protection safety shoes
- ESD dissipative safety shoes (Essential for sieve room ATEX zone, recommended for all areas)
- 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.

If furnace has been specified, heat resistant gauntlets are required.

WARNING: IT IS THE RESPONSIBILITY OF THE END USER TO ENSURE THE CORRECT PERSONAL PROTECTIVE EQUIPMENT IS AVAILABLE FOR EVERY OPERATOR, IT IS WORN CORRECTLY AND WHERE NECESSARY, IT IS MAINTAINED.

Wash any metal powder contaminated clothing separately from other clothing.

Figure 27 Example of personal protective equipment

WARNING: PERSONAL PROTECTIVE EQUIPMENT USED IN THE SIEVE ROOM MUST ALSO BE ATEX RATED (FOR EXAMPLE BATTERY OPERATED RESPIRATORS).

WARNING: WEAR PROTECTIVE EYEWEAR, FULL FACE RESPIRATOR (CONFORMING TO EN143 TYPE P3+A1) 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.

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

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.

Wash hands thoroughly with water and soap after disposal.

Wash any contaminated clothing separately from other clothing.

8.6 Correct usage

The Renishaw AM250/AM400 is solely intended 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. Materials vary, but broadly the requirements are a particle size distribution of 15 µm to 45 µm with a mass-median-diameter (d_{50}) of 26 µm.

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 AM250/AM400 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 specification of the glass panel fitted to the door on the AM250/AM400 system, this must be risk assessed and the risks understood before using the non-Renishaw powder.

8.7 Improper use

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

1. 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.
2. The removal of system components and/or the operation of system components in a position other than the one prescribed for them.
3. Warning and safety instructions not properly maintained.
4. Modifications to hardware components that have not been authorised by Renishaw.
5. Modifications to software elements that have not been authorised by Renishaw.
6. Operation without argon shielding gas.
7. Disabling the safety devices.

8.8 Handling of metal powders

WARNING: ALWAYS RISK ASSESS THE HANDLING OF METAL POWDERS, INCLUDING BUT NOT RESTRICTED TO: CAREFUL EXAMINATION OF THE APPROPRIATE SAFETY DATA SHEET, THE PROCESSES THAT WILL BE FOLLOWED, APPLICABLE LEGISLATION, LOCAL RULES, ETC.

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.

This ability to rapidly oxidise imparts the need for careful handling, as the potential for fire exists, because the oxidation of the powders gives off heat and, in some cases, explosive gas and is therefore

potentially volatile and self-sustaining. Avoid disturbing the powder, particularly in an oxygen rich atmosphere. Risk assess any powders by careful examination of the appropriate Safety Data Sheet.

8.9 Toxicity/personnel exposure

Some metal powders may be harmful to health. This can only be ascertained by consulting the Safety Data Sheet and once again going through the risk assessment procedure and taking note of the guidance and procedures. In general, metal powders create a family of hazards (harmful or not), for example:

1. 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/m^3 (WEL 8-hr limit). The recommended Workplace Exposure Limit will be indicated on the Safety Data Sheet for each respective powder.

2. Eye contact may cause irritation and burning. In the event of such exposure, the procedure indicated on the Safety Data Sheet should be followed.

3. Similarly, if skin is exposed, the procedure indicated in the Safety Data Sheet should be followed.

4. If large quantities of powder are inhaled, the procedure indicated in the Safety Data Sheet should be followed.

8.10 Flammability

Metal powders burn rapidly and at elevated temperatures and can produce very 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.

8.11 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 Sheet 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 system.

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, 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 DUST CLOUD.

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

WARNING: USING WATER ON SOME TYPES OF BURNING METALS MAY RESULT IN THE RELEASE OF EXPLOSIVE HYDROGEN GAS.

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.

8.12 Handling and processing

- Avoid contact of metal powders with potential ignition sources (for example flames or sparks).
- Spills – see Section 8.14 "Spills".
- Ensure that any vacuuming of powder is kept to a minimum quantity – 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 8.14 – "Spills". Only ever use an ATEX vacuum cleaner (wet separator) 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.
- Metal powders may be subject to export control regulations, which may restrict shipment to some countries.

8.13 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.

8.14 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 brush into a metal receptacle (anti-static dustpan and brush).

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

WARNING: DO NOT USE COMPRESSED AIR TO CLEAN-UP SPILLS OF METAL POWDER.

8.15 Metal powder safety checklist

- 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 and USA 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:
    a. Fuels
    b. Strong oxidising agents
    c. Steam
    d. Oils
    e. Grease
    f. 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 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 (SOPs) for all aspects of metal

powder handling and processing, including proper risk assessment, Control of Substances Hazardous to Health (COSHH) assessment or similar local equivalent, 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 spill clean-up and waste disposal for metal powder?
- Is the ancillary equipment, such as an ATEX vacuum cleaner (wet separator) and powder sieve, approved for use with the materials in use?

This checklist along with any other documents relating to risk management should be stored in your organisations Explosion Prevention Document.

8.16 Residual dangers, maintenance and protective measures

Ensure that local risk assessments have been carried out to ensure that the Renishaw AM250/AM400 system operates in a safe manner under normal defined operating conditions.

Ensure that the risk assessments are revised regularly, 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.

8.17 Explosion prevention document

Renishaw recommend that you develop and maintain an Explosion Prevention Document in line with the applicable local legislation in the geographic area where the AM250/AM400 is located. In the absence of applicable local legislation, Renishaw recommend 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. It is recommended that an Explosion Prevention Document includes the following as a minimum:

- Identify potentially explosive atmospheres
- Information on adequate measures taken
- Prepare a list and diagrams of ATEX zoning
- Operational and maintenance measures to maintain a safe working environment

9 Safety during maintenance

The following is intended as a general guide. However, it may not be exhaustive. It is the responsibility of the end user to ensure that any maintenance work is conducted in a safe manner.

WARNING: THERE IS THE POSSIBILITY OF PERMANENT EYE DAMAGE AND SERIOUS INJURY WHEN EXPOSED TO LASER LIGHT.

WARNING: MAINTENANCE PERSONNEL MUST FOLLOW THE APPROPRIATE SAFETY PROTOCOLS WHEN MAINTAINING THE SYSTEM, INCLUDING WEARING THE RELEVANT PERSONAL PROTECTIVE EQUIPMENT AND FOLLOWING WARNINGS.

9.1 Guide to general maintenance

Maintenance work may only be carried out by qualified technicians who are trained to work on the Renishaw AM250/AM400.

The following statements cover general advice for users when preparing systems for scheduled service visits.

- Ensure that the system is fully cleaned and free from waste powder and other process by-products captured in the filter system.
- Before maintenance starts, carry out a risk assessment to determine what actions are necessary to complete the work safely.
- Wear the correct personal protective equipment for the work being undertaken and restrict access to the working area.
- Isolate at the mains power supply by turning the main switch to the 0 or OFF position and lock off with a personal padlock. Attach a visible warning sign to indicate that the panel is isolated. Carry out safe isolation procedure checks in accordance with IEE standards.
- Isolate the supply of argon. This is used to operate valves and to provide the gas shielding blanket.
- Ensure that all equipment elements that become hot during operation have cooled down to room temperature.
- Allow time for the power supply units to drain.
- Ensure that adequate hoisting devices and load-bearing equipment are on hand for the replacement of larger equipment parts.

- Cordon off access to the work area of the system.
- Replace worn or damaged parts using only original replacement parts supplied by Renishaw.

9.2 Work on electrical equipment

The following points must be observed when working on live electrical equipment:

- Work on electrical equipment must only be carried out by qualified electrical technicians who are trained to work on the Renishaw AM250/AM400.
- It is generally considered safe to work on isolated equipment only after carrying out a safe isolation procedure in accordance with IEE standards.
- Check electrical equipment regularly. Retighten loose connections and immediately replace any damaged cables or wires.
- Always keep the switch cabinet and all power supply units closed. Access to these is only permitted for authorised persons with a key or special tool.
- Never clean electrical devices with water or similar liquids.

WARNING: NEVER WORK ON LIVE EQUIPMENT. FAILURE TO OBSERVE THIS RULE COULD RESULT IN INJURY OR DEATH TO INDIVIDUALS AND THIRD PARTIES BY ELECTROCUTION.

WARNING: THE ELECTRICAL ENCLOSURE MUST REMAIN LOCKED SHUT DURING NORMAL OPERATION. THE KEY MUST BE HELD BY A MAINTENANCE TECHNICIAN OR SIMILAR SUPERVISOR.

9.3 Thermal hazards

If scheduled maintenance work is to be undertaken, 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 maintenance is to be carried out.

WARNING: HOT SURFACES CAN CAUSE INJURY. TAKE CARE WHEN USING THE GLOVE BOX TO ACCESS THE SYSTEM CHAMBER.

9.4 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 ≤ 43 °C (≤ 109 °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 and method statements for maintenance work should identify any latent hazards and the steps required to nullify them.

9.5 Hazards due to unexpected malfunctions

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.

WARNING: SERIOUS INJURY MAY RESULT FROM UNEXPECTED SYSTEM MOVEMENT.

9.6 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 ATEX area zone classification will define the risk of an explosive event.

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.

9.7 Identifiable ignition sources

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

Figure 28 AM250/AM400

10 Technical specification

10.1 Technical specification

Technical specifications may change from time to time. Renishaw reserves the right to change any technical specification at any time without prior notification. Any specification not listed in the table below is available on request by using the contact details indicated earlier.

For the Site preparation guide refer to H-5800-0838 or contact your local Renishaw office.

All dimensions are quoted length × width × height.

Dimensions without accessories – AM250/ AM400	853 mm × 1 700 mm × 2 115 mm (33.6 in × 66.9 in × 83.3 in)
Height including fill bottle – AM250/AM400	2 500 mm (98.4 in)
Size of build chamber (X × Y × Z)	250 mm × 250 mm × 300 mm (10 in × 10 in × 12 in)
Typical maximum build envelope (X × Y × Z) (using standard 15 mm / 3/5 in substrate)	248 mm × 248 mm × 285 mm (10 in × 10 in × 11 in)
Minimum pressure in chambers (vacuum)	950 mbar-gauge or 5 kPa (-13.8 psi)
Working pressure in chamber (overpressure)	10 to 20 mbar-gauge or 101 to 202 kPa (0.15 to 0.30 psi)
Power supply	220 V to 240 V, 16 A, 45 to 60 Hz, single phase, or localised via transformer
Data connections	Standard network connection RJ45
Chilled water connection	From chiller
Argon gas supply connection	3/8 in BSP male cone fitting
Dry air supply – AM400 only	10 mm diameter pneumatic tube to air drier, 6 mm diameter from drier to AM400. 1.6 bar to 2.4 bar (23 psi to 35 psi) minimum flow of 10 l/min (0.35 ft3)
Running argon consumption (after initial fill)	10 L/hr to 50 L/hr (0.4 to 1.8 ft^3/hr)
Filling / purge consumption	600 L to 1 500 L (21 ft^3 to 53 ft^3)
Argon quality (greatest permissible impurities)	20 ppm or better (99.998% pure)
Continuous noise level	67 dB
Maximum noise level (temporary)	68 dB

10.2 Oxygen level monitoring within the room

Refer to the Site preparation guide, risk assessments to establish whether or not there is a need for low-level oxygen level monitoring within the room. Argon can be discharged into the room when the chamber doors are opened. Additionally, whilst the system is purging, argon is exhausted to the atmosphere.

The system features an argon exhaust port which may be connected to an external ventilation point, Renishaw do not recommend this. Refer to the Site preparation guide for details of AM250/AM400 system emissions.

WARNING: RENISHAW RECOMMEND THAT A ROOM OXYGEN SENSOR IS INSTALLED.

10.3 Transport and system relocation

If your AM250/AM400 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 transport of the AM250/AM400 should only be carried out following the advice and recommendations of Renishaw plc.

11 Safety precautions

11.1 Laser safety precautions

When using 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 above Class 2.

Under extreme circumstances, it may be necessary for maintenance to be undertaken with laser covers removed. If so, the requirements of laser Class 4 must be fulfilled. These include:

- Secure the installation room to prevent both unauthorised access and laser light leakage – ensure that all windows are covered, or use laser screening.
- It must be possible to seal off access to the installation room.
- Ensure that the following safety warning is fitted to all access doors to the installation room:

  CLASS 4 LASER IN OPERATION. NO ADMITTANCE.

- Only personnel who have received instructions in laser safety are allowed in the hazard area, wearing complete personal protection equipment, including laser goggles with protection level D L7 for wavelengths in the range of 1000 nm to 1100 nm according to EN 207 (European Norm).
- These guidelines are not intended to be exhaustive, for the most up to date recommendations always refer to the local legislative body, for example the European Committee for Standardisation for EN (European Norm) standards, or Laser Institute of America for ANSI (American National Standards Institute) standards.

11.2 Fire precautions

Do not place yourself at risk. In all cases when tackling a fire, the first action is to call the emergency services. See section 8.11 – "Fire-fighting".

Renishaw recommends that specialist fire-fighting advice is sought before commencing operation of the system.

Place the following safety warning on all access doors to the installation room:

OPEN FLAMES, SMOKING AND FIRE ARE PROHIBITED

11.3 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: PROTECTIVE GLOVES, FULL FACE RESPIRATOR (TO EN143 TYPE P3+A1), EYE PROTECTION, ESD SAFETY SHOES AND COTTON OR FIRE RETARDANT OVERALLS WITH FULL LENGTH SLEEVES (MADE OF STATIC-DISSIPATIVE MATERIALS) SHOULD ALWAYS BE USED WHEN EXPOSED TO METAL POWDER.

WARNING: ALWAYS IDENTIFY AND LABEL HAZARDOUS METAL POWDERS.

- All metal powders are 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 sealed dry container, damp or humid power 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 electrostatic 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. This could cause an explosive cloud to form.
- Do not brush combustible metal powders for long distances, as this could cause electrostatic charges to be formed.
- We recommend the following safety equipment:
- ATEX vacuum cleaner (wet separator), 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.

11.4 Inert gas safety

WARNING: THE CONCENTRATION OF INERT GAS IN THE AMBIENT AIR NEEDS TO BE MONITORED AND LOW OXYGEN CONCENTRATION (<19.5%) INDICATED BY A VISIBLE AND AUDIBLE WARNING DEVICE.

The Renishaw AM250/AM400 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 AM250/AM400 has been qualified using argon gas only. As a consequence of this low gas consumption, our recommendation is to use argon gas, which offers the additional benefit of being compatible with materials that are nitrogen reactive.

WARNING: IT IS POSSIBLE THAT NITROGEN GAS MAY GIVE YOU BUILD RESULTS WHICH ARE MORE SUITABLE FOR YOUR ADDITIVE MANUFACTURING APPLICATION. THE AM250/AM400 HAS BEEN QUALIFIED USING ARGON GAS AND RENISHAW RECOMMEND THE USE OF ARGON GAS DURING BUILDS. THE USE OF NITROGEN IN THE AM250/AM400 IS AT THE RISK OF THE END USER OF THE AM250/AM400 SYSTEM.

A small amount of inert gas is emitted from the sieving station and AM250/AM400 system when in use. On the AM250/AM400 system, it is possible to connect the argon vent port to a connection outside the building to deal with gas emitted whilst the working chamber is being prepared.

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 room is well ventilated in accordance with the guidance in the installation section of this manual and also in accordance with local regulations.

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.

11.5 Build plate materials

Ideally all build plates should be indelibly marked (for example engraved or stamped) on the edge of the plate to indicate their material composition.

Plates are to be cleaned-up after use by grinding, milling or turning. The cleaned-up plates should maintain a tolerance of 50 µm for flatness and parallelism over their thickness, and a surface finish of up to 1.6 µm Ra (ground finish).

It is particularly important to ensure that the underside of the build plate is not convex, as this can have a detrimental effect on the flatness of the upper working face when installed in the system. This can lead to failed builds because of uneven powder distribution on the initial layers and poor adhesion to the plate.

After machining, all cutting fluid residue must be removed using an appropriate cleaning medium. Normally ethanol or isopropanol is sufficient.

Build plate thickness must be measured prior to final fixing onto the build table. Failure to input the correct thickness value may result in damage to the system or process inconsistency.

Depending on the application a build plate thicker than standard may be required, to ensure the internal stress in the part is adequately resisted – this is typically only when very large and particularly dense parts are fabricated. If in doubt contact the applications team.

See Appendix A "AM250/AM400 build plate drawings" for standard build plate drawings, and Appendix B "Part numbers of spare parts" for build plate part numbers.

Figure 29 AM250/AM400

12 Overview of system features

12.1 AM250/AM400 front

Figure 30 AM250/AM400 front

1	Process chamber door	7	Laser and PC door
2	Lower door	8	Lockable glove hatch
3	Emergency Stop button – see Section 13.1	9	Chamber access gloves
4	Operator touch screen interface (HMI) – see Section 13.2	10	Main electrical isolator – see Section 13.1
5	Reset button	11	Laser safe viewing window
6	Electrical access panel	12	Adjustable feet

12.2 Left hand user access door AM250/AM400

12.2.1 AM250 with safe change filter

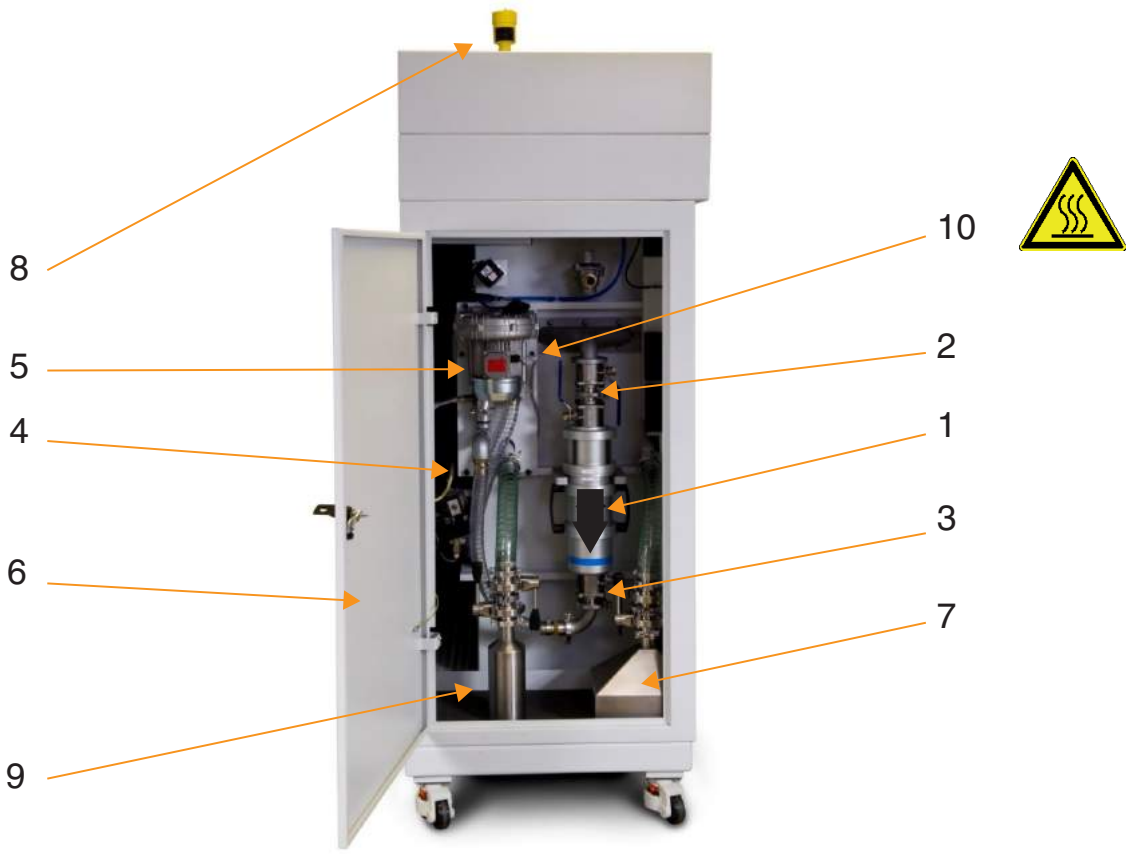


Figure 31 Left hand user access door AM250 safe change filter

1	Removable safe change filter	6	Left hand access door for safe change filter
2	Upper safe change filter isolation valve (V4)	7	Large overflow bottle
3	Lower safe change filter isolation valve (V5)	8	Powder level sensor
4	Argon connection to system circuit	9	Small powder bottle
5	Gas recirculation pump	10	Oxygen sensor – Warning hot surface

12.2.2 AM250/AM400 with large safe change filter

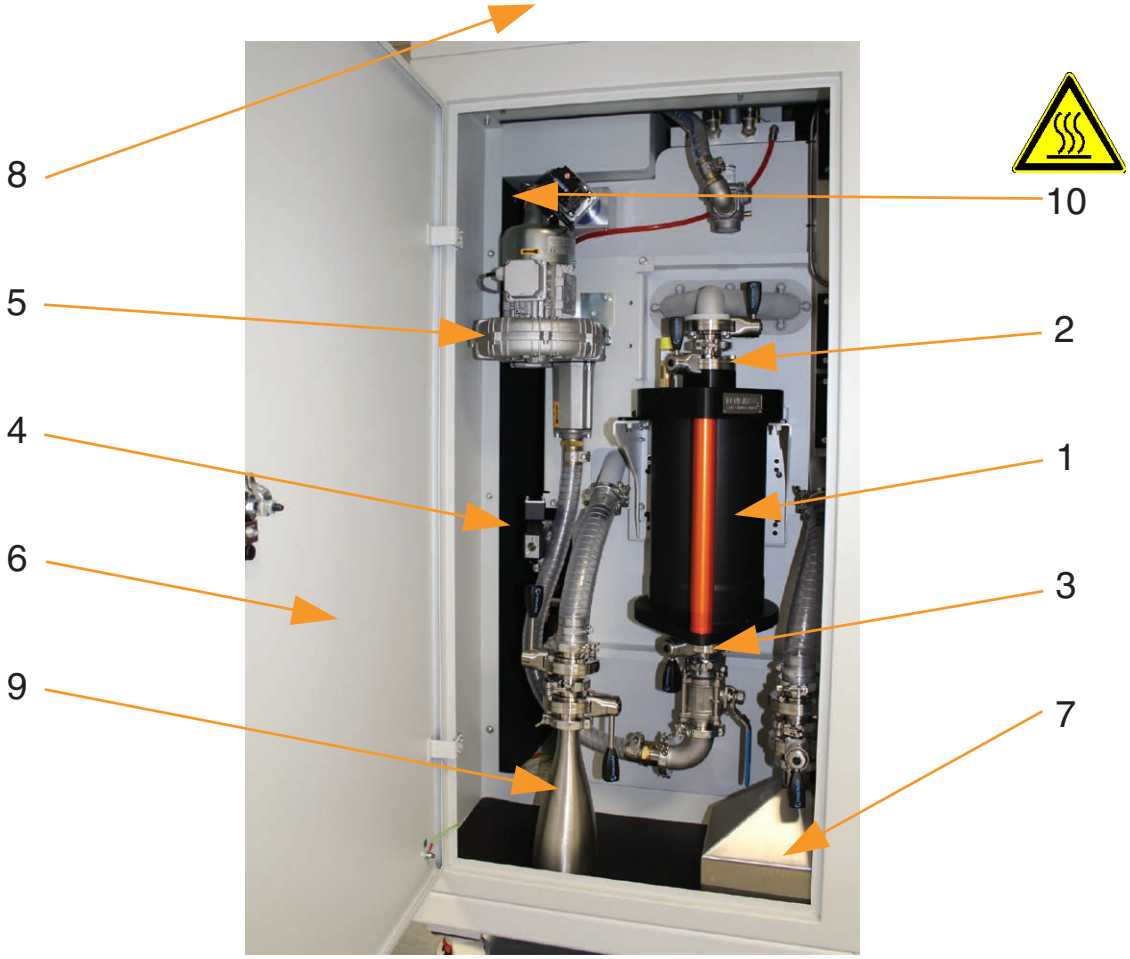


Figure 32 Left hand user access door AM250/AM400 with large safe change filter

1	Removable large safe change filter	6	Left hand access door for large safe change filter
2	Upper large safe change filter isolation valve (V4)	7	Large overflow bottle
3	Lower large change filter isolation valve (V5)	8	Powder level sensor (on top of AM250/AM400 system - not shown)
4	Argon connection to system circuit	9	Small powder bottle
5	Gas recirculation pump	10	Oxygen sensor – Warning hot surface

12.3 Keys and user accessibility

There are three access areas:

- Trained operator – the glove box and left hand user access door (powder filter).
- Trained operator – the panel housing the laser, the laser key, and the operating PC enclosure key.
- Maintenance / trained electrician – the three electrical panels.

Keys are provided to access the areas above.

The electrical enclosures must remain locked when the system is in operation. Keys should only be allocated to personnel who have received adequate training to operate the system.

WARNING: ISOLATE SUPPLY BEFORE OPENING COVER. ELECTRICAL ENCLOSURE MUST REMAIN LOCKED, AND ACCESS RESTRICTED TO TRAINED PERSONNEL.

12.4 Valve labels

All valves fitted to the AM250/AM400 system are labelled. The complete list of valves and their locations are as follows:

Serial	Label	Description
1	AV1	Powder bottle filling adaptor valve (Figure 33)
2	A1	Small powder bottle valve (rear overflow, sieve upper and sieve lower) (Figure 34)
3	B1	Large powder bottle valve – front overflow (Figure 35)
4	V1	Silo isolation valve (Figure 36)
5	V2	Rear overflow valve on system pipework (Figure 37)
6	V3	Front overflow valve on system pipework (Figure 38)
7	V4	Upper safe change filter/large safe change filter isolation valve on system outlet pipework (Figure 39)
8	V5	Lower safe change filter/large safe change filter isolation valve on system recirculation pipework (Figure 40)
9	F1	Upper safe change filter/large safe change filter isolation valve on filter assembly (Figure 41)
10	F2	Lower safe change filter/large safe change filter isolation valve on filter assembly (Figure 42)
11	S1	Sieve upper valve (Figure 43)
12	S2	Sieve lower valve (Figure 44)
13	IV1	Doser isolation valve (Figure 45)

Figure 33 1 – Powder bottle adaptor fill valve – AV1

Figure 34 2 – Small powder bottle (rear overflow, sieve upper and sieve lower) – A1

Figure 35 3 – Large powder bottle valve – front overflow – B1

Figure 36 4 – Silo fill valve – V1

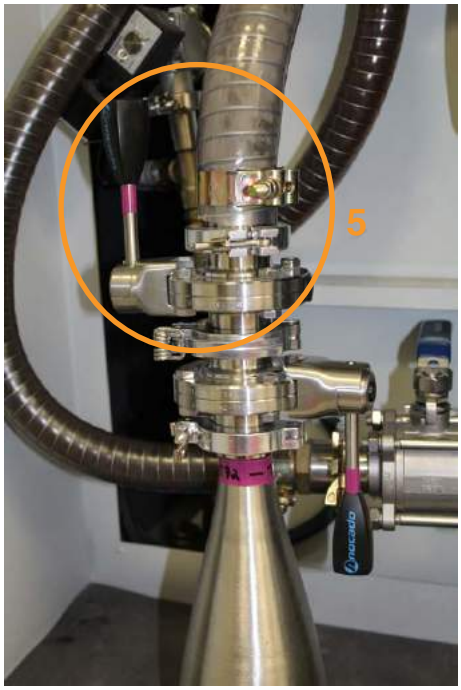


Figure 37 5 – Rear overflow valve on system pipework – V2

Figure 38 6 – Front overflow valve on system pipework – V3

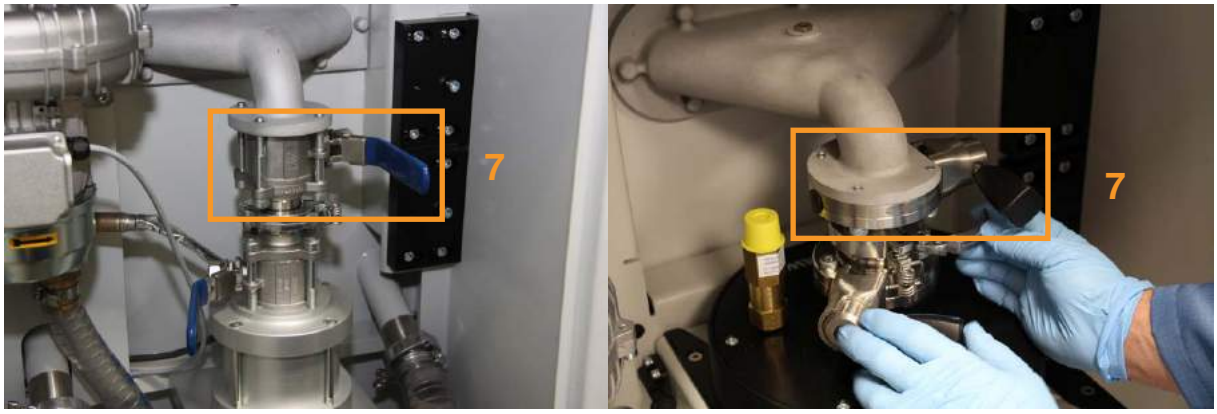


Figure 39 7 – Upper safe change filter/large safe change filter isolation valve on system outlet pipework – V4

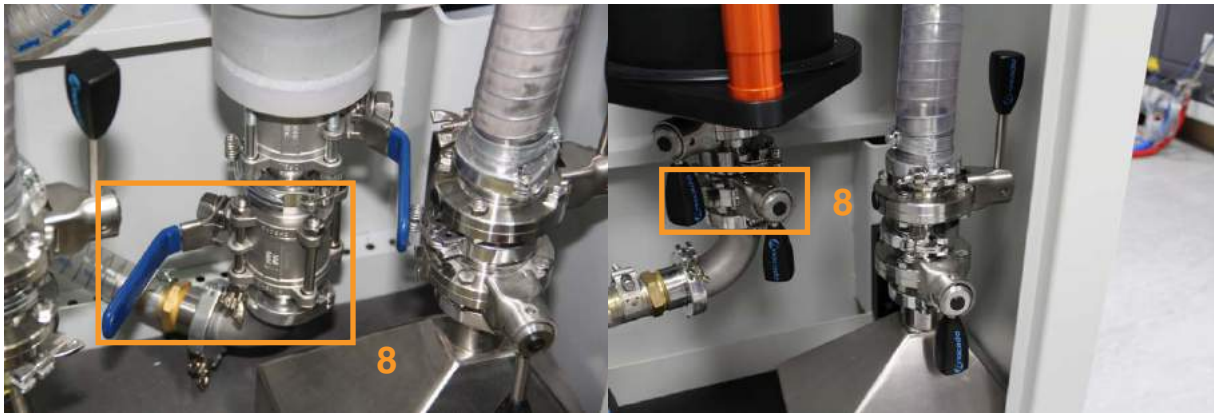


Figure 40 8 – Lower safe change filter/large safe change filter isolation valve on system recirculation pipework – V5

Figure 41 9 – Upper safe change filter/large safe change filter isolation valve on filter assembly – F1

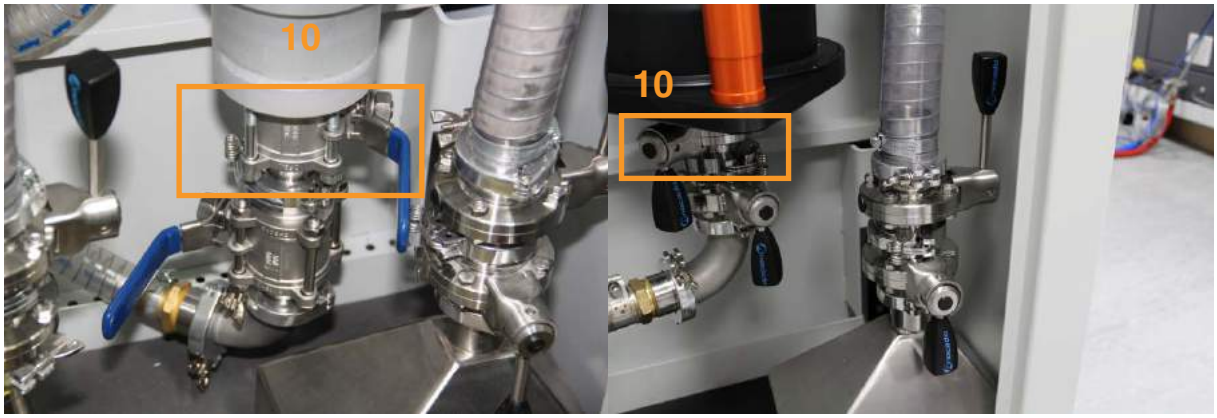


Figure 42 10 – Lower safe change filter/large safe change filter isolation valve on filter assembly – F2

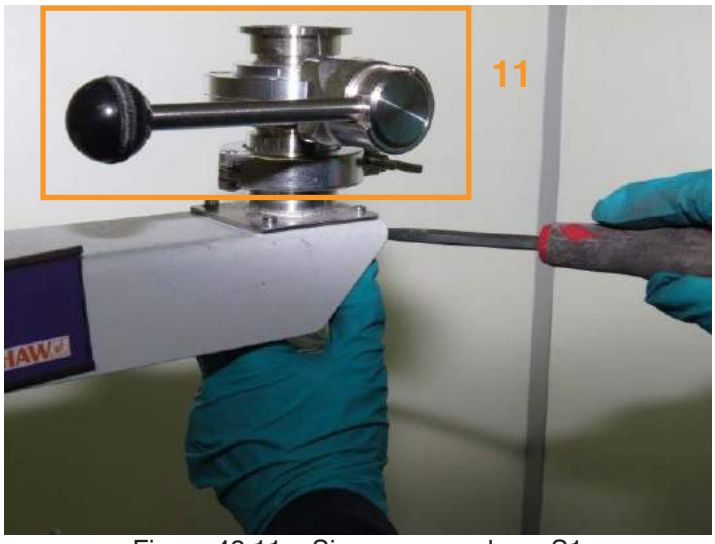


Figure 43 11 – Sieve upper valve – S1

Figure 44 12 – Sieve lower valve – S2

Figure 45 13 – Doser isolation valve – IV1

12.5 Clamp labels

All clamps fitted to the AM250/AM400 system are labelled. The complete list of clamps and their locations are as follows:

Serial	Label	Description
1	L1	Silo fill clamp (Figure 46)
2	L2	Silo isolation valve to silo lid clamp (Figure 46)
3	L3	Powder level sensor to silo lid clamp (Figure 46)
4	L4	Safe change filter/large safe change filter upper clamp (Figure 47)
5	L5	Safe change filter/large safe change filter lower clamp (Figure 48)
6	L6	Filter waste pipe inlet clamp (Figure 49)
7	L7	Filter waste pipe outlet clamp (Figure 50)
8	L8	Rear overflow upper clamp (Figure 51)
9	L9	Rear overflow flexi pipe to rear overflow isolation valve clamp (Figure 52)
10	L10	Rear overflow clamp (Figure 52)
11	L11	Front overflow upper clamp (Figure 53)
12	L12	Front overflow flexi pipe to rear overflow isolation valve clamp (Figure 54)
13	L13	Front overflow clamp (Figure 55)
14	SL1	Small powder bottle to sieve upper isolating valve clamp (Figure 55)
15	SL2	Sieve upper isolating valve to bracket clamp (Figure 55)
16	SL3	Sieve inlet to KF flange adaptor clamp (Figure 56)
17	SL4	Sieve outlet to KF flange adaptor clamp (Figure 57)
18	SL5	Bracket to sieve lower isolation valve clamp (Figure 57)
19	SL6	Sieve lower isolation valve to small powder bottle clamp (Figure 57)

Note: There are a number of worm drive clamps fitted to the AM250/AM400. These are not listed in the table above.

Figure 46 1,2 & 3 – Silo fill, silo isolation valve and powder level sensor clamps – L1, L2 and L3

Figure 47 4 – Safe change filter/large safe change filter upper clamp – L4

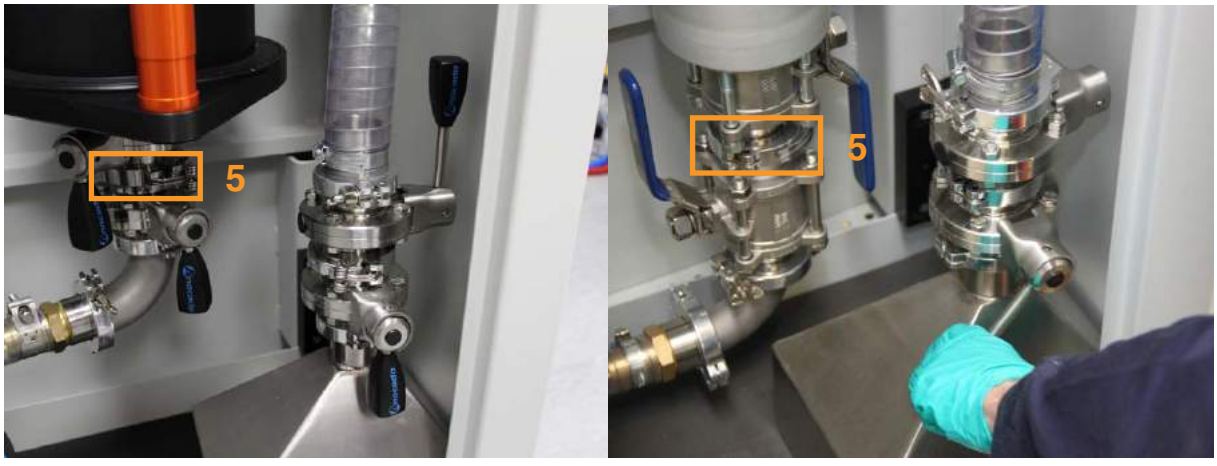


Figure 48 5 – Safe change filter/large safe change filter lower clamp – L5

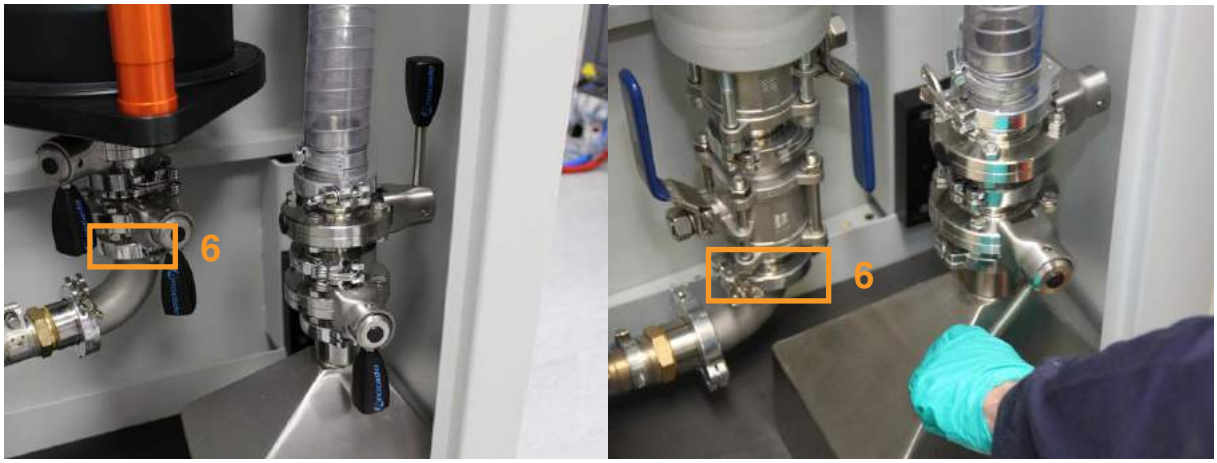


Figure 49 6 – Filter waste pipe inlet clamp – L6

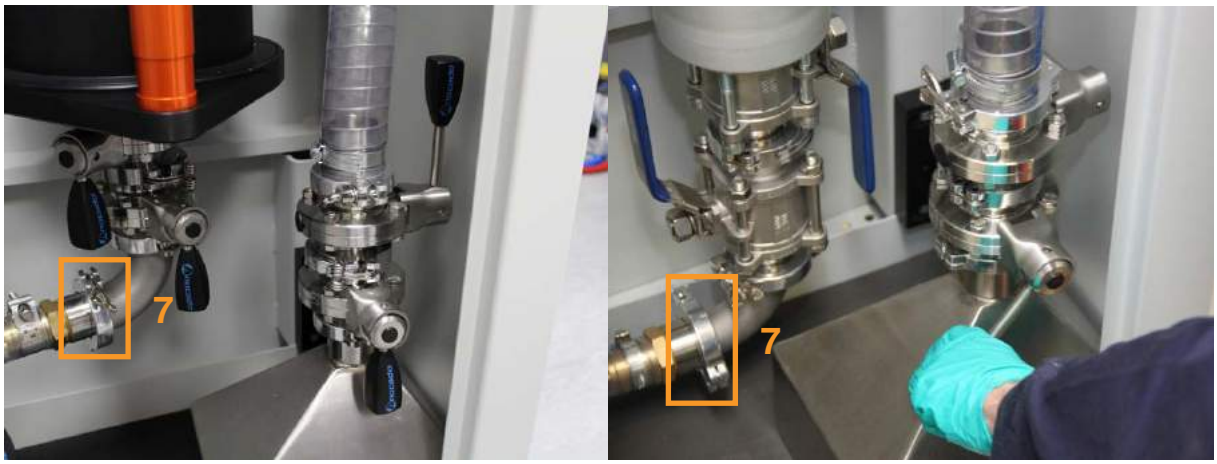


Figure 50 7 – Filter waste pipe outlet clamp – L7

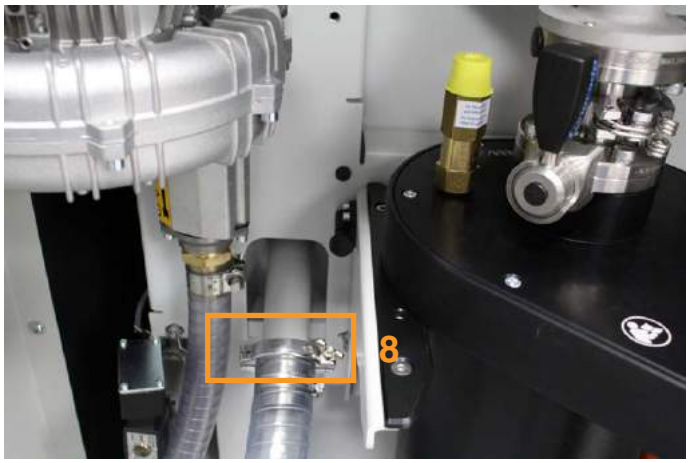


Figure 51 8 – Rear overflow upper clamp – L8

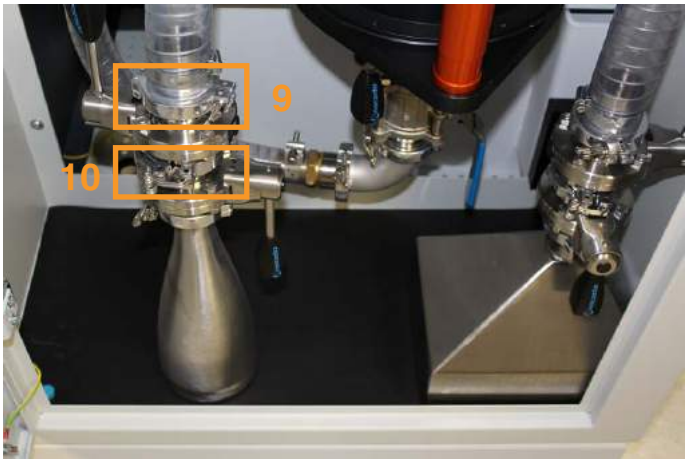


Figure 52 9 & 10 – Rear overflow flexi pipe to rear overflow isolation valve clamp and rear overflow clamp – L9 & L10

Figure 53 11 – Front overflow upper clamp – L11

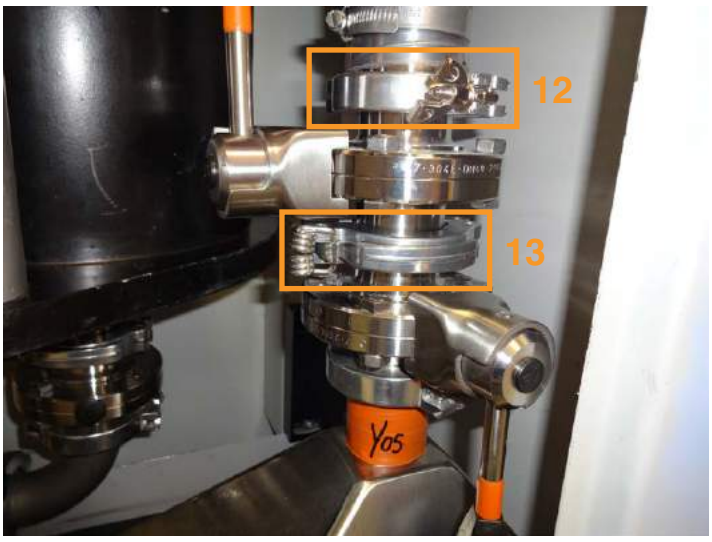


Figure 54 12 & 13 – Front overflow flexi pipe to front overflow isolation valve clamp – L12 and front overflow clamp – L13

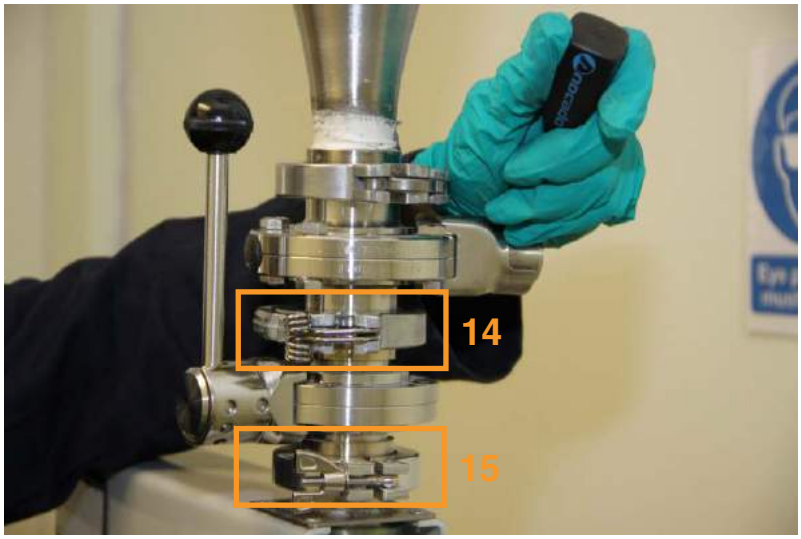


Figure 55 14 & 15 – Small powder bottle to sieve upper isolating valve clamp – SL1 and sieve upper isolating valve to bracket clamp – SL2

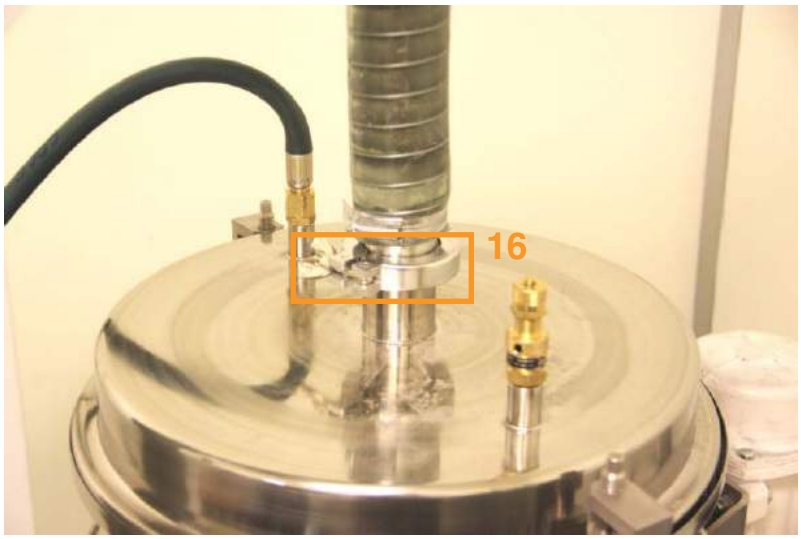


Figure 56 16 – Sieve inlet to KF flange adaptor clamp SL3

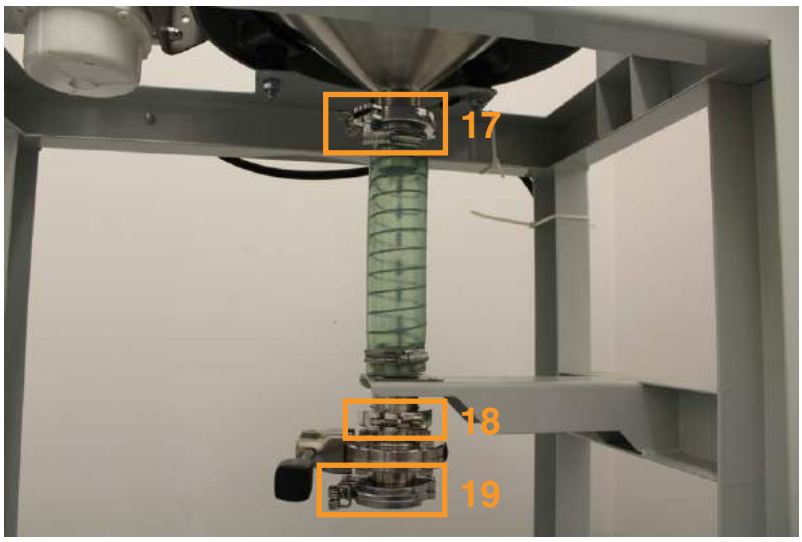


Figure 57 17, 18 & 19 – Sieve outlet to KF flange adaptor clamp – SL4, bracket to sieve lower isolation valve clamp – SL5 and sieve lower isolation valve to small powder bottle clamp – SL6

13 Functional description

13.1 Main switch and Emergency Stop button

The equipment main isolator switch is mounted on the right hand side of the AM250/AM400 cabinet. Switch the main isolator to ON or 1. The controller and the main computer will then begin the start-up routine.

WARNING: OPERATING THE EQUIPMENT MAIN ISOLATOR DOES NOT ISOLATE THE ELECTRICAL SUPPLY TO THE MAINS CONDITIONING MODULE. TO ISOLATE POWER TO THE MAINS CONDITIONING MODULE ISOLATE THE POWER AT THE CUSTOMERS MCB.

Switch on the main regulator for the argon gas located on top of the argon cylinder connected to the equipment. This should be regulated to 1.5 bar (do not exceed 2 bar maximum).

When the controller and the main computer have started, the system is ready for operation.

To operate the equipment, unlatch the Emergency Stop button, situated below the touch screen on the front of the cabinet, by rotating it clockwise. To enable the safety relay, press the blue RESET button next to the Emergency Stop.

Caution: DO NOT leave the Emergency Stop in the latched position for long periods of time.

Caution: Ensure that the laser key switch is in the on position.

Pressing the Emergency Stop button at any point in the cycle will stop the manufacturing process. The laser and mechanical components will be inoperable. The main computer and controller will be available to the operator; however their functionality will be disabled until the alarm messages have been cleared. The argon atmosphere will remain in place to retain a safe inert atmosphere inside the process chamber. If the Emergency Stop is pressed, to enable the safety relay, press the blue RESET button next to the Emergency Stop. The z-axis uses an incremental encoder, with a proximity sensor to provide an accurate home position. Operating the Emergency Stop will require the z-axis home position to be re-taught.

13.2 Touch screen (HMI) and PLC

The Additive Manufacturing build process is controlled from a Human Machine Interface (HMI) touch screen on the front of the AM250/AM400 cabinet. It incorporates a user privilege access system. The level of access will depend on the individual operator's unique login code (up to a maximum of six alphanumeric characters).

The Programmable Logic Controller (PLC) controls the system operation, the mechanical and

monitoring functions of the equipment such as wiper assembly, z-axis, pumps and valves and the selection of the parts for building.

13.3 Main computer

The build and process control software runs on this PC. It is located within the framework of the AM250/AM400 cabinet inside the lower door. In normal use there are no input or output devices for human intervention. The PC will be started and stopped from the PLC system using the PC on/off override buttons.

13.4 Laser

The laser provides the energy source for the AM process. It is located within the framework of the system. Further information about the laser can be obtained from Renishaw upon request.

13.5 Chiller

A chiller (supplied with the system) maintains a stable temperature for the laser and optical system. It is imperative that the chiller is maintained in accordance with the manufacturer's instructions and that a suitable anti-fungal inhibitor is used. See Section 14.1 "Chiller". There are two sizes of chiller, the size of chiller supplied depends upon the AM system supplied.

13.6 Beam aperture protective window

The F-Theta lens focuses the laser beam on to the metal powder surface on the substrate plate housed in the top chamber. For AM250 the lens protective cover should only be cleaned by following the procedure as detailed in section 30.4. For AM250 with PlusPac and AM400 the WPS (Window Protection System) should only be cleaned by following the procedure as detailed in section 30.5.

A cleaning kit is available from Renishaw – see Appendix B "Part numbers of spares" for details of the kit and its contents.

13.7 Viewing window

The main chamber door of the build volume features a viewing window and a protective insert. This meets the standard ANSI Z136.1 – 2007 and is specified to protect against scattered laser radiation for the wavelength used in the AM250/AM400. The viewing port is located in the door of the top chamber and in this application permits a Class 1 laser specification to be achieved.

13.8 Loading metal powder using powder bottles

Metal powder of the correct particle size should be loaded from the supplier's containers into small powder bottles using a mask, gloves and eye protection as detailed in the safety section of this manual.

WARNING: DO NOT LOAD POWDER DIRECTLY FROM THE SUPPLIERS CONTAINER INTO THE AM250/AM400 – POWDER MUST FIRST BE DECANTED INTO A POWDER BOTTLE. DO NOT ATTEMPT TO FILL THE SILO WHILST THE SYSTEM IS PREPARING THE BUILD ATMOSPHERE (DURING THE VACUUM CYCLE).

Figure 58 Decanting adaptor and powder bottle

Decanting reactive materials, such as titanium and aluminium, should be done in an inert atmosphere – inside an argon glove box.

Alternatively, Renishaw is able to provide adaptors for a range of powder containers that link a supplier's container to a KF40 adaptor. (These are designed and manufactured on request depending on the supplier's container type.)

The Renishaw powder bottles are sealed with a butterfly valve and can be used to load material into the system. The large powder bottle is a large capacity vessel designed to collect excess powder. It is located in the lower part of the side access door alongside the safe change filter. To empty, connect it to a small powder bottle to decant material. Only the small powder bottle (part number 796531000) should be fitted to the sieving station following a build.

WARNING: THE FULL LARGE POWDER BOTTLE IS HEAVY (UP TO 40 KG (88 LB) DEPENDING ON MATERIAL) – USE SUITABLE MANUAL HANDLING PROCEDURES.

13.9 Loading the powder silo

The AM250/AM400 features a removable silo arrangement; this can be exchanged for a cleaned or powder-specific unit when changing powders. An overhead crane or gantry with a minimum lifting capacity of 200 kg is required when removing the silo. Renishaw recommend using a Renishaw silo changeover lift part number A-5771-1000, (Figure 59).

Loading powder into the silo requires a small powder bottle to be fitted to the top of the silo. Two valves are required – one to isolate the bottle (A1) and one to isolate the silo (V1).

The silo can be refilled whilst a build is in process, but not until the initial vacuum and inert cycle has completed.

Figure 59 Renishaw silo lift

WARNING: DO NOT ATTEMPT TO FILL THE SILO WHILST THE SYSTEM IS PREPARING THE BUILD ATMOSPHERE (DURING THE VACUUM CYCLE).

13.10 Powder level sensor

The AM250/AM400 is fitted with a Vega powder level sensor. A separate user manual is available for this device. The integration in to the AM250/AM400 gives a reading down to the point at which the silo meets the main chamber. The silo volume is non-linear and, as such, the calibration curve programmed into the sensor incorporates an allowance for this. The system can be configured to pause at a given level via the user interface.

13.11 Powder delivery

The powder delivery mechanism is situated inside the chamber and dispenses a dose of metal powder on to the base of the top chamber process plate. The mechanism can be configured to vary the amount of powder dosed. The percentage dosage can be entered using the HMI touch screen, see Section 27.5 "Setting the dosing percentage".

13.12 Wiper assembly

The wiper assembly, (Figure 60) comprises the wiper arm, pulleys and toothed belts concealed behind sheet metal covers. The wiper traverses the base of the top chamber, distributing a uniform layer of metal powder over the top of the substrate plate. Excess powder is discharged through front and rear apertures in the process plate.

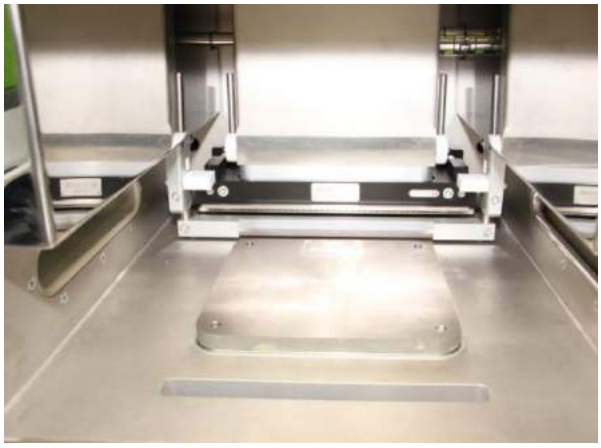


Figure 60 Wiper assembly

13.13 Gas circuit

On the AM250 system gas enters the build chamber from the lower right hand side of the chamber. On AM250 with PlusPac and AM400 gas enters the build chamber from the top left, top right and lower right hand sides of the chamber. It creates a flow of gas directed across the substrate plate. The finest metal powder and soot particles produced during the build process are collected and directed to a port on the left hand side of the top chamber which is connected in turn to a safe change filter/large safe change filter outside the chamber. The filter housing containing the filter element can be accessed through the left hand door, isolated and removed for replacement.

On AM250 systems fitted with PlusPac and on AM400 systems, the gas circuit has additional pipework fitted to the top of the build chamber to more efficiently direct the flow of gas.

On AM250 systems fitted with PlusPac and on AM400 systems, there is an option to control the flow of gas across the build plate when the system is dosing powder. If enabled, flow regulation decreases the output of the recirculation pump whilst the doser is delivering powder into the build chamber and whilst the wiper is distributing this powder across the build plate. Flow regulation is enabled in Level 4 login. The reduction in recirculation output is configurable in Level 2 login, and by default is set to a 50 % reduction. If a value outside the normal range is entered an error message wil be shown.

13.14 Build plate

The build plate is the surface upon which the build process takes place. It is bolted onto the top surface of the table housed in the bottom chamber using M5 cap screws. It then gets covered by progressive layers of metal powder. The powder is selectively melted, fusing it first to the substrate then to the previous layer to create a homogeneous solid component. Each powder type requires a compatible substrate material. See Section 36 Appendix A "AM250/AM400 build plate drawings", for build plate requirements.

13.15 Heating/temperature control

There are heaters built into the table which can be used to heat the substrate plate. The temperature can be set in degrees on the thermostat (170 °C max (338 °F max)) via the HMI touch screen.

13.16 Safe change filter and large safe change filter

The system features a recirculating gas flow across the build area, flowing from right to left. The rate of flow can be altered from the HMI touch screen. The finest metal powder and soot that is emitted from the process is carried by the flow of gas and captured in either the safe change filter or large safe change filter housed in an aluminium cylinder located on the left hand side of the cabinet. AM250 systems will be fitted with a safe change filter. AM250 with PlusPac and AM400 systems will be fitted with the large safe change filter. The filtered inert gas is then re-circulated through the system to maintain extremely low oxygen content. The filter housing can be isolated using the upper and lower valves (V4 and V5) and then removed by releasing the two KF40 flanges.

Following removal of the safe change or large safe change filter housing, it must be made inert by filling with water, and placed into a vented drum full of water and a 5% solution of Hydra-Sol-MAG additive (P-LU08-0004) – see Section 22 – "Safe change or large safe change filter".

Please seek advice from your local waste disposal provider; details of the contaminants for a range of materials can be provided on request.

13.17 Oxygen monitoring sensors

The oxygen levels in the chamber and the gas recirculation circuit are continuously monitored at two separate points in the system gas circuit. If the oxygen level exceeds the maximum value set in the user interface, the system will add inert gas. The process will pause briefly until the required level is achieved.

In practice, oxygen levels are generally maintained well below 500 ppm (parts per million) or 0.05%. The default setting is 1000 ppm (0.1%) before the build will commence, and the upper safe threshold is 5000 ppm (0.5%).

13.18 Dehumidifier – AM400 only

A dehumidifier (supplied with the system) maintains a supply of clean, dry and temperature-controlled air to the AM400. The supply of air is required to cool parts of the optical system on the AM400 laser.

13.19 Disposal of waste materials

WARNING: THE SUBSTANCES INDICATED BELOW MUST BE DISPOSED OF IN A SAFE MANNER. THEY MUST NOT BE ALLOWED TO CONTAMINATE THE ENVIRONMENT.

13.19.1 Metal powders

Disposal of metal powder, whether new, used, or in the form of contaminated components and filters, must be conducted in accordance with the relevant COSHH sheet and/or applicable local legislation.

Wear eye protection, full face respirator (to EN143 Type P3+A1), protective gloves and cotton or fire retardant overalls with full length sleeves (made of static-dissipative material).

Do not allow the dust to form a cloud.

Do not eat, drink or smoke in the vicinity of the AM system.

Wash hands thoroughly with water and soap after disposal.

Wash any contaminated clothing separately from other clothing.

13.19.2 Storage and disposal of waste products

Some process waste is hazardous in nature. This includes materials that are combustible when dry and give off flammable gaseous emissions when mixed with water. Further information on safe working practices is given in this manual, see Section 14.2 "ATEX vacuum cleaner (wet separator)" and Section 22 – "Safe change or large safe change filter". Further information is available on request.

In general, our recommendation is to remove and store waste filters in water and a 5% solution of Hydra-Sol-MAG additive (part number: P-LU08-0004) in well ventilated containers, to await disposal from a suitably accredited organisation accustomed to dealing with hazardous waste.

WARNING: WASTE FILTERS MUST BE STORED IN WATER WITH A 5% SOLUTION OF HYDRA-SOL-MAG ADDITIVE IN A WELL VENTILATED CONTAINER.

14 Ancillaries

14.1 Chiller

14.1.1 Chiller cooling fluid level check

The AM250/AM400 requires a supply of temperature-controlled fluid to keep the optical components at a stable temperature. The chiller is a closed-loop cooling circuit and has a direct communication connection to the system that allows status and warnings to be viewed via the HMI touch screen.

Regular weekly checks are required to ensure that the chiller fluid level is maintained – it should not be allowed to drop below the L mark on the sight glass (Figure 61). The chiller cooling circuit can be filled with either Glycol or Nalco fluid. Using Glycol requires the use of a corrosion inhibitor / fungicide which is available from your local Renishaw office. Glycol is a concentrated solution and is mixed with purified filtered water at a concentration of 25% by volume. Description – Glycol chiller additive. Part number: P-HX04-0001. Nalco is supplied pre-mixed, does not require the use of any additional additives and should only be topped up with pre-mixed Nalco. Description – Nalco chiller additive. Part number: P-HX04-0003. Do not fill above the H mark on the sight glass. Do not mix the chiller fluids.

In addition to this regular inspection, maintenance is required, refer to the recommendations in the manufacturers service manual, see Section 37 "Supplier manuals" for information on the make, model and manufacturer. There are two sizes of chiller, the chiller supplied depends upon the AM system supplied.

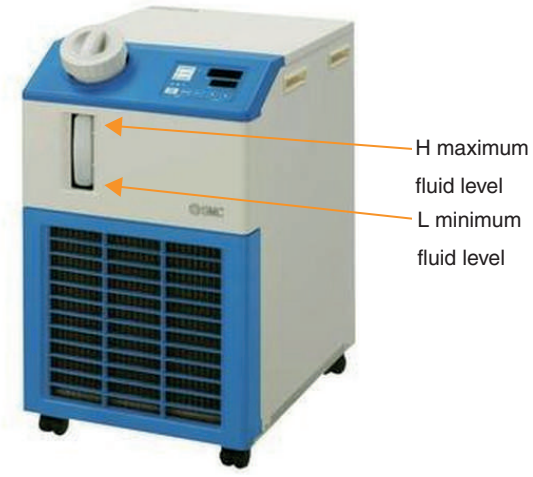


Figure 61 Chiller fill levels

14.1.2 Basic chiller maintenance

The cover for the chiller is held in place by magnetic strips. Release the cover by sliding it downwards and pulling the bottom edge out (Figure 62).

Figure 62 Release cover by sliding down

Use the ATEX vacuum cleaner (wet separator) to vacuum the dust from the chiller filter (Figure 63).

Figure 63 Cleaning the chiller cover

After vacuuming, replace the cover using the magnetic strips at the bottom of the chiller (Figure 64).

Figure 64 Reassemble the cover

The temperature parameters should be checked every two weeks to ensure efficient use of the chiller (Figure 65).

Figure 65 Recommended temperature parameters

Check the fluid levels are within the H (maximum) and L (minimum) markings, (Figure 66). If required top-up with chiller fluid, this is either Glycol or Nalco. Do not mix the chiller fluids together.

- Glycol 25%, (part number P-HX04-0001) mixed with purified filtered water
- Nalco pre-mixed, (part number P-HX04-0003)

Do not fill above the H mark on the sight glass.

To ensure efficient use of the chiller for the AM250/AM400 system, these tasks should be completed on a monthly basis.

Caution: Only mix Glycol with purified filtered water. DO NOT mix Glycol with any other type of water. Do not mix Glycol with de-ionised, de-mineralised, tap or plant water. Nalco is supplied pre-mixed and does not need water adding.

Figure 66 Check fluid level

14.2 ATEX vacuum cleaner (wet separator)

WARNING: DO NOT STORE THE ATEX VACUUM CLEANER (WET SEPARATOR) IN A CLOSED UNVENTILATED SPACE. ALWAYS MAINTAIN THE ATEX VACUUM CLEANER (WET SEPARATOR) IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS. NEVER USE AN INAPPROPRIATE VACUUM CLEANER TO CLEAN AWAY POWDER OR WASTE PRODUCT.

WARNING: IN AREAS WHERE POWDER IS NOT EXPECTED TO BE PRESENT BUT MAY BE PRESENT FOR SHORT PERIODS ALL EQUIPMENT IN THAT AREA (INCLUDING PORTABLE) MUST BE ELECTRICALLY BONDED AND EARTHED. IT IS RECOMMENDED THAT ALL PORTABLE EQUIPMENT IS FITTED WITH STATIC-DISSIPATIVE WHEELS, AND IT IS ALSO GOOD PRACTICE TO GROUND WITH AN EXTERNAL GROUND WIRE. CONSIDER CREATING AN ATEX ZONE 22 OR NFPA 484 IN HANDLING AREAS SUCH AS SIEVING, DECANTING, AND DE-BUILD.

WARNING: VACUUM NOZZLES, HOSES AND FITTINGS MUST BE CONDUCTIVE (ELECTROSTATIC-DISSIPATIVE) AND NON-SPARKING. NEVER USE INSULATING PLASTIC, DOMESTIC NOZZLES, OR MAKE ANY UNAPPROVED MODIFICATIONS. IT IS RECOMMENDED TO CLEARLY MARK ESD VACUUM FITTINGS (WITH YELLOW TAPE AND AN ESD SYMBOL) TO ENSURE THEY CAN NOT BE MIXED WITH NON-ESD PLASTIC FITTINGS.

WARNING: COMPONENTS/SUBSTRATES BEING VACUUMED MUST 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. IT IS RECOMMENDED THAT SUPPLEMENTARY BONDING IS FITTED BETWEEN THE VACUUM AND OBJECT BEING VACUUMED (SUBSTRATE PLATE, BENCH TOP OR AM SYSTEM). RENISHAW OR RUWAC CAN PROVIDE A SUPPLEMENTARY BONDING LEAD (RUWAC PART NUMBER 59803 FOR NA7 OR 68134 FOR NA35).

WARNING: A REGULAR INSPECTION, TESTING, AND MAINTENANCE PROGRAM INCLUDING TESTING OF ELECTRICAL CONTINUITY (BONDING BETWEEN PIECES OF EQUIPMENT) AND EARTHING/GROUNDING (RESISTANCE TO GROUND) MUST BE PUT IN PLACE AND RECORDS KEPT. ESD DISSIPATIVE MATERIALS 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 ENERGIZED ELECTRICAL EQUIPMENT, WHILST THE UPPER RESISTANCE LIMIT (10^8 OHMS) IS SPECIFIED TO ENSURE ADEQUATE CHARGE DISSIPATION.

WARNING: AS MUCH POWDER AS POSSIBLE MUST BE REMOVED WITHIN THE AM250/AM400 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 CAN NOT BE REMOVED USING THE PREVIOUS METHODS. DO NOT USE COMPRESSED AIR FOR POWDER REMOVAL OR CLEANING AS IT WILL GENERATE A DUST SUSPENSION.

WARNING: THESE ACTIONS DO NOT CONSTITUTE A FULL ASSESSMENT OF RISK. USERS MUST SATISFY THEMSELVES THAT THE INSTALLATION STANDARDS AND WORKING PRACTICES ARE SUITABLE. THE FOLLOWING STANDARDS SHOULD BE REFERRED TO: ATEX, NFPA 77, NFPA 484.

The Renishaw AM system requires the use of an ATEX vacuum cleaner (wet separator) to clean away small remnants of material and waste process emissions. These materials are potentially dangerous and the appropriate procedures as detailed in this manual must be observed.

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 (wet separator) is used to extinguish any potential ignition whilst the material is vacuumed.

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 volatile.

    a. To control and mitigate this hazard, the ATEX vacuum cleaner (wet separator) features a ventilation valve which remains normally open when the cleaner is not being used.

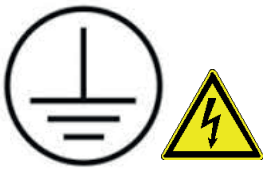
    b. For the ventilation valve to function effectively, it is essential to store the ATEX vacuum cleaner (wet separator) in a well ventilated area.

    c. Use of a 5% solution of Hydra-Sol-MAG additive (P-LU08-0004) in the ATEX vacuum cleaner (wet separator) will help to inhibit the generation of hydrogen.

The Renishaw supplied and approved ATEX vacuum cleaner (wet separator) is a Ruwac NA7 (Figure 34) (earlier installations may also be using the Ruwac NA35).

The manufacturer's user manual for the Ruwac NA7 is supplied, and should be read before use. Key points are listed below:

14.2.1 ATEX vacuum cleaner (wet separator) safety checks



Ensure the ATEX vacuum cleaner (wet separator) is electrically earthed.

< 10^6 Ohms between plug and components.

< 1 MOhm for conductive components.

< 10^8 Ohms for dissipative parts.

Check fluid level is correct before every start-up, and top-up as necessary.

Ensure correct additives are used.

Check the hydrogen ventilation valve(s) work before start-up by pressing and ensuring they spring back (open).

Ensure the ATEX vacuum cleaner (wet separator) is emptied and cleaned after every shift.

These checks must be carried out on both the Ruwac NA35 and NA7 models.

Ensure the ATEX vacuum cleaner (wet separator) is electrically earthed.

Check the earth continuity between each of the components that come into contact with powder against each other. Check the resistance of the plug earthing (largest diameter pin) against the body. If a reading greater than 1 MOhm (open circuit) is detected between any component, the unit must be disassembled and checked.

Ruwac recommends that an insulation tester is used with a voltage of 250 V; however a low voltage multimeter should be sufficient. Renishaw recommends that this is checked at least after every disassembly or weekly if no disassembly occurs.

Ensure the fluid level is checked before every start-up and the correct additives are used.

This can be easily checked through the window of the Ruwac NA7, however the NA35 must be disassembled to check.

Users must have completed the appropriate Renishaw training course before handling oxygen reactive

Figure 67 Ruwac NA7 ATEX vacuum cleaner (wet separator)

metals. Among other recommendations this will specify the need to add a 5% solution of Hydra-Sol-MAG additive (part number P-LU08-0004) to the Ruwac ATEX vacuum cleaner (wet separator).

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 number 792322000). It is essential that foam is not allowed to build up as it will be drawn into the cleaner resulting in corrosion.

Ensure the ventilation valve(s) are checked before start-up

Note that the ventilation valve is designed to close when in use. First, turn off the Ruwac ATEX vacuum cleaner (wet separator). Push the inner disk (Figure 68 and Figure 69). It should move approximately 5 mm and spring back (open) – if no movement is detected the valve is stuck. Immediately quarantine the Ruwac ATEX vacuum cleaner (wet separator) by placing it in a well ventilated area away from possible ignition sources.

Contact Renishaw for replacement parts.

Ensure the ATEX vacuum cleaner (wet separator) is emptied and cleaned after every shift. This will limit the time that the oxygen reactive metal is in contact with water. Waste water must be stored in a vented drum in a well ventilated area (preferably outdoors) until it can be recycled.

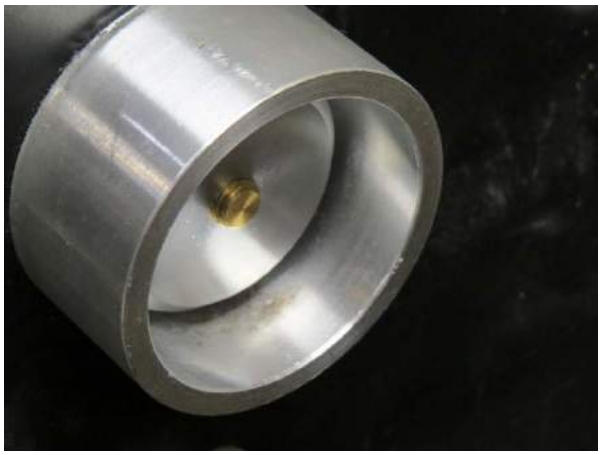


Figure 68 Ventilation valve in open position

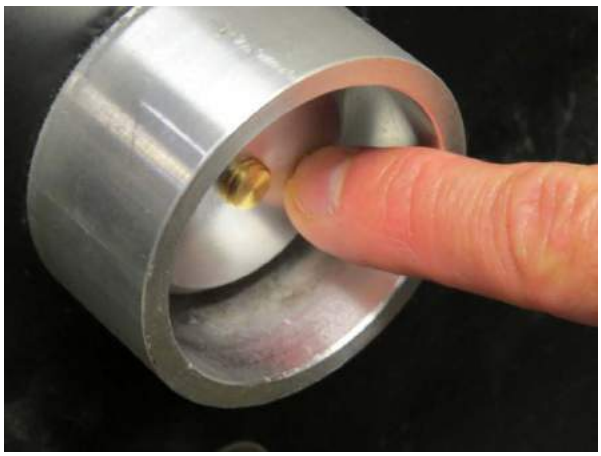


Figure 69 Press the ventilation valve to confirm movement

14.3 Renishaw powder recovery system (sieve)

WARNING: 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) BEFORE STARTING THIS TASK.

Note: To minimise the risk from Argon leakage Renishaw recommend using a small argon gas cylinder of approximately 1000 L (35 cu/ft). Renishaw also recommend using a trigger type gas valve to prevent the gas supply being accidently left on.

WARNING: WHEN IN OPERATION THE BODY OF THE SIEVE MOVES RELATIVE TO THE SUPPORT FRAME. THERE IS A POSSIBILITY OF BODY PARTS BECOMING TRAPPED BETWEEN THE SIEVE BODY AND SUPPORT FRAME. ENSURE HANDS ETC ARE KEPT AWAY FROM THE SIEVE WHEN IT IS IN OPERATION.

14.3.1 Attaching the argon supply

The sieve station has a gas supply port, which can be connected to an argon supply. This is essential for oxygen reactive metals (titanium for example). This should be regulated to 0.1 bar (1.5 psi). The sieve is ATEX rated to run containing air, however the properties of oxygen reactive metals may be affected by doing so. Ensure the argon supply line is connected to the sieve (Figure 70).

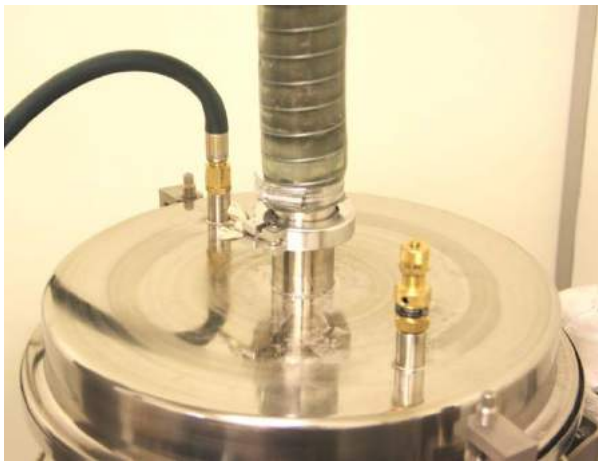


Figure 70 Sieve with argon inlet attached

Place an o-ring seal on an empty powder bottle. Engage the empty powder bottle KF flange to the bottom flange of the sieve assembly and seal the connection using a quick-release clamp (SL6) (Figure 71).

Open the valves of both sieve assembly (S2) and empty bottle (A1) to complete connection (levers aligned with direction of flow) (Figure 72).

Open the argon valve and ensure it is regulated to 0.05 bar to 0.15 bar (0.7 psi to 2.2 psi).

Figure 71 Insert seal and attach clamp (SL6)

Figure 72 Open valves (A1 and S2)

Open the sieve upper valve (S1) to allow air to be purged. Leave open for 30 seconds (Figure 73), switch off the argon supply and close the sieve upper valve (S1).

Figure 73 Open sieve upper valve (S1)

WARNING: DO NOT PRESSURISE THE SIEVE BY MORE THAN 1 BAR (15 PSI) AS THE OVER-PRESSURE VALVE WILL RELEASE THE ARGON.

14.3.2 Loading material

Connect a bottle full of un-sieved powder onto the top of the sieve using an o-ring and quick-release clamp (SL1) (Figure 74).

Figure 74 Connect full bottle – Insert seal and attached clamp (SL1)

Open both of the upper valves (S1 and A1) to complete the connection (Figure 75).

Figure 75 Open valves (S1 and A1)

Where multiple materials are used Renishaw recommend colour coding both sieve and powder bottles – check the correct material is being loaded.

Switch on the sieve and start sieving powder (Figure 76).

Figure 76 Press start button

Run the sieve for at least 10 minutes to allow sufficient time to sieve all of the powder, set a timer (Figure 77).

Figure 77 Set timer for 10 minutes

Caution: Running the sieve for less than 10 minutes may result in powder being left in the sieve – this will overfill the next bottle resulting in a spillage.

Check completion by tapping the neck of the lower powder bottle. If it sounds hollow run the sieve for longer.

When the appropriate amount of time has passed switch off the sieve.

Close both of the valves on the sieve (S1 and S2) and the bottom powder bottle (A1) (lever perpendicular to flow) (Figure 78).

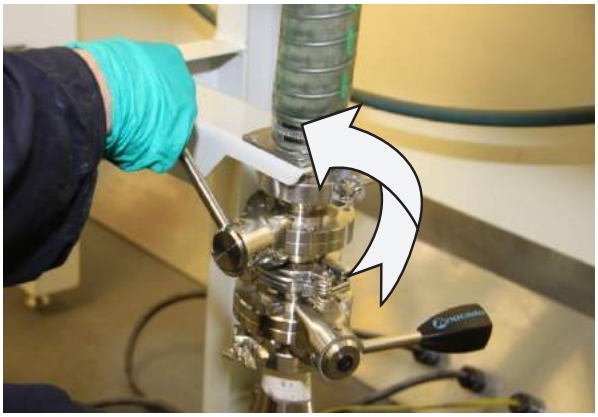


Figure 78 Shut off valves (S1 and S2)

Figure 79 Remove clamp (SL6)

Remove the quick-release clamp (SL6) (Figure 79).

Remove the full powder bottle from the bottom of the sieve and repeat for empty bottle on top of the sieve. Ensure that the bottle containing the sieved powder is correctly labelled, with both material type and status (that it is sieved).

14.3.3 Disassembly of the sieve for cleaning and maintenance

WARNING: SIEVE MAINTENANCE MAY RELEASE SMALL AMOUNTS OF POWDER FROM THE SIEVE. THIS MUST BE RISK ASSESSED AND SUITABLE PRECAUTIONS TAKEN, REFER TO THE APPLICABLE ATEX AND DSEAR DIRECTIVES.

WARNING: ENSURE THAT NO POWDER REMAINS IN THE SIEVE, THAT THE PIPES ARE EMPTY AND THE BOTTLES HAVE BEEN REMOVED.

It is still necessary to wear the correct Personal protective equipment to protect against residual powder.

Remove any external powder resting on the outer body of the sieve and on top of the lid using an ATEX vacuum cleaner (wet separator).

Electrically isolate the sieve by switching the isolator to 0 or OFF.

Disassemble the clamp connecting the top pipe to the lid of the sieve (SL3), then remove the centring ring (Figure 80).

Figure 80 Remove top clamp (SL3)

Release the two clamps applied to the lid (Figure 81).

Figure 81 Release both clamps

Ensure the argon supply has been switched off. Remove the argon line connection to the sieve lid using two adjustable spanners (Figure 82).

Figure 82 Remove argon line

Remove the lid (Figure 83).

Figure 83 Remove lid

Disassemble the seal and main body of the sieve leaving the mesh grating exposed (Figure 84).

Figure 84 Remove body

Carefully remove the mesh grating and dispose of the scrap powder remaining on the mesh. (Figure 85).

Figure 85 Remove sieve and dispose of powder

Disassemble the large seal around the mesh grating (Figure 86).

Caution: Sieve mesh is a delicate component and must be removed with care. Do not vacuum or otherwise clean the mesh.

Figure 86 Remove outer seal

Remove the sieve balls and store in a bottle full of Isopropanol Class 3 (Figure 87).

Figure 87 Remove balls and store in IPA

Remove the perforated plate (Figure 88).

Figure 88 Remove perforated plate

Remove the sieve funnel top seal (Figure 89).

Figure 89 Remove funnel seal

Remove the worm drive hose clamp retaining the top pipe to the upper valve (S1), (Figure 90).

Figure 90 Remove worm drive hose clamp and pipe

Following the same procedure remove and disassemble the bottom pipe and lower valve (SW2) assembly, (Figure 91).

Figure 91 Remove pipe insert

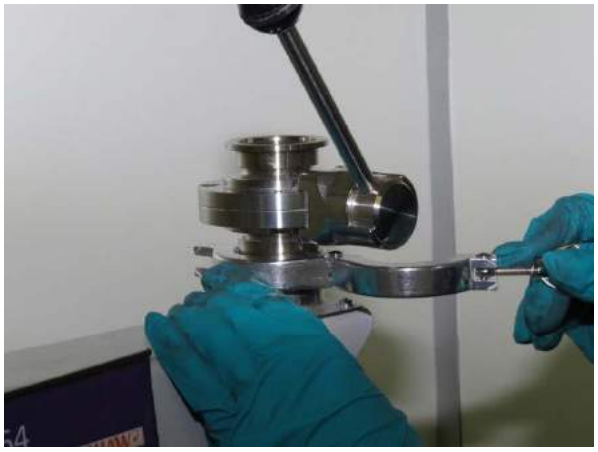


Figure 92 Remove upper valve (S1) assembly

When all the components have been removed, they need to be cleaned down.

Firstly, use the ATEX vacuum cleaner (wet separator) to remove any powder on the sieve components (Figure 93).

Figure 93 Use the ATEX vacuum cleaner (wet separator) to vacuum all components

Use Isopropanol and disposable cloth for cleaning of all other components including pipes, valves (S1 and S2), and centring rings (Figure 94).

Figure 94 Clean-down all components with IPA

It may be necessary to insert IPA soaked cloth down the length of the tube to fully clean the inner bore.

Clean the sieve ball by rinsing in Isopropanol Class 3, then wiping clean with disposable cloth (Figure 95).

Note: Renishaw recommends a set of sieve balls for each material type used; in which case cleaning during material changeover is not required.

Figure 95 Wipe sieve balls with IPA

14.3.4 Disassembly of the sieve for material changeover

Follow Section 14.3.3 to disassemble and clean the sieve.

Once all components are removed from the sieve station the sieve frame and stand need to be cleaned down.

Firstly, use the ATEX vacuum cleaner (wet separator) to remove any powder on the sieve frame and stand. Then use Isopropanol and disposable cloth to clean off all the surfaces on the sieve frame and stand (Figure 96).

Figure 96 Wipe down all surfaces with IPA

Once you are satisfied that all traces of the previous material have been removed, reassemble the sieve.

14.3.5 Reassembly of sieve

Note: Ensure all components are completely dry before they are reassembled.

Reassemble the components of the sieve in reverse order.

Replace the funnel seal (Figure 97).

Figure 97 Replace the funnel seal

Replace the perforated plate (Figure 98).

Figure 98 Replace the perforated plate

Caution: Sieve mesh is a delicate component and must be removed with care. Do not vacuum or otherwise clean the mesh.

Replace the sieving balls (Figure 99).

Figure 99 Replace the sieving balls

Assemble the large seal around the mesh (Figure 100).

Figure 100 Assemble the mesh seal

Replace the mesh on top of the sieving balls. Ensure the deeper recess is face down.

Place the main body on top of the mesh (Figure 101).

Figure 101 Assemble the main body

Place the seal on top of main body.

Replace the lid on the sieve (Figure 102).

Figure 102 Replace the lid

Place the centring o-ring onto the upper KF flange (Figure 103).

Figure 103 Place the centring o-ring

Attach the upper valve (S1) using a clamp (SL2) (Figure 104).

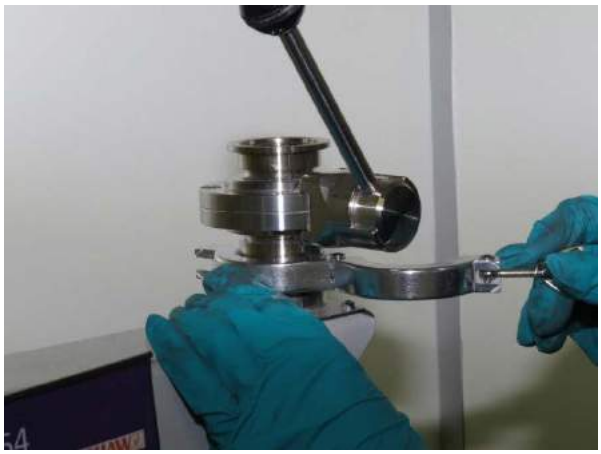


Figure 104 Attach the upper valve (S1) with clamp (SL2)

Attach the top pipe using a worm drive hose clamp, (Figure 105).

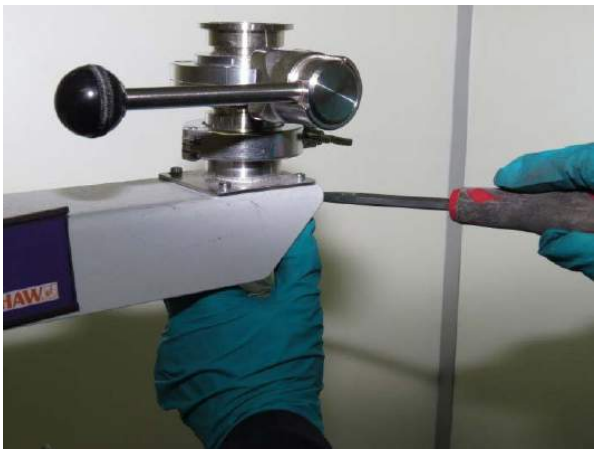


Figure 105 Attach the top pipe

Slide the worm drive hose clamp over the pipe, locate the insert into the pipe, place the o-ring over the flange and then connect to the lid with a swing clamp (SL3) (Figure 106).

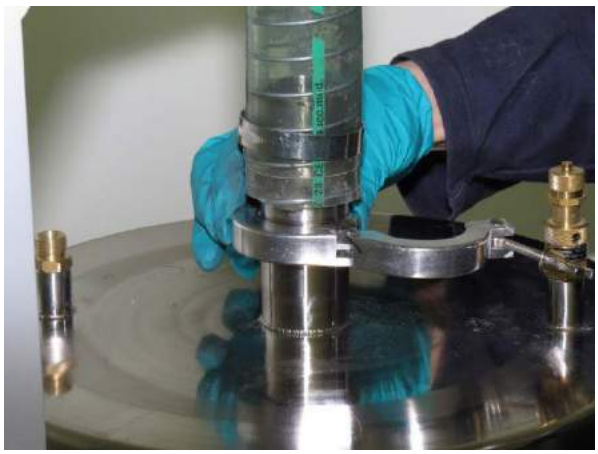


Figure 106 Connect pipe insert to lid using clamp (SL3)

Now tighten the worm drive hose clamp (Figure 107).

Figure 107 Tighten worm drive hose clamp

Follow the same process to assemble the lower pipe.

Apply the clamps to the sieve (Figure 108).

Figure 108 Apply the clamps

The clamping torque should periodically be checked using the Russell Finex clamp assist tool, (Figure 109).

Figure 109 Russel Finex clamp assist tool

See the following pages for the operating instructions for the Russell Finex clamp assist tool.

Attach the argon connection (Figure 110).

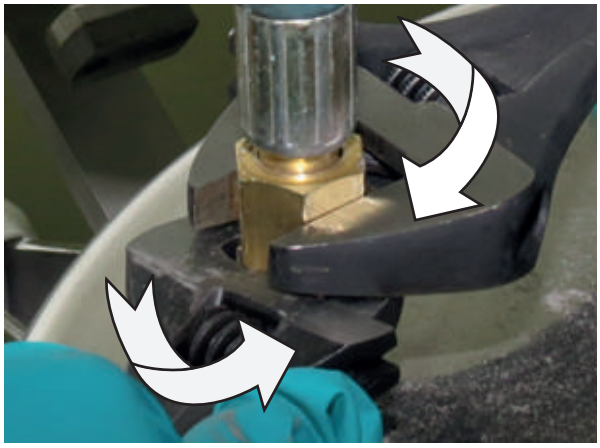


Figure 110 Tighten the argon connection

14.3.6 Operating instructions for Russell clamp assist tool

The Russell Clamp, (Figure 111) has been developed to assist the operator in setting the correct clamping force on hand-operated sieve clamps. It is for use on both under-clamps and toggle-clamps fitted onto the Russel Finex range of sieves. It has been preset to enable the operator to apply the correct torque setting by hand.

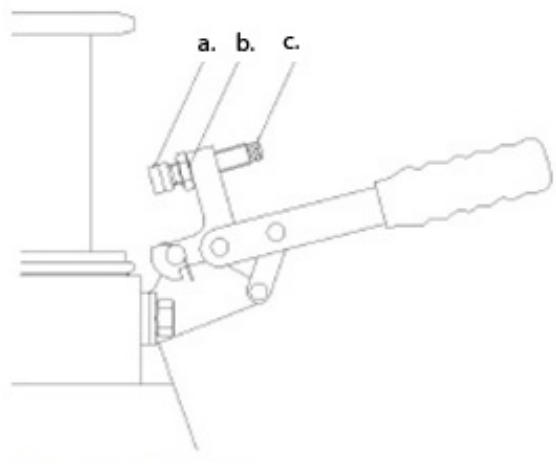
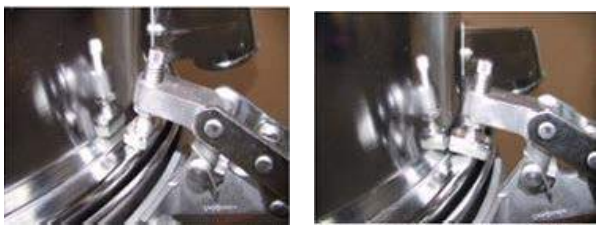


Figure 111 a. Clamp pad, b. Hex nut, c. Spindle

1. Ensure that the clamp pad (a.) is aligned with the sieve panwork.



Correct **Incorrect**

2. Engage the clamp by hand. If the clamps are too tight to engage, screw the spindle (c) up by a few half turns. If too loose, screw the spindle down by a few half turns.

3. Repeat the above until it is possible to engage the clamps by hand but without requiring excessive force. Release the clamps.

4. Slide the Clamp Assist over the clamp handle.

5. Engage the clamp using the tool as shown, ensuring the torque arrow on the tool is correctly orientated, (Figure 112).

Figure 112 Under-clamp type (left), toggle-clamp type 1 (middle) and type 2 (right)

6. Follow the actions in the table to adjust the clamp to the correct settings.

	When using the Clamp Assist	Clamp setting	Action
A	The Tool clicks well BEFORE the clamp engages	CLAMP IS TOO TIGHT	Adjust pad upwards
B	The tool DOES NOT click before the clamp engages	CLAMP IS TOO LOOSE	Adjust pad downwards
C	The tool clicks on engagement of the clamp	Correct clamp settings achieved	None

7. Tighten the Hex nut.

8. Repeat the above procedure for the other clamp.

9. Check the clamps periodically and reset to the correct torque when required.

10. Clamps should be checked and reset to the correct when replacing any of the following:

- Gaskets
- Mesh frames
- Underpan/sieve deck – ensure surfaces are clean

11. Check clamps operate smoothly and replace any clamps that do not function properly or have become stiff.

12. Check the clamp pads periodically and replace when signs of wear are observed.

14.4 Renishaw silo lift

Figure 113 Renishaw silo lift

14.4.1 Operating instructions

WARNING: BEFORE USING THE SILO LIFT, IT IS THE USERS RESPONSIBILITY TO COMPLY WITH LOCAL LIFTING LEGISLATION, TO CARRY OUT A RISK ASSESSMENT AND TO ENSURE THAT THE SILO LIFT IS SUITABLE FOR THE TASK FOR WHICH IT HAS BEEN PURCHASED. NO FORMAL LICENCE OR TRAINING IS REQUIRED TO OPERATE THE SILO LIFT, BUT RENISHAW STRONGLY ADVISE FAMILIARISATION TRAINING IS CARRIED OUT.

- Before using the silo lift, ensure that all functions are working correctly.
- Never exceed the maximum permissible load for the silo lift and comply strictly with the requirements of the load diagram, on any equipment supplied.
- Ensure that the load is evenly distributed.
- Ensure that your silo lift is the correct type for the area you are to work in. Do not enter a hazardous zone with an unsuitable silo lift.
- Do not carry divisible loads that sit higher than the fork carriage or backrest extension.
- Keep a safe stopping distance. Laden silo lifts cannot be stopped as quickly.
- If the silo lift develops a fault or feels unsafe, suspend operations, park and report.
- The silo lift should not be left unattended on a gradient.
- Be cautious of overhead limitations or obstructions.

Driving and braking

The silo lift is not fitted with any kind of drive or braking devices and so driving and braking are both controlled by the operator pushing the silo lift. The rear castors are fitted with foot brakes for parking purposes.

Loading

The forks are specifically designed to securely locate a silo, ensure the silo is pushed against the dead-stops, and fork tips located correctly.

When using the plate for general purpose lifting ensure it is fixed in place and the load appropriately located.

Lifting

Operate the manual hand pump by moving the pump handle lever backwards and forward at full stroke. Lift is achieved by each stroke of the handle.

Lowering

Open the manual control valve by turning the release lever anti-clockwise.

This lever can be set at any required angle by depressing the top button and revolving. It will lock automatically once the button has been released.

Note: The speed of lowering can be controlled directly through the degree of turn of the knob, the valve will spring shut once the lever is released and lowering will halt.

Caution: Always apply the wheel brakes when lifting or lowering a load.

14.4.2 Rated capacity

WARNING: DO NOT EXCEED THE LIFT'S RATED CAPACITY OF 200 KG AT 200 MM (440 LB AT 8 IN).

14.4.3 Regular inspection and maintenance

- Every user shall ensure that work equipment is maintained in an efficient state, in efficient working order and in good repair.
- Every user shall ensure that where any system has a maintenance log, the maintenance log is kept up to date.

It is important that equipment is maintained so that its performance does not deteriorate to the extent that it puts people at risk. Efficient relates to how the condition of the equipment might affect health and safety. It is not concerned with productivity.

Lifting equipment needs to be checked frequently to ensure that safety-related features are functioning correctly. The frequency of checks/inspection and maintenance should take into account the duty cycle.

Maintenance should only be carried out by a suitably qualified person, if in doubt contact Renishaw.

Recommended checks		
Wheels	3 monthly	Check for any damage or excessive wear. Any damage to the wheels must be acted upon.
Fork arms	Annually	Arms shall be inspected carefully by trained engineers at a minimum interval of 12 months, or depending on application. Any damage, failure, or deformation which may impair safe use must be acted upon.
Wire rope	6 monthly	Every six months the lifting wire rope must be inspected for fraying or damage. If frayed or damaged in any way, the rope must be replaced. Slack in any rope can be removed/taken up, by adjusting the threaded end fitting end nut which is anchored to a cross tie. The top bolt must be returned to a position where it prevents the rope from accidentally disengaging the pulley.
Mast/ carriage rollers	3 monthly	The rollers are greased when fitted and should require no further lubrication in use (Lithium complex grease 873). Check for damaged or worn rollers and arrange replacement if necessary.
Hydraulic circuit	3 monthly	Check the hydraulic fluid level in the reservoir. Fully lower the fork carriage. Remove the hydraulic reservoir top filler cap and inspect level of fluid. Top-up to cap if necessary with ISO grade 11158 grade 32 (EN 51524).

For further information refer to the manual supplied with the equipment, see Section 37 Appendix D "Supplier manuals" for information on the make, model and manufacturer.

14.5 Dehumidifier

The AM400 requires a supply of temperature-controlled air to keep some of the optical components at a stable temperature.

Regular checks are required to ensure that the dehumidifier functions correctly and continues to supply temperature-controlled air to the optical system, see Section 37 Appendix D "Supplier manuals" for information on the make, model and manufacturer.

Caution: The dehumidifier and laser optics require a reliable compressed air supply. This should be checked regularly.

15 Argon supply connection and changeover

The AM250/AM400 requires a supply of inert gas in order to safely process the raw material. The AM250/AM400 will run from either mains supply or bottled argon, the following procedure covers gas cylinders.

A minimum cylinder pressure of approximately 25 bar (363 psi) is recommended at the start of any build. If the argon supply is depleted, the build process will pause and an alarm will sound. Depending on the expected build duration it may be prudent to exchange for a full argon cylinder.

WARNING: ARGON GAS CYLINDERS CAN BE 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.

WARNING: TAKE SUITABLE PRECAUTIONS WHEN HANDLING PRESSURISED GAS BOTTLES.

15.1 Removing and re-installing the gas cylinder

Note: The following photographs and text describe a typical gas cylinder available in the UK. The size and type of gas cylinder, and gas regulator will be different in the geographic area where your AM250/AM400 machine is located.

Close the argon gas cylinder valve by rotating it clockwise (Figure 114).

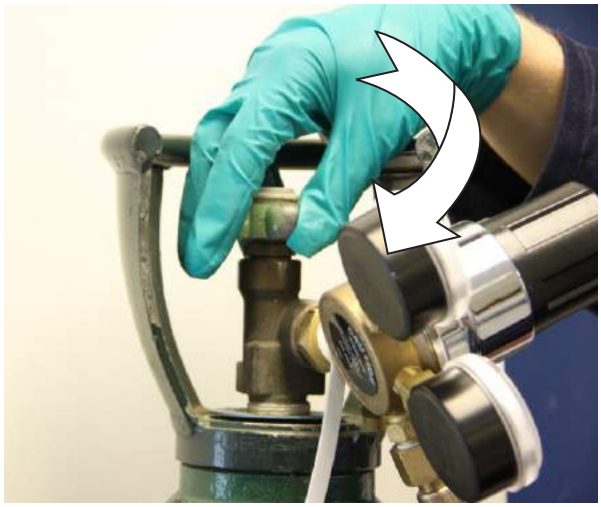


Figure 114 Close cylinder valve

Detach the regulator from the gas valve using a 1⅛ in (approximately 29 mm) or adjustable spanner, (Figure 115).

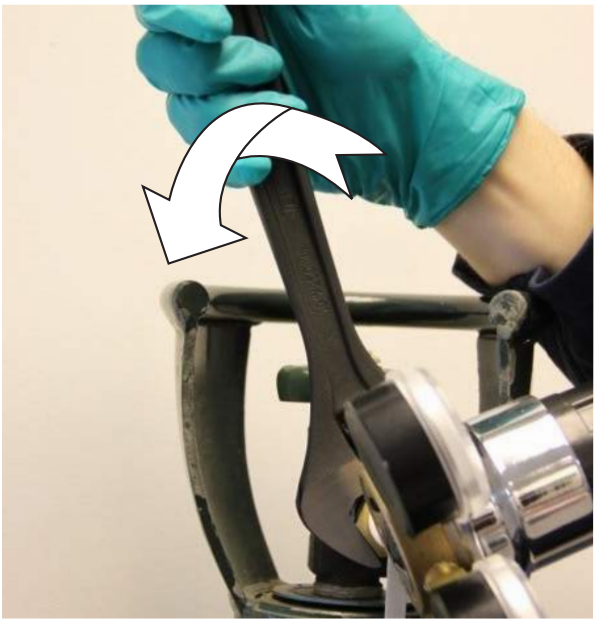


Figure 115 Unscrew regulator from the cylinder

Remove the empty gas cylinder, store securely, by chaining it in the designated storage location.

Install a full gas cylinder in the designated location near the system, and secure appropriately (Figure 116).

Figure 116 Secure the gas cylinder

Attach the regulator to the cylinder valve using a 1 ⅛ in (approximately 29 mm) or adjustable spanner (Figure 117).

WARNING: NEVER USE OIL OR GREASE, SEALING COMPOUNDS OR TAPES ON THE GAS CYLINDER CONNECTIONS.

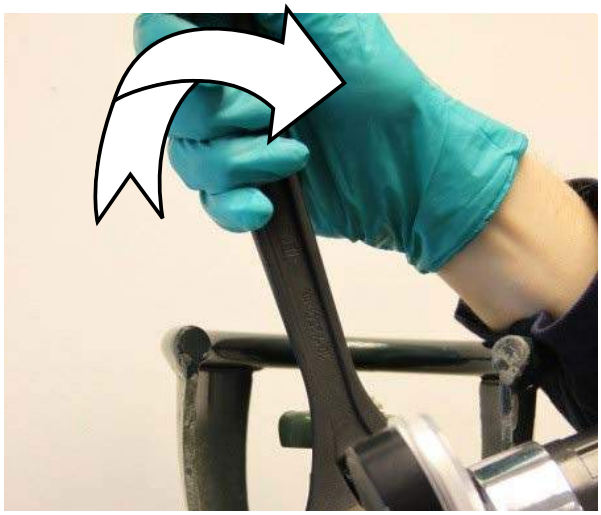


Figure 117 Attach regulator

Open the argon gas valve by unscrewing the valve completely (anti-clockwise), then back off by screwing clockwise half a turn.

Regulate the supply pressure to between 1.5 bar and 1.8 bar (22 psi to 26 psi) (Figure 118).

Figure 118 Left gauge shows supply pressure, right gauge cylinder pressure.

WARNING: DO NOT EXCEED 2 BAR (29 PSI) LINE PRESSURE WHEN REGULATING ARGON GAS. OVERPRESSURE WILL CAUSE THE SYSTEM TO HALT

Clockwise on the regulator valve will increase the pressure (Figure 119).

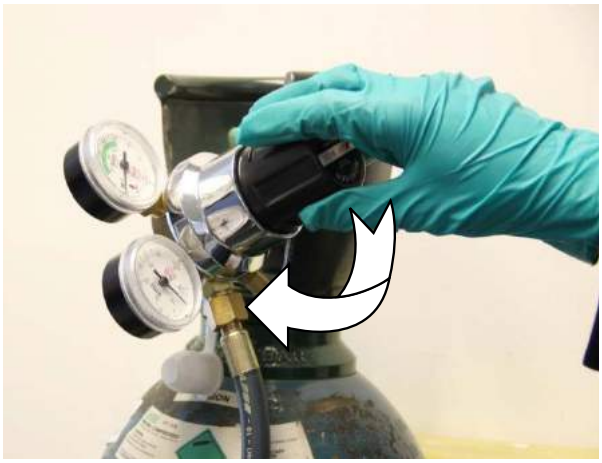


Figure 119 Rotate regulator right to increase supply pressure

A minimum cylinder pressure of approximately 25 bar (363 psi) is recommended at the start of any build. If the argon supply is depleted, the build process will pause and an alarm will sound.

Test the installation as follows to ensure there are no leaks of argon gas. Ensure the AM250/AM400 valves are closed. Pressurise the supply hoses to 1.8 bar, close the regulator, wait ten minutes, ensure the supply hose pressure on the gauge has not dropped. Open the regulator and pressurise to 1.8 bar.

16 System controls

16.1 Powering on the system

WARNING: BEFORE SWITCHING ON – ENSURE THE SYSTEM DOOR IS CLOSED.

WARNING: ALWAYS CHECK THE CHILLER AND DEHUMIDIFIER HAVE BEEN SWITCHED ON BEFORE STARTING THE AM250/AM400. SEE SECTIONS 16.2 "POWERING ON THE CHILLER" AND SECTION 16.3 "POWERING ON THE DEHUMIDIFIER".

The equipment main isolator switch is mounted on the right hand side of the AM250/AM400 cabinet. Switch the main isolator to ON or 1 (Figure 120), when the reset button illuminates, press it. The controller and the main computer will then begin the start-up routine.

Figure 120 Main isolator switch

The chiller, process heating system and laser will also be enabled when the main isolator is switched on.

When the controller and main computer are booted, the system is ready for operation. This is indicated by the welcome screen (Figure 121).

Figure 121 Welcome screen

16.1.1 Powering down the system

WARNING: DO NOT SWITCH OFF USING THE ISOLATOR BEFORE FOLLOWING THIS PROCEDURE TO AVOID DAMAGE TO THE CONTROL PC.

From the main menu, select the following on the AM250/AM400 HMI touch screen (Figure 122):

> Service > PC On / Off Override > Shutdown PC

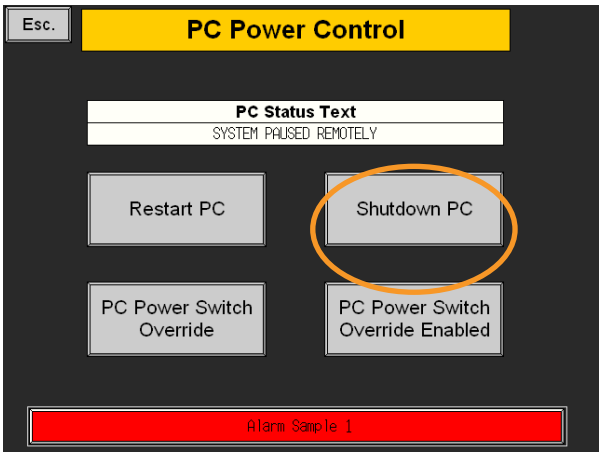


Figure 122 Select shutdown PC

This will begin the shutdown sequence for the control PC, after several seconds the PC communication alarm will show.

Open the lower right door, then open the cover on the PC – once the green LED light has gone out the PC has been successfully shutdown (Figure 123).

It is now safe to shut off power to the AM250/AM400 by turning the main isolator to 0 or OFF.

Once the AM250/AM400 has been switched off, the chiller can also be switched off.

WARNING: DO NOT SWITCH OFF THE CHILLER WHILST THE SYSTEM IS STILL ON.

Figure 123 Open PC cover and wait for green LED light circled to expire

16.2 Powering on the chiller

The AM250/AM400 requires a supply of temperature-controlled fluid to keep the optical components at a stable temperature.

To switch on the chiller, ensure that the main power lead is connected to a suitable power supply, then switch on the main switch on the back of the unit (Figure 124). Press the RUN / STOP button once to switch on the pump, the run light will illuminate (Figure 124).

Once the chiller is switched on, it can be set to run using the controls on the front panel circled below. The SV (Set Value) temperature should be set to 20 °C (68 °F) (Figure 124).

Figure 124 Chiller on switch (top) and chiller temperature (bottom)

16.3 Powering on the dehumidifier – AM400 only

The AM400 only requires a supply of temperature-controlled air to keep parts of the optical system at a stable temperature.

To switch on the dehumidifier, ensure that the main power lead is connected to a suitable power supply. Switch on the illuminated On/Off switch, (Figure 125) on the front of the dehumidifier. The switch should illuminate to show that the dehumidifier is operating normally.

Figure 125 Dehumidifier on/off switch

16.4 Pages not requiring login

The AM250/AM400 features a touch screen interface from which the system and other user interactions can be controlled. All file preparation is completed in an offline environment within the file preparation software and then loaded to the system via network connection or ethernet connection.

In order to allow viewing of the system status and modes, several pages can be toggled without user login. This allows language configuration and viewing of information pages (Figure 126). Navigating these pages can be done safely without affecting the system, providing the user is not logged in.

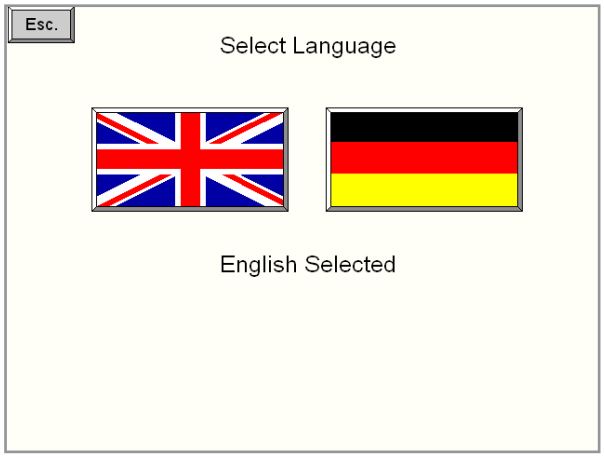


Figure 126 Language selection page (optional on software installation)

17 Logging in

Following the start-up page, user languages can be selected by pressing the appropriate flag, if installed.

To loginto the AM250/AM400 control interface, tap the screen and select the following (Figure 127):

> Login In/Out

Figure 127 Loginto the user interface before selecting the required user level

The AM250/AM400 has different access levels depending on the user (Figure 128). The default levels passwords are:

Level 1 > AMPD1: End user operator level

Level 2 > AMPD2: End user technician level

Level 3 > Maintenance engineer level

Level 4 > Software engineer and configuration engineer

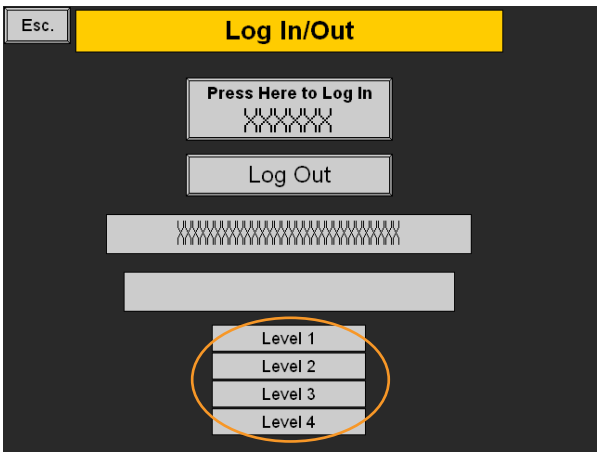


Figure 128 Range of levels which the user can gain access to

Select **<Press Here to Login>**

Key in the alphanumeric pass-code using the keypad (Figure 129) and press return.

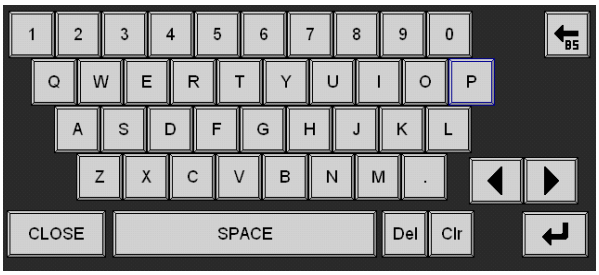


Figure 129 Enter pass-code using keypad

The user access level is defined by the individual user account. User account entry level is highlighted in yellow.

All operations are carried out from the menu page. Once logged on, continue to the menu page as follows (Figure 130).

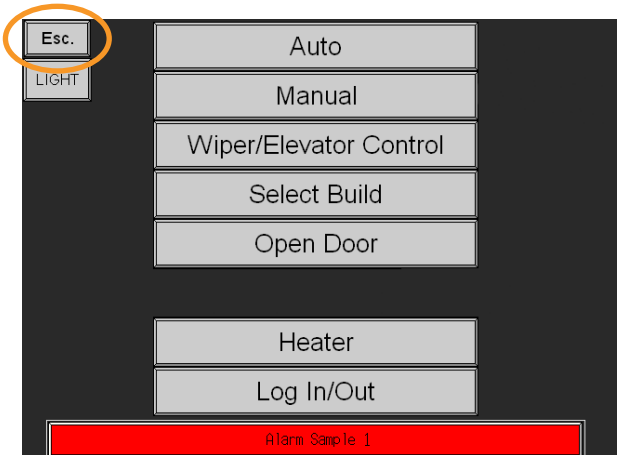


Figure 130 Select <Esc.>

Select <Esc>

Note: Before a new user can login, the previous user must be logged out, unless the 15 minute timeout has elapsed.

Note: The default access passwords can be altered when logged into level 4.

17.1 Logging out

To log out of the system, select the following:

> Esc. > Login In/Out > Log Out

18 Opening and closing the system doors

WARNING: ALWAYS ENSURE THAT YOU ARE WEARING THE REQUIRED PERSONAL PROTECTIVE EQUIPMENT BEFORE OPENING THE SYSTEM PROCESS CHAMBER DOOR.

Wear eye protection, full face respirator (to EN143 Type P3+A1), protective gloves and cotton or fire retardant overalls with full length sleeves (made of static-dissipative material.)

Do not allow the dust to form a cloud.

Do not eat, drink or smoke in the vicinity of the AM250/AM400 system.

Wash hands thoroughly with water and soap after contact or use.

Wash any contaminated clothing separately from other clothing.

To open the system door, user login is required. Do not attempt to open the door whilst the process is running.

18.1 Opening the process chamber door

To open the upper chamber door, override the door interlock by selecting the following (Figure 131):

Open Door > Door Interlock Override Disabled

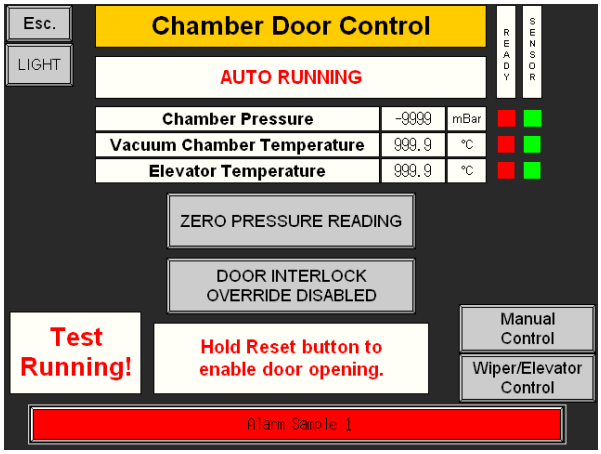


Figure 131 Open door window in AM250/AM400 control screen interface

Open the door by holding the reset button and pulling the handle (Figure 132).

Figure 132 Opening the door whilst pressing the reset button

18.1.1 Closing the process chamber door

To then close the door, ensure the latch engages fully, push firmly with one hand, whilst shutting the latch with the other, (Figure 133).

Figure 133 Engage the latch and push firmly shut

18.1.2 Resetting the door alarm

After opening the door, an **Emergency Alarm** initiates that needs to be reset before operating the system. Select the following on the AM250/AM400 control interface:

> Override enabled

Press the blue reset button on the AM250/AM400 system to remove the alarm.

Wiper home will be required before any functions may be used. To find **Wiper Home**, select the following on the AM250/AM400 control interface (Figure 134):

> Wiper/Elevator Control

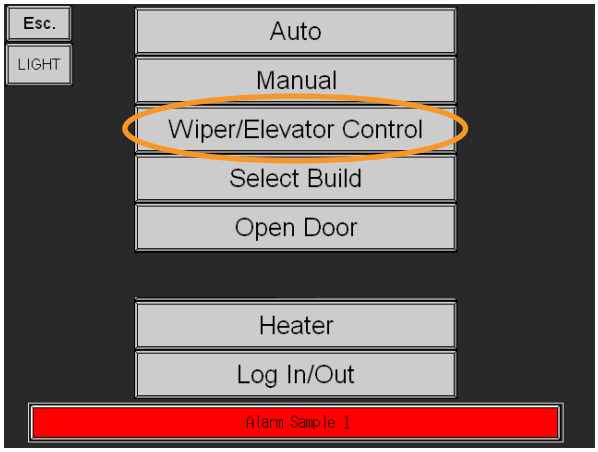


Figure 134 Wiper/Elevator control button in AM250/AM400 main menu

Then select the following (Figure 135):

> Wiper/Elevator Control > FIND WIPER HOME

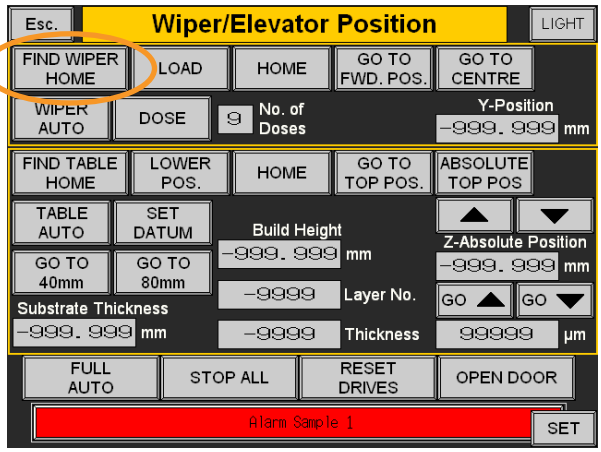


Figure 135 Wiper/Elevator control window in AM250/AM400 control interface

18.2 Opening and closing the lower chamber door

This is only possible once the upper door is open.

Pull on the lower handle (Figure 136).

Figure 136 Opening the lower door

When closing the door, ensure that the latch engages fully. Push firmly on the door with one hand, whilst shutting the handle with the other (Figure 137).

Figure 137 Engage the latch and push firmly shut

18.3 Checking the pressure sensor

The ambient pressure reading must be checked and re-zeroed after every build, to accommodate changes in atmospheric pressure

With the door open the chamber pressure reading should be 0 mbar (Figure 138).

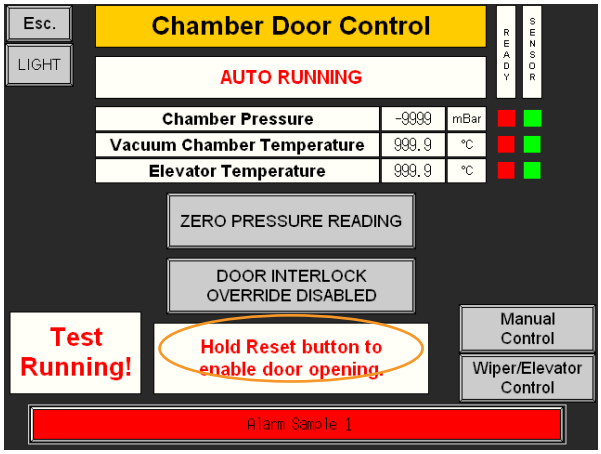


Figure 138 Zero pressure reading if not reading zero when the door is open

If it is not 0, when the door is open the **Zero Pressure Reading** button will be visible. Pressing this will reset the pressure sensor.

Note: An incorrect pressure reading may prevent the system from achieving the set pressure required to operate.

Caution: An incorrect pressure reading may result in a build halting or failing.

19 Powder transfer from supplier's containers

This section describes the safe transfer of metallic powder from the supplier's container to the system powder bottles. It requires the use of an adaptor. Various types of adaptor are available from Renishaw on request.

WARNING: 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) BEFORE STARTING THIS TASK.

For titanium powder, firstly remove the silica desiccant bag from the supplier's container on opening (Figure 139).

Figure 139 Removal of silica desiccant from container

WARNING: DO NOT LOAD POWDER DIRECTLY FROM THE SUPPLIERS POWDER BOTTLE INTO THE AM250/AM400 – POWDER MUST FIRST BE DECANTED INTO A RENISHAW POWDER BOTTLE.

WARNING: WHEN USING TITANIUM POWDER THE SILICA DESICCANT BAG MUST BE REMOVED FROM THE SUPPLIERS CONTAINER TO PREVENT IT BEING TRANSFERRED TO SYSTEM BOTTLE.

Screw a suitable powder bottle adaptor on to the suppliers powder bottle, (Figure 140). Ensure the isolating valve (AV1) is closed, the handle will be at 90° to the direction of flow.

Be aware that the powder bottle is open and it must be connected with care to avoid any spillage of powder. The time spent with the powder bottle open should be kept as short as possible.

Figure 140 Connect quick-release clamp and invert bottles

Fit a centring ring to the isolating valve (AV1) KF flange adaptor of the supplier powder bottle.

Take a small powder bottle complete with isolating valve (A1), ensure the isolating valve (A1) is closed, handle at 90° to the direction of flow.

Connect the KF flanges of the small powder bottle and supplier powder bottle adaptor together and secure with a quick-release clamp, (Figure 140).

Rotate both the supplier powder bottle and small powder bottle. Open both isolation valves (AV1 and A1) and allow the powder to transfer. Tap the small powder bottle to determine when it is full (hollow sound when empty).

When the small powder bottle is full, close the isolating valve (A1) and invert both bottles so that the supplier powder bottle is lowermost. Allow any remaining powder in the coupling to drop back into the supplier powder bottle and then close the isolating valve (AV1).

Remove the quick-release clamp between the two isolating valves (AV1 and A1) and separate the two powder bottles.

20 Powder loading

The powder silo features a KF40 flange for loading. This should be fitted with a valve (V1) secured by a clamp (L1) at all times. To fill the silo, follow the procedure detailed in this section.

Ensure that there is a minimum of three full bottles of powder in the system before starting the process. The silo can be filled whilst the process is running – but not during the vacuum cycle.

WARNING: 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) BEFORE STARTING THIS TASK.

WARNING: DO NOT LOAD POWDER DIRECTLY FROM THE SUPPLIERS CONTAINER INTO THE AM250/AM400 – POWDER MUST FIRST BE DECANTED INTO A RENISHAW POWDER BOTTLE.

WARNING: DO NOT FILL THE POWDER SILO ABOVE THE LEVEL OF THE OVERFLOW PIPES. DO NOT ATTEMPT TO FILL THE SILO WHILST THE SYSTEM IS PREPARING THE BUILD ATMOSPHERE (DURING THE VACUUM CYCLE).

WARNING: ALWAYS SIEVE POWDER USING A RENISHAW POWDER RECOVERY SYSTEM BEFORE LOADING. NEVER LOAD CONTAMINATED POWDER.

Use a safe working at height platform to reach the silo on the top of the system (Figure 141).

Figure 141 Use the safe working platform

Place a clean centring ring seal on the KF flange of the silo isolating valve (V1) (Figure 142).

Figure 142 Place an centring ring on silo isolating valve (V1) (closed)

Ensure that the small powder bottle isolating valve (A1) and silo isolating valve (V1) are in the closed position (handle at 90° to the direction of flow) (Figure 143).

Figure 143 Powder bottle assembled to the silo using a quick-release clamp (L1)

Place the small powder bottle on top of the centring ring seal, then slide half the collar of the quick-release clamp (L1) over the edge of the flange (Figure 144).

Figure 144 Close clamp (L1)

Close the second half of the quick-release clamp (L1) and attach the spring-loaded lever (Figure 110).

Open the valves on the bottle first (A1) then the silo (V1), (Figure 145).

Figure 145 Powder bottle to silo with valves (A1 and V1) open

Wait until the bottle has emptied into the silo – check by tapping the bottle gently (Figure 146).

Figure 146 Tap gently

Close the valve on the small powder bottle (A1) and then the silo (V1).

Remove the quick-release clamp (L1) and remove the bottle from the system.

21 Installing the overflow bottles

WARNING: 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) BEFORE STARTING THIS TASK.

The powder overflow bottles should be fitted inside the left hand access panel below the safe change filter/large safe change filter. Each should have two valves – one to isolate the system (V2 and V3) and one to isolate the bottle (A1 and B1).

Ensure that the overflow bottle valves (A1 and B1) and system valves (V2 and V3) are in the closed position – perpendicular to the direction of flow. If not, pull the handle to unlock and rotate it by 90° (Figure 147).

Note: Renishaw recommend fitting the front and rear powder overflow bottles before fitting the safe change filter/large safe change filter.

Note: If either of the powder overflow bottles needs to be replaced whilst the AM250/AM400 is running then consider purging/filling the powder overflow bottle with argon gas before fitting it to the AM250/AM400 system.

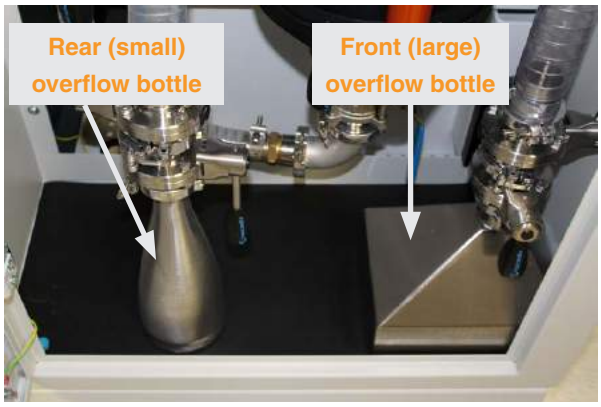


Figure 147 Four overflow valves (A1, B1, V2 and V3) - shown in open position

21.1 Rear overflow

Position the rear overflow bottle under the rear overflow pipe (Figure 148).

Figure 148 Rear overflow – small powder bottle

Place a centring ring on the KF flange of the rear powder bottle isolating valve (A1) (Figure 149).

Figure 149 Place seal on flange

Engage the rear powder bottle flange with the rear overflow pipe flange and slide half the collar of the quick-release clamp (L10) over the edge of the KF flanges (Figure 150).

Figure 150 Engage the first half of the clamp (L10)

Close the quick-release clamp (L10), ensuring a correct fit around the flanges (Figure 151).

Figure 151 Engage second half and close clamp L10)

Open both the valves (A1 and V2) to complete the installation of the rear overflow bottle (Figure 152 and Figure 153).

Figure 152 Open both valves (A1 and V2)

Figure 153 Valves (A1 and V2) open

21.2 Front overflow

Position the front (large) overflow bottle under the front overflow pipe.

Place a centring ring seal on the KF flange of the large overflow bottle isolation valve (B1) (Figure 154).

Figure 154 Locate seal on flange

Engage the large overflow bottle isolation valve (B1) flange with the overflow pipe flange (V3) (Figure 155).

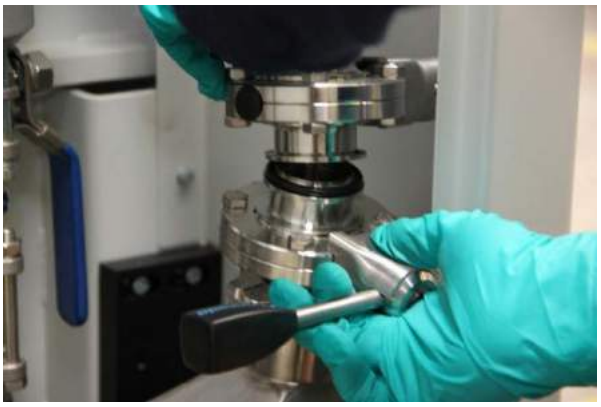


Figure 155 Mate large overflow bottle isolation valve (B1) flange with pipework isolation valve (V3) flange

Slide half the collar of the quick-release clamp (L13) over the edge of the isolating valves (B1 and V3) mating flanges (Figure 156).

Figure 156 Engage first half of the clamp (L13)

Swing the other collar of the quick-release clamp (L13) over the flanges, ensuring that the engaged flanges are secure, then lock the latch on the quick-release clamp (L13) to secure in place (Figure 157).

Figure 157 Engage second half and close clamp (L13)

Open both valves (B1 and V3) to complete the installation of the front (large) overflow bottle (Figure 158). All used metal powder must be sieved to remove part-sintered material before refilling the system.

Figure 158 Open both valves (B1 and V3)

22 Safe change filter and large safe change filter – change

22.1 Safe change filter OR large safe change filter?

WARNING: THE AM250, AM250 WITH PLUSPAC AND AM400 SYSTEMS FEATURE A FILTER TO CAPTURE PROCESS EMISSIONS. THIS FILTER MUST BE CHANGED AFTER EVERY BUILD. THIS APPLIES TO BOTH THE SAFE CHANGE FILTER AND LARGE SAFE CHANGE FILTER.

If your machine is fitted with a safe change filter, (Figure 159) follow the procedure in Section 22.2.

Figure 159 Safe change filter

If your machine is fitted with a large safe change filter, (Figure 160) follow the procedure in Section 22.3

Figure 160 Large safe change filter

22.2 Safe change filter - replace

22.2.1 Removing the safe change filter assembly

WARNING: 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) BEFORE STARTING THIS TASK.

WARNING: DO NOT REMOVE OR ATTEMPT TO CHANGE THE SAFE CHANGE FILTER WHILST A BUILD IS RUNNING.

Caution: Do not close the filter valves (V4 and V5) whilst the machine is running, only when paused or after build completion.

1. The safe change filter must be replaced after every build.

2. Ensure that the four valves (two upper and two lower) on the filter housing (F1 and F2) and system pipes (V4 and V5) are closed (Figure 161 and Figure 162). The handles should be at 90° to the direction of flow.

Figure 161 Lower valves closed (V5 and F2)

Figure 162 Upper valves (F1 and V4) closed

3. Open the latch on the quick-release clamp (L4) between the two upper isolation valves (F1 and V4) at the top of the filter, (Figure 163).

4. Swing one collar of the quick-release clamp (L4) off the upper KF flange connection, whilst supporting the safe change filter assembly.

5. Swing the second collar of the quick-release clamp (L4) off the KF flange connection to disengage the two KF flanges, whilst allowing the safe change filter assembly to drop down onto the retaining bracket (Figure 163).

Figure 163 Remove the upper quick-release clamp (L4)

6. Remove the centring ring from the KF flange at the top of the safe change filter and store it with the quick-release clamp (L4).

7. Open the latch on the quick-release clamp (L5) located between the two lower isolating valves (F2 and V5) at the bottom of the filter, (Figure 164).

Figure 164 Open the latch on the quick-release clamp (L5)

8. Whilst supporting the recirculation pipe, swing one collar of the quick-release clamp (L5) off the KF flange connection, then the second collar to completely remove the clamp (L5) (Figure 165).

Figure 165 Support pipe and remove clamp (L5)

9. Gently place the recirculation pipe into the bottom of the machine.

10. Remove the centring ring from the KF flange at the top of the recirculation pipe and store it with the quick-release clamp (L5).

11. Take a firm grip of the handles on the safe change filter assembly. Slide the safe change filter assembly off the retaining bracket (Figure 166).

Figure 166 Removing safe change filter from retaining bracket

12. The filter element contains fine particulate, which must be neutralised by wetting, flood the filter assembly with water before removing the filter element. This procedure must be followed irrespective of material type processed.

Caution: The safe change filter element contains fine particulate which must be neutralised by wetting.

WARNING: FAILURE TO SUBMERGE THE FILTER ELEMENT BEFORE DISASSEMBLY MAY RESULT IN FIRE.

13. Once the safe change filter assembly has been removed from the machine, begin the neutralising process immediately. Refer to Section 22.2.2 "Changing the filter element".

22.2.2 Changing the filter element

The safe change filter assembly needs to go straight through the disassembly process after removal from the AM250 machine.

WARNING: IT IS MANDATORY TO INERT THE FILTER ELEMENT BY FLOODING THE FILTER ASSEMBLY WITH WATER PRIOR TO DISASSEMBLY. THIS IS BECAUSE THE FILTER ELEMENT CONTAINS SUB-MICRON PARTICLES WHICH DUE TO INCREASED SURFACE AREA CAN IGNITE IN THE PRESENCE OF OXYGEN. THIS APPLIES TO ALL MATERIALS.

WARNING: IN ADDITION TO FLOODING THE FILTER ASSEMBLY WITH WATER THE TOP VALVE (F1) MUST BE LEFT OPEN WHEN WET. THIS IS BECAUSE THE FILTER ELEMENT CONTENTS REACT RAPIDLY WITH WATER TO LIBERATE HYDROGEN GAS; THIS MUST BE PERMITTED TO ESCAPE. FILTER DISASSEMBLY MUST BE CARRIED OUT IN A WELL VENTILATED AREA AWAY FROM POSSIBLE SOURCES OF IGNITION. THIS APPLIES TO ALL MATERIALS.

Ensure that the following conditions are met before starting:

- Ensure the correct PPE is worn before starting – gloves, full face respirator (conforming to EN143 Type P3+A1) 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.
- Immediately clean-up any water spillages and mop the area clean after use.

1. Begin the disassembly process for the safe change filter immediately after removing it from the AM250 system.
2. Take the safe change filter assembly to a water tap location with a hose pipe fitting.
3. Open the upper isolating valve (F1) on the safe change filter assembly and fill with water to just below the top of the valve seal (Figure 167).

Figure 167 Open valve (F1) and fill filter housing

WARNING: TO AVOID HYDROGEN GAS BUILD UP THE FILTER MUST BE DISASSEMBLED AS SOON AS POSSIBLE AFTER WETTING. DO NOT CLOSE THE TOP VALVE (F1) AFTER WETTING. DO NOT STORE WET POWDER IN SEALED CONTAINERS.

4. Assign a drum for filter disposal (Figure 168).

Figure 168 Drum assigned for filter disposal

5. Fill the drum with water and a 5% solution of Hydra-Sol-MAG additive (Part number P-LU08-0004).

6. Open the drum and position the filter assembly above the drum. Open the lower isolating valve (F2) to empty the water drained through the filter element (Figure 169).

Figure 169 Draining water through the filter

7. Once the water has drained from the filter assembly, close the lower isolating valve (F2).

8. Disassemble the filter assembly, using a 6 mm hexagonal key to unscrew the four M8 bolts (Figure 170).

Figure 170 Disassembly of filter assembly

9. Lift the top off the filter assembly and remove the used filter element (Figure 171).

Figure 171 Removal of used filter element from filter housing

10. Store immersed in the storage drum. Replace the lid on the drum, ensuring that the drum remains ventilated, (Figure 172).

Figure 172 Storage of used filter elements in assigned disposal drum

11. Thoroughly clean and dry the filter housing using paper towels. Allow to stand in a dry environment for approximately 24 hours, or in a low temperature oven at a maximum of 50 °C (122 °F), until completely dry.

12. Renishaw recommend stocking an additional filter assembly. Once the fully dry, install a new filter element (part number 790730000), see Section 22.2.3 "Installing a new safe change filter element".

22.2.3 Installing a new safe change filter element

The AM250 features a safe change filter to capture process emissions. This filter element must be changed after every build.

WARNING: NEVER RESTART AN AM250/AM400 SYSTEM WITHOUT REPLACING THE FILTER ELEMENT. NEVER RUN AN AM250/AM400 SYSTEM WITHOUT A SAFE CHANGE FILTER IN PLACE.

1. Prepare the components for assembly (Figure 173).

Figure 173 Safe change filter assembly

2. Take a machine filter element and lightly lubricate the black centring ring seals on the open end using the high vacuum grease supplied in the filter box (Figure 174).

Caution: Ensure that the hollow end of the filter element is facing downwards.

Figure 174 Apply grease to open end

3. Place the filter element into the bottom half of the filter housing, applying firm downward pressure, and rotate slightly to lock in place (Figure 175).

Figure 175 Insert hollow end

4. Apply grease to the seal on the closed end (Figure 176).

Figure 176 Apply grease to closed end seal

5. Replace the top half of the filter housing, ensuring that the upper and lower valves (F1 and F2) are closed (levers are perpendicular to the direction of flow). Insert the four M8 bolts into their assembly position, and tighten until resistance is felt (finger tight) (Figure 177).

Figure 177 Pre-tighten

6. Tighten the bolts using a 6 mm hexagonal key to approximately 15 Nm following the sequence in Figure 178.

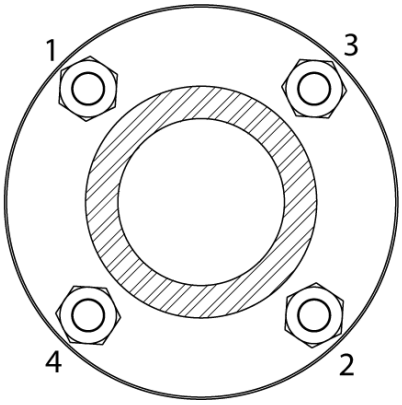


Figure 178 Tightening sequence

7. After completing the installation of a new safe change filter element, the filter assembly should be installed on the AM250 system, see Section 22.2.4 "Installing the safe change filter on the AM250 system".

22.2.4 Installing the safe change filter assembly on the AM250 system

Note: Renishaw recommend fitting the front and rear powder overflow bottles before fitting the safe change filter/large safe change filter assembly.

1. After completing the installation of a new filter element, place a centring ring seal on the upper isolating valve (F1) KF flange of the safe change filter assembly.

2. Slide the safe change filter assembly onto the retaining bracket at the side of the AM250 system, ensuring that all four isolating valves (V4, V5, F1 and F2) are closed (levers are perpendicular to the direction of flow) (Figure 179).

Figure 179 Insert seal, slide onto retaining bracket with valves (F1 and V4)

WARNING: TAKE CARE WHEN REMOVING THE SAFE CHANGE FILTER CLAMP (L4) CLOSE TO THE OXYGEN SENSOR, AS IT MAY BE HOT.

3. Lift the safe change filter assembly slightly and engage the safe change filter upper KF flange with the system outlet KF flange (Figure 180).

Figure 180 Lift safe change filter assembly to top flange

4. Slide half the quick-release clamp (L4) collar over the edge of the engaged flanges (Figure 181).

Figure 181 Slide first half of the clamp (L4) over the flanges

5. Close the quick-release clamp (L4) and ensure that it fully secures the engaged flanges (Figure 182).

Figure 182 Lock clamp (L4)

6. Place a centring ring seal between the system recirculation pipe isolation valve (V5) KF flange and the lower flange of the safe change filter isolating valve (F2).

7. Support the system recirculation pipe isolation valve (V5) against the safe change filter isolating valve (F2) and place one collar of a quick-release clamp (L5) over the two flanges.

8. Swing the second collar of clamp (L5) around to fully secure the flanges. Lock the latch on the quick-release clamp (L5) to complete the assembly (Figure 183).

Figure 183 System recirculation pipe isolation valve (V5) assembled to the lower safe change filter isolation valve (F2)

9. Open all four valves (V4, V5, F1 and F2), the levers will be aligned with the direction of flow, just before the build commences (Figure 184).

Figure 184 Valves (F1, F2, V4 and V5) in the open position

22.3 Large safe change filter - replace

WARNING: 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) BEFORE STARTING THIS TASK.

WARNING: THE AM250/AM400 SYSTEM HAS A LARGE SAFE CHANGE FILTER TO CAPTURE PROCESS EMISSIONS. THE LARGE SAFE CHANGE FILTER CONTAINS A FILTER ELEMENT WHICH MUST BE REPLACED AFTER EVERY BUILD.

- A summary of this procedure is in Section 22.3.1 – Large safe change filter – replace – summary.
- A detailed version of this procedure is in Section 22.3.2 – Large safe change filter – replace – detailed procedure.

22.3.1 Large safe change filter – summary

WARNING: DO NOT REMOVE OR ATTEMPT TO CHANGE THE LARGE SAFE CHANGE FILTER WHILST A BUILD IS RUNNING.

Note: Renishaw recommend fitting the front and rear powder overflow bottles before fitting the safe change filter/large safe change filter.

1. When the AM250/AM400 system is idle, close all four valves (V4, V5, F1 and F2) to retain argon (Figure 185). Remove large safe change filter assembly from the AM250/AM400 to a disassembly area.

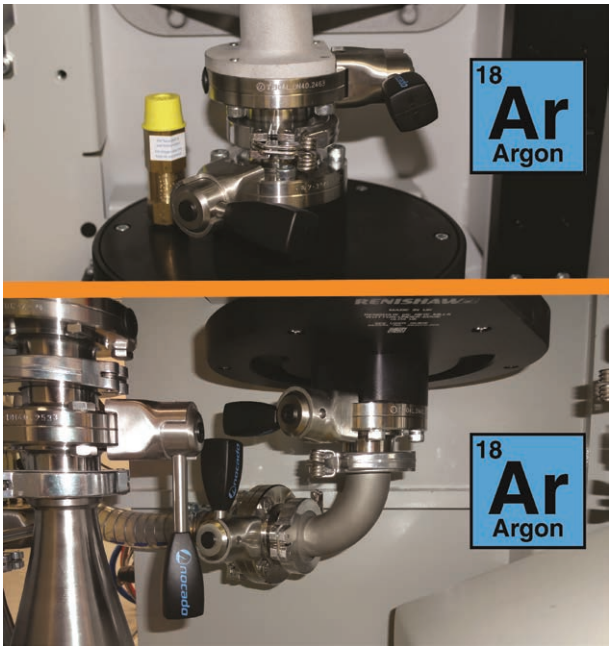


Figure 185 Isolating valves (V4, V5, F1 and F2)

2. Open the upper valve (F1) and fill with water (Figure 186). Check the water level and top-up as necessary. Soak for between three and five minutes. **KEEP VALVE (F1) OPEN**.

Figure 186 Fill large safe change filter assembly with water, check level and top-up

3. Disassemble immediately after soaking for three to five minutes. **DO NOT LEAVE** for longer as hydrogen gas may be formed.

Figure 187 Disassemble immediately after soaking

4. Store used filter element immersed in water in a ventilated container, (Figure 188).

Figure 188 Storage of used filter element

22.3.2 Large safe change filter assembly – detailed procedure

22.3.2.1 Large safe change filter assembly – remove

WARNING: DO NOT REMOVE OR ATTEMPT TO CHANGE THE LARGE SAFE CHANGE FILTER WHILST A BUILD IS RUNNING.

WARNING: DO NOT CLOSE THE LARGE SAFE CHANGE FILTER ISOLATION VALVES (V4, V5, F1 AND F2) WHILST THE AM250/AM400 SYSTEM IS RUNNING. ONLY CLOSE THE ISOLATING VALVES (V4, V5, F1 AND F2) WHEN THE AM250/AM400 SYSTEM IS PAUSED OR AFTER THE BUILD HAS COMPLETED.

WARNING: THE LARGE SAFE CHANGE FILTER ELEMENT MUST BE REPLACED AFTER EVERY BUILD.

1. There are two isolating valves on the large safe change filter assembly, one above (F1) and one below (F2) the filter canister. There is one on the system outlet (V4) and one on the system recirculation (V5) pipes.

2. Operate the four isolating valves on the filter assembly, system outlet and system recirculation pipes (V4, V5, F1 and F2), and move them to the isolated position (Figures 189 and 190). The large safe change filter assembly, system outlet and system recirculation pipes are now sealed.

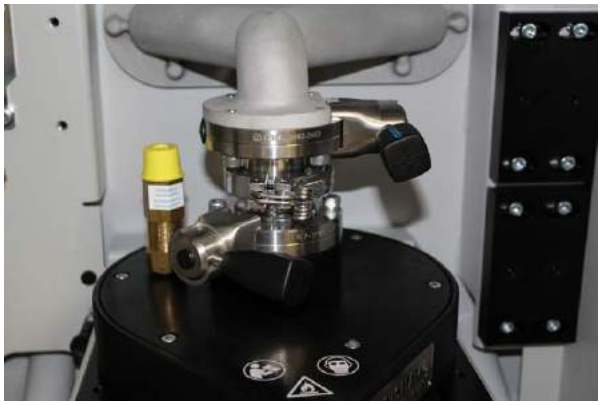


Figure 189 Upper valves closed (V4 and F1)

Figure 190 Lower valves closed (V5 and F2)

3. At the top of the large safe filter assembly, between the two isolating valves (V4 and F1) is the upper quick-release clamp (L4). The upper quick-release clamp (L4) secures the system outlet and upper large safe change filter isolation valve KF40 flanges together.

4. Open the latch on the upper quick-release clamp (L4).

5. Remove the two collars of the quick-release clamp (L4) from the upper KF40 flange connection, and disengage the two KF40 flanges (Figure 191).

Figure 191 Open the latch on the upper quick-release clamp (L4)

6. At the top of the large safe change filter assembly, remove the centring ring from the KF40 flange and store it with the quick-release clamp (L4) until required during refit.

7. At the bottom of the large safe change filter assembly, between the two isolating valves is the lower quick-release clamp (L5). The lower quick-release clamp (L5) secures the lower KF40 flanges together. Open the latch on the lower quick-release clamp (L5) (Figure 192).

Figure 192 Lower quick-release clamp (L5)

8. Support the recirculation pipe and remove the two collars of the quick-release clamp (L5) off the lower KF40 flange connection.

9. Carefully lower the recirculation pipe into the bottom of the AM250/AM400 system.

10. At the bottom of the large safe change filter, remove the centring ring from the KF40 flange and store it with the quick-release clamp (L5) until required during refit.

11. Push down on the large safe change filter sprung bracket until the plunger engages and secures the sprung bracket in the lower position (Figure 193).

Note: The large safe change filter assembly weighs approximately 15 kg when dry. Use suitable lifting equipment as necessary.

Figure 193 Spring plunger

12. Grip the handle with the right hand, support the weight of the large safe change filter assembly at the base with the left hand, and carefully slide it off the sprung bracket and out of the system (Figure 194).

Figure 194 Remove the large safe change filter assembly from the system

WARNING: THE LARGE SAFE CHANGE FILTER ELEMENT CONTAINS FINE PARTICULATE WHICH MUST BE NEUTRALISED BY WETTING.

WARNING: FAILURE TO SUBMERGE THE FILTER ELEMENT IN WATER BEFORE DISASSEMBLY MAY RESULT IN FIRE.

13. The filter element contains fine particulate, which must be neutralised by wetting. The large safe change filter assembly must be filled with water before removing the filter element. This procedure must be followed regardless of the material type being processed.

WARNING: THE LARGE SAFE CHANGE FILTER ASSEMBLY WEIGHS APPROXIMATELY 30 KG WHEN FULL OF WATER. USE SUITABLE LIFTING EQUIPMENT TO SUPPORT THE WEIGHT OF THE LARGE SAFE CHANGE FILTER ASSEMBLY IN AN UPRIGHT POSITION.

14. Filling the large safe change filter assembly with water will increase its weight to approximately 30 kg. The increased weight and awkward shape of the large safe change filter assembly make it unsuitable for one person to manually handle. Use two people or suitable lifting equipment to support its weight upright. Renishaw recommends that this task is risk assessed according to the customers local rules before it is carried out.

15. Renishaw recommend using a Renishaw silo changeover lift, part number A-5771-1000 fitted with a large safe change filter support bracket to move the large safe change filter assembly when full of water (Figure 195).

Figure 195 Renishaw silo changeover lift fitted with large safe change filter assembly support bracket

16. Ensure that the following precautions are put into practice:

- Ensure the correct PPE is being worn. Protective eye wear, full face respirator (conforming to EN143 Type P3+A1), 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) and rubber or plastic gloves, are essential for this task.
- Immediately clean-up any water spillages and mop the area clean and dry after use.

17. Using suitable lifting equipment take the large safe change filter assembly to a water tap location with a hose pipe fitting.

18. On the large safe change filter assembly, open the upper isolating valve (F1), insert a hose and fill with water until full (Figure 196). The full level is just below the top of the valve seal.

Figure 196 Open valve (F1) and fill the filter chamber with water

19. When the large safe change filter assembly is full, observe the water level, if the water level drops, add more water. Continue observing the water level and adding more water as necessary until the water level has stabilised just below the top of the valve seal. This may take several minutes.

WARNING: THE LARGE SAFE CHANGE FILTER ASSEMBLY MUST BE COMPLETELY FILLED WITH WATER TO NEUTRALISE THE FINE PARTICLES IN THE FILTER ELEMENT.

20. After filling with water DO NOT close the upper isolating valve (F1).

21. Leave the filter to soak in water for three to five minutes before disassembling it. DO NOT leave the filter to soak for more than five minutes. See Section 22.3.2.2 – "Large safe change filter element – remove".

22.3.2.2 Large safe change filter element – remove

The large safe change filter assembly must be disassembled after removal from the AM250/AM400 system and soaking in water for three to five minutes.

WARNING: THE LARGE SAFE CHANGE FILTER ELEMENT CONTAINS FINE PARTICULATE WHICH MUST BE NEUTRALISED BY WETTING.

WARNING: TO AVOID HYDROGEN GAS BUILD UP THE LARGE SAFE CHANGE FILTER ASSEMBLY MUST BE DISASSEMBLED AS SOON AS POSSIBLE AFTER WETTING.

WARNING: DO NOT CLOSE THE UPPER ISOLATION VALVE (F1) AFTER WETTING.

1. Locate the filter disposal drum and open it (Figure 197).

Figure 197 Filter disposal drum

2. If the drum is empty, fill it with enough water to submerge the filter element and a 5% solution of Hydra-Sol-MAG additive (Part number P-LU08-0004).

3. Position the lifting equipment supporting the large safe change filter assembly above the drum.

4. Open the lower isolating valve (F2) and empty the water from the large safe change filter assembly into the drum (Figure 198).

Figure 198 Filter disposal drum

5. When the water has drained from the large safe change filter assembly, close the lower isolating valve (F2).

6. When the drum becomes full, ensure the contaminated water and filters are disposed of by suitably licenced waste contractors in accordance with the applicable local legislation.

7. Using a 5 mm hex key, remove the six M5 bolts securing the top cover of the large safe filter assembly (Figure 199).

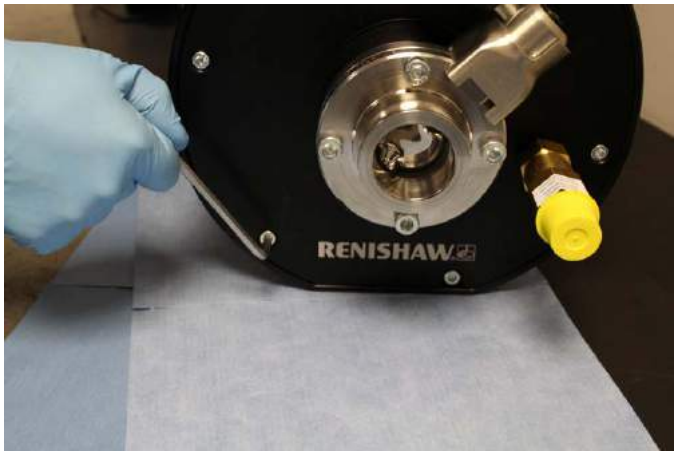


Figure 199 Disassemble the large safe change filter assembly

8. Lift the top cover off the large safe change filter assembly and remove the used filter element (Figure 200).

Figure 200 Remove used filter element from large safe change filter assembly

9. Dispose of the used filter element in the filter disposal drum and ensure it is fully submerged (Figure 201).

Figure 201 Dispose of used filter element in the filter disposal drum

10. Refit the lid to the drum. Ensure that the drum remains ventilated.

11. Wipe the filter chamber and top cover inside and out with isopropanol alcohol and a disposable cloth to remove any residue.

12. To reduce system down time, Renishaw recommend that a second filter assembly is purchased. Drying time will depend upon ambient humidity and temperature - it is important that moisture is not introduced into the AM250/AM400 system. Recommended drying times (following a dry wipe) is 4 hours for the large safe change filter chamber and top cover.

13. At the top of the filter chamber check the o-ring seal. Ensure it is fitted correctly. Ensure there are no signs of damage or deformation that will affect its ability to seal. Replace the o-ring as necessary (Figure 202).

Figure 202 Filter chamber o-ring seal

14. Once the filter chamber is fully dry, install a new filter element from the filter kit (part number A-5778-6000), see Section 22.3.2.3 – Large safe change filter element – refit.

22.3.2.3 Large safe change filter element – refit

WARNING: NEVER RESTART AN AM250/AM400 SYSTEM WITHOUT A FILTER INSTALLED. NEVER RESTART AN AM250/AM400 SYSTEM WITH A USED FILTER.

1. Open the packaging and remove the filter element.

WARNING: ENSURE THAT THE OPEN END OF THE FILTER ELEMENT IS AT THE OPEN END OF THE FILTER CHAMBER.

2. Fit the filter element into the filter chamber. The closed end of the filter element must be at the closed end of the filter chamber.

3. Ensure the filter element is centred in the filter chamber.

4. Refit the top cover to the filter chamber.

5. Refit the six M5 bolts securing the top cover to the filter chamber.

6. Torque tighten the bolts to 20 Nm in a diagonal sequence, using a 5 mm hex key and a suitable torque wrench.

7. On the large safe change filter assembly ensure the upper (F1) and lower (F2) isolating valves are closed, the handles will be at 90° to the direction of gas flow.

8. Once the filter element has been replaced install the large safe change filter assembly into the AM250/AM400 system, see Section 22.3.2.4 – "Large safe change filter assembly – refit".

22.3.2.4 Large safe change filter assembly – refit

Note: Renishaw recommend fitting the front and rear powder overflow bottles before fitting the large safe change filter.

After completing the procedure for fitting a new filter element to the filter chamber, the large safe change filter assembly must be fitted to the AM250/AM400 system.

WARNING: DO NOT CLOSE THE LARGE SAFE CHANGE FILTER ISOLATING VALVES (F1 AND F2) WHILST THE AM250/AM400 SYSTEM IS RUNNING. ONLY CLOSE THE ISOLATING VALVES (F1 AND F2) WHEN THE AM250/AM400 SYSTEM IS PAUSED OR AFTER THE BUILD HAS COMPLETED.

Note: The large safe change filter assembly weighs approximately 15 kg when dry.

1. Check that the large safe change filter sprung bracket is in the lower position. If it is not, push down on the sprung bracket until the plunger engages and secures the bracket in the lower position.

2. Grip the large safe change filter handle with the right hand, support the weight at the base with the left hand, and carefully slide it on to the sprung support bracket in the AM250/AM400 system (Figure 203).

3. Obtain the upper and lower quick-release clamps (L4 and L5) and centring rings removed during filter assembly removal.

Figure 203 Refit the large safe change filter assembly to the sprung support bracket

4. Check the two centring ring seals are free from damage and deformation. Replace the seals as necessary.

5. Place one centring ring on the upper KF40 flange of the large safe change filter assembly.

6. Operate the plunger and raise the large safe change filter assembly to engage the filter assembly KF40 flange with the system outlet KF40 flange.

7. Fit the quick-release clamp (L4) over the KF flanges.

8. Close the quick-release clamp (L4) collars and ensure that it fully secures the engaged flanges.

9. Close the latch on the quick-release clamp (L4) to fully secure the quick-release clamp, (Figure 204).

10. Place the second centring ring on to the KF flange of the system recirculation pipe.

Figure 204 Close the latch on the upper quick-release clamp (L4)

11. Lift the system recirculation pipe and bring its KF flange together with the lower KF flange of the large safe change filter isolation valve (F2).

12. Support the system recirculation pipe and fit the quick-release clamp (L5) over the KF flanges.

13. Close the quick-release clamp (L5) collars and ensure that it fully secures the engaged flanges.

14. Close the latch on the quick-release clamp (L5) to fully secure the quick-release clamp.

15. There are four isolation valves on the large safe change filter assembly, system outlet pipe (V4), system recirculation pipe (V5), large safe change filter upper isolation valve (F1) and large safe change filter lower isolation valve (F2). Check that all four valves are all in the closed position, (Figure 205).

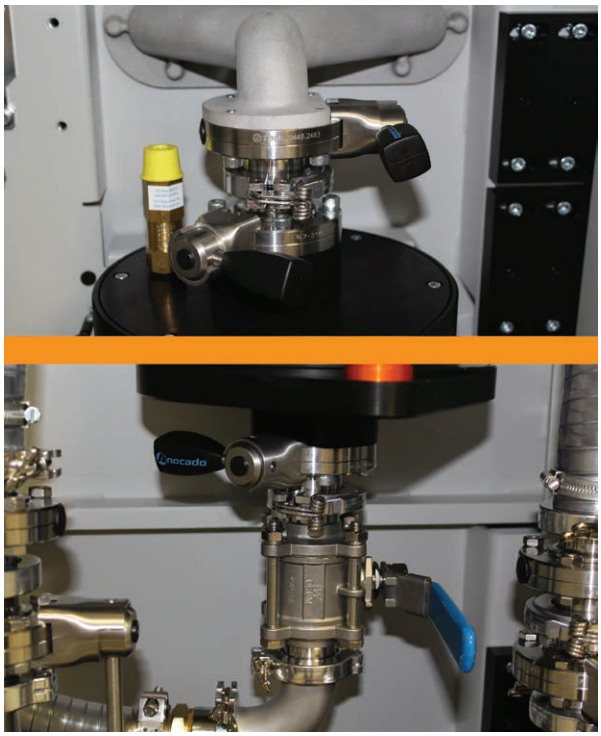


Figure 205 Upper and lower isolating valves (F1, F2, V4 and V5) in the closed position

23 Preparing the build chamber

23.1 Build plate requirements

The build plate is the surface upon which the build process takes place. It is covered by progressive layers of metal powder which are selectively melted and fused to the adjacent created layer in order to create a homogeneous solid component.

It is a sacrificial consumable and can be re-machined and used again, providing the tolerances detailed in Appendix A of this manual are adhered to. Replacements can be purchased from your local Renishaw office.

The substrate plate is secured onto the top surface of the z-axis table housed in the bottom chamber using M5 cap screws. It is accessed via the upper process chamber door of the AM250/AM400 system.

CAUTION: DO NOT USE ZINC PASSIVATED SCREWS TO SECURE THE BUILD PLATE TO THE Z-AXIS. THERE IS A POSSIBILITY OF ZINC FUMES BEING EMITTED AND THE SCREWS BECOMING BRITTLE WHEN THE BUILD PLATE IS HEATED BEFORE THE BUILD COMMENCES.

Each material requires a compatible substrate material. Ideally all plates should be indelibly marked (such as engraved or stamped) on the edge of the plate to indicate their material composition.

23.2 Homing the wiper

Before installing the substrate, first ensure that the wiper is in the home position at the back of the AM250/AM400 system. To do this, first close the system door, press the blue reset button on the front of the system and then select the **Find Wiper Home** home button (Figure 206):

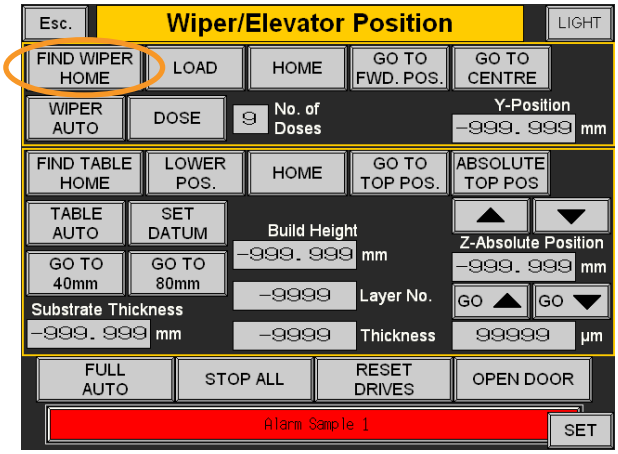


Figure 206 Select Find wiper home

> Wiper/Elevator Control > Find Wiper Home

Once the wiper is homed, the button will turn red and the Y position readout will be stable.

23.3 Installing the build substrate

Follow the process described in Section 17 to open the system door.

Select a build substrate in a suitable material for the powder being processed.

WARNING: BUILD SUBSTRATES CAN BE HEAVY. A STAINLESS STEEL SUBSTRATE WEIGHS 7.5 KG, TITANIUM 4 KG AND ALUMINIUM 3 KG. HANDLE SUBSTRATES CAREFULLY TO AVOID INJURY AND DAMAGE TO THE SUBSTRATE.

Clean-down the substrate with isopropanol to remove any machining fluid residue, taking care to ensure that the surface is completely dry (Figure 207).

WARNING: ALWAYS CLEAN AWAY ISOPROPANOL RESIDUES TO AVOID CHEMICAL REACTIONS WITH CARBON STEEL.

Figure 207 Wipe with IPA

Using an appropriate measuring device such as a micrometer or digital calliper, measure the substrate at each corner (Figure 208).

Figure 208 Measure thickness

Take an average reading and ensure that the mean reading does not deviate more than 0.05 mm (0.002 in) between the highest and lowest measurements. If in doubt, see Section 36 Appendix A " AM250/AM400 build plate drawings".

From the AM250/AM400 system control interface main menu select the following:

> Wiper/Elevator Control

Select the value for the **Substrate Thickness** and input the average of the measured substrate thickness using the number pad, and then press Enter (Figure 209).

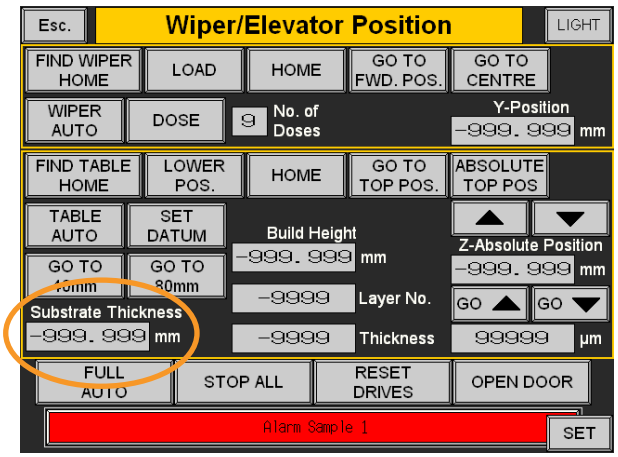


Figure 209 Enter average of measured thickness

Ensure that the wiper is at the home position at the rear of the platform, then place the substrate on the platform with the counter-bored holes facing upwards (Figure 210).

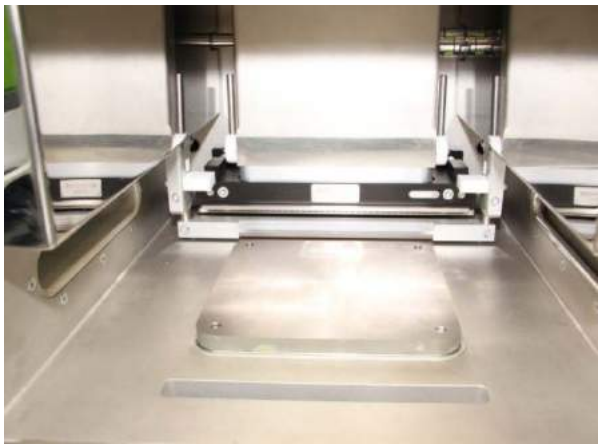


Figure 210 Place build plate on platform

Caution: Ensure a build plate is fitted as building directly on to the system substrate will damage the z-axis of the AM250/AM400 system.

Caution: Although the build plate can be installed in any of four positions, the front of the build plate is marked with a shallow blind hole in the centre of the front edge, (Figure 211).

Figure 211 Build plate front edge identification

WARNING: DO NOT USE ZINC PASSIVATED SCREWS TO SECURE THE BUILD PLATE TO THE Z-AXIS. THERE IS A POSSIBILITY OF ZINC FUMES BEING EMITTED AND THE SCREWS BECOMING BRITTLE WHEN THE BUILD PLATE IS HEATED BEFORE THE BUILD COMMENCES.

Insert the four M5 bolts and tighten to between 3 Nm and 5 Nm (2.2 lbf/ft and 3.7 lbf/ft) using a 4 mm hexagon key (Figure 212) and a suitable torque wrench. Tighten opposing corners in pairs.

Figure 212 Insert and tighten the four bolts

Close the door and reset the **Emergency Stop** operated error by pressing the blue reset button (Figure 213).

Figure 213 Press blue reset button

Still in the **Wiper Elevator Control** menu, select **Find Wiper Home** then select **Go To Top Position** (Figure 214).

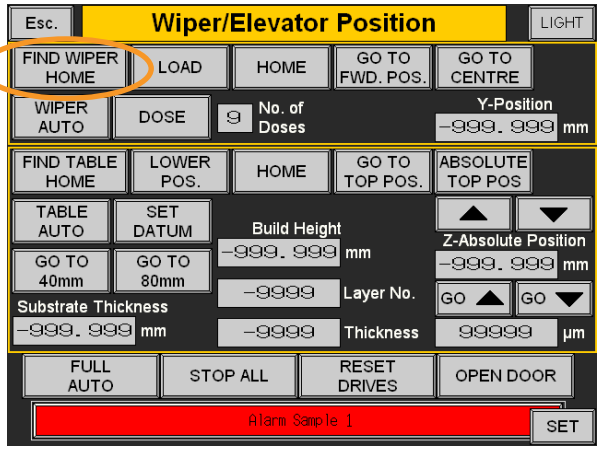


Figure 214 Press Find wiper home then Go to top pos.

The build plate installation is now complete.

24 Installing and setting the wiper blade

24.1 Installing the wiper blade

The wiper housing is made from two pieces of aluminium and is secured together with M4 cap screws and requires an M3 hexagon key for disassembly and reassembly. Removing the cap screws along the entire length of the aluminium housing allows the old blade insert to be rotated to a clean area prior to refitting the cap screws and tightening. Alternatively, replace the wiper material if it is too badly damaged to continue. A replacement wiper insert is available from your local Renishaw office.

Description: Silicone wiper blade

Part number: M-5774-0886

Wiper blades may be reused several times by rotating the silicone rubber, however if damaged it is prudent to replace it after every build.

To replace the wiper blade insert, first measure a length of silicone wiper blade to 259 mm ±1 mm (10 5⁄32 in to 10 15⁄64 in) using a rule (Figure 215).

Figure 215 Measurement of silicone rubber

Cut the rubber using a pneumatic pipe cutter or scalpel (Figure 216).

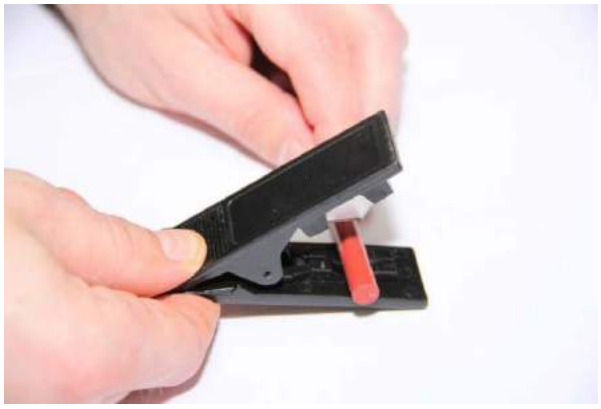


Figure 216 Cut with pipe cutter

Gauge the cut length using the blade assembly – it should just fit in the chamfer. If it is too long, re-cut it (Figure 217). Note that an oversize insert can cause distortion and poor powder surface, leading to failed builds.

Figure 217 Gauge length using blade assembly

Loosen the five M4 bolts of the wiper blade housing using a 3 mm hexagon key (Figure 218).

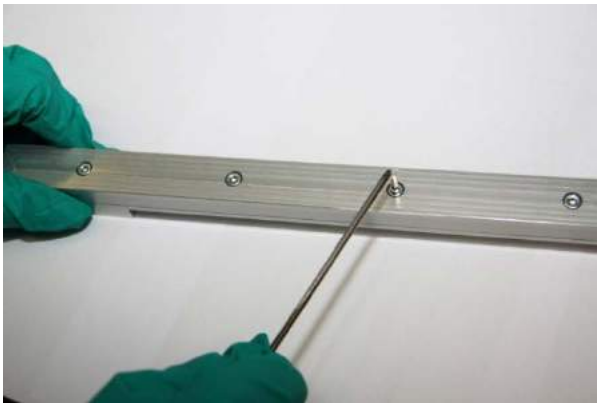


Figure 218 Loosening of bolts in wiper blade retainer

Unscrew until the heads are proud, do not remove them completely (Figure 219).

Figure 219 Unscrew until head is proud

Insert the cut length of the silicone wiper blade (Figure 220).

Figure 220 Insertion of rubber silicone into the wiper blade retainer

Check the gap left at both ends of the wiper – it should not pass the start of the radius arrowed (Figures 221 and Figure 222).

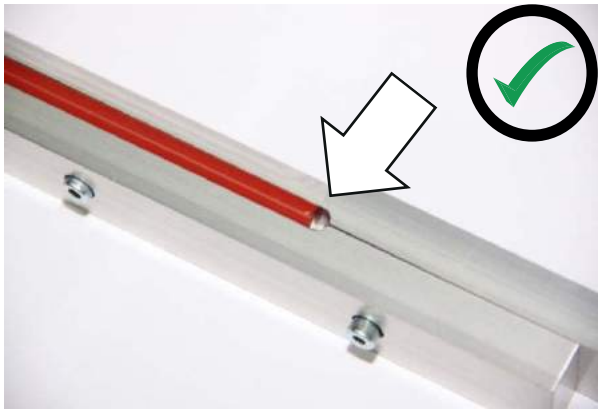


Figure 221 Correctly align with chamfer

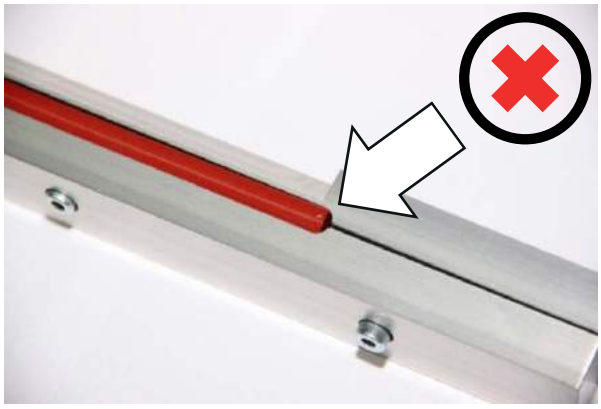


Figure 222 Incorrectly – past the chamfer

Using a flat surface, such as a surface table, press down firmly on the reverse side of the wiper housing and tighten from the centre the five M4 retaining bolts using a 3 mm hexagon key. Do not overtighten – 2 Nm (1.5 lbf/ft) maximum (Figure 223).

Figure 223 Tightening of bolts to clamp silicone rubber into the wiper blade retainer

Ensure even pressure across the blade to prevent deformation of the silicone. This is helped by laying the wiper on a flat surface and applying slight pressure.

24.2 Setting up the wiper

Ensure that the substrate thickness has been entered and that the substrate is at the top position. Select the following (Figure 224 and Figure 225):

Wiper/Elevator Control > Go To Top Pos

Close the door and reset the emergency stop.

Use the **Go To Centre** button on the Wiper/Elevator Position page of the HMI touch screen to send the wiper to the centre position (Figure 224 and 225):

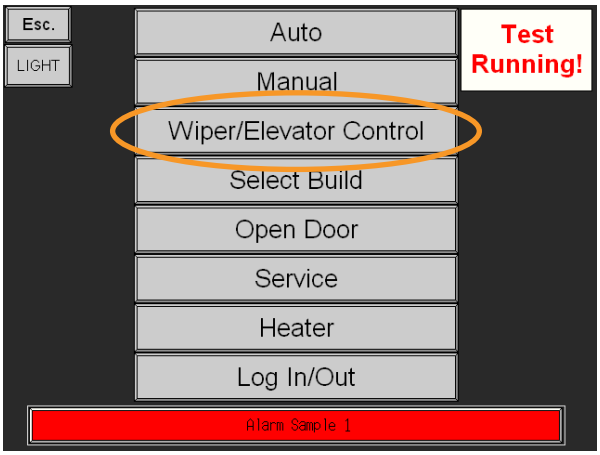


Figure 224 Wiper/Elevator control

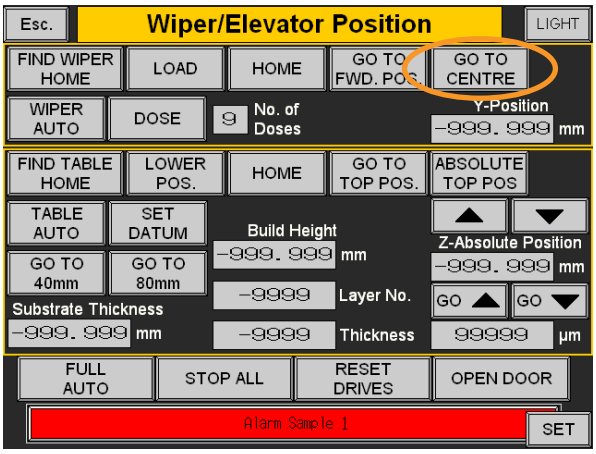


Figure 225 Go to centre

Wiper Elevator Control > GO TO CENTRE

Open the door as described in section 18.1.

Install the wiper assembly into the system using the two M6 cap screws and an M5 hexagon key (Figure 226).

Figure 226 Securing the wiper

Once the wiper assembly is secured in place, loosen the pinch bolt (Figure 227) on the driven uprights to allow adjustment in the Z height of the wiper blade assembly (Figure 228).

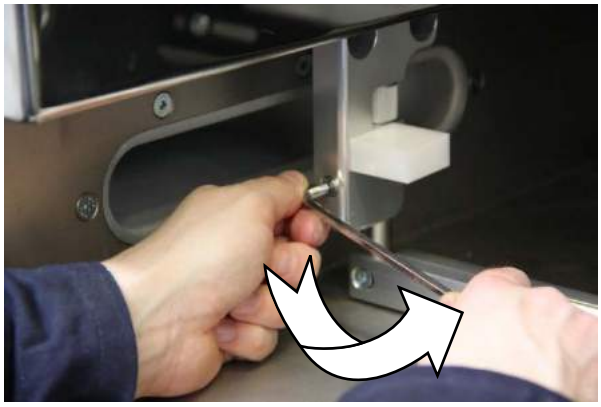


Figure 227 Loosen the pinch bolt

Figure 228 Thumb screw adjustment

Turn the thumb screw clockwise to raise the wiper blade, and anti-clockwise to lower the wiper blade.

Raise the wiper blade allowing sufficient space to place a 0.05 mm (0.002 in) feeler gauge under the wiper blade (Figure 229).

Figure 229 Feeler gauge used to set wiper blade z height

Lower the wiper blade and use the feeler gauge to ensure an even 0.05 mm (0.002 in) gap between the wiper and the substrate – measure in at least three places.

There should be even pressure and resistance on the feeler gauge across the width of the substrate.

Tighten the pinch bolts on the wiper arm using a 5 mm hexagon key (Figure 230).

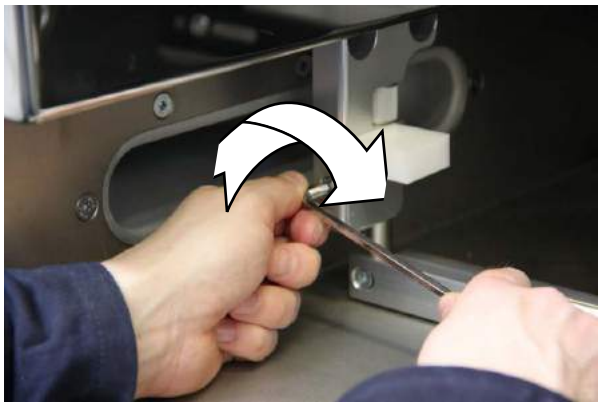


Figure 230 Tighten the upper bolts on wiper

After setting up the wiper blade, close the chamber door, and reset the alarm.

Caution: The wiper must be setup (0.05 mm (0.002 in) above the substrate) before dosing or moving to home position. Failure to set the height can result in the wiper assembly hitting the doser, and subsequent damage.

To set the dosing level to 3 in the control window, enter **3** into **No. of Doses** (Figure 231):

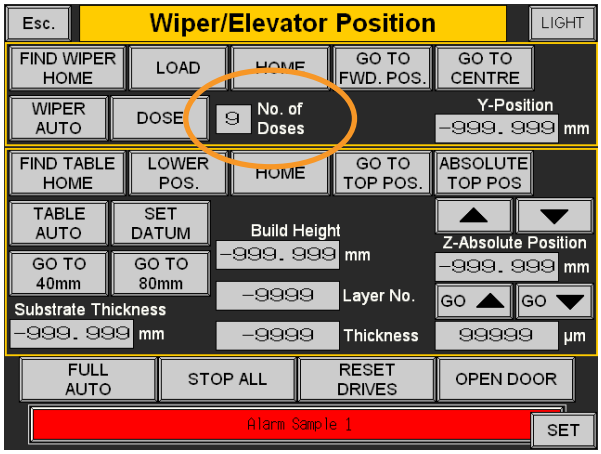


Figure 231 Set No of doses to 3, dose, then go to FWD POS

Wiper/Elevator Control > No of Doses

Dose the powder (Figure 231):

Wiper/Elevator Control > Dose

Send the wiper to the forward position (Figure 231):

Wiper/Elevator Control > GO TO FWD. POS.

The first powder layer should be an even spread across the whole of the substrate, and the substrate should still be visible, whilst all four bolt holes are completely full of powder (Figure 232).

If the layer is not even – repeat the setup steps and check again.

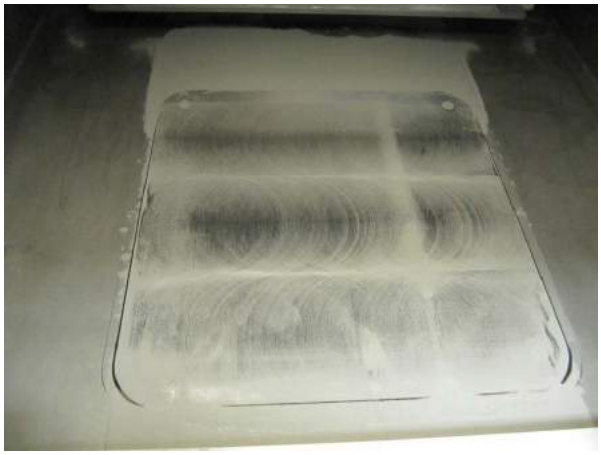


Figure 232 Ensure a thin and even distribution

25 Build platform heater

25.1 Heat soak procedure

The use of the heated build plate is guided by the choice of materials. It can aid material flow and assist the processing of some materials. Above 70 °C (158 °F) the door remains interlocked and does not allow the main process chamber door to be opened.

WARNING: IT IS POSSIBLE TO ACCESS THE CHAMBER VIA THE GLOVE BOX WHILST THE HEATER IS ON. ALWAYS CHECK THE CHAMBER TEMPERATURE VIA THE HMI TOUCH SCREEN BEFORE OPENING THE GLOVE BOX DOOR AND PROCEED WITH CAUTION.

Login at the delegated user level and select the heater from the main menu on the control interface (Figure 233). Enter the required material temperature (Figure 234). Always refer to the material file supplied with your metal powder for the most accurate temperature to suit your application.

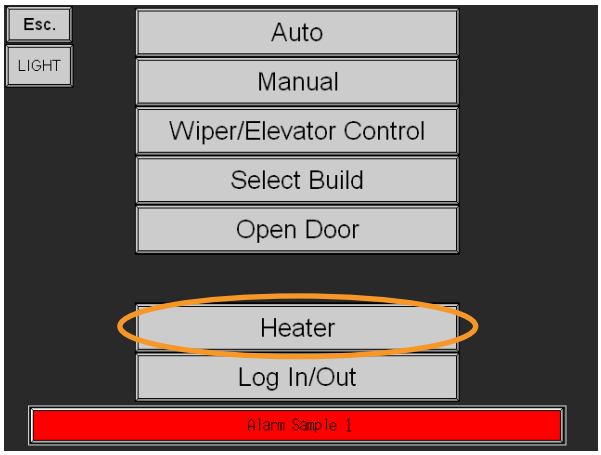


Figure 233 Select heater

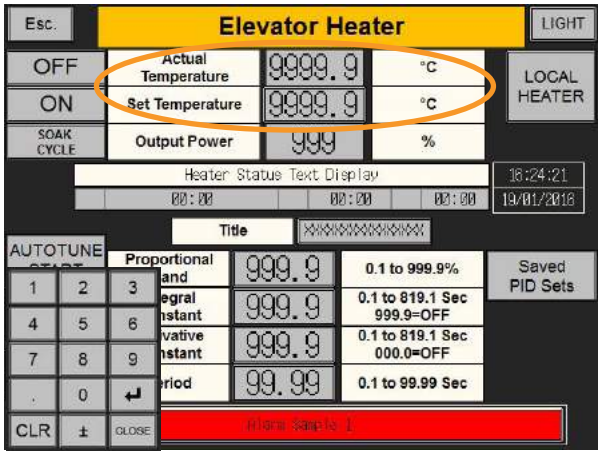


Figure 234 Enter temperature

Heater > Set Temperature > Enter the required material temperature

Always refer to the material file supplied with your metal powder for the most accurate temperature to suit your application. If the material file is not available or you would like further advice contact your local Renishaw office, www.renishaw.com/contact

Begin the heater soak cycle by selecting the following on the control interface (Figure 235):

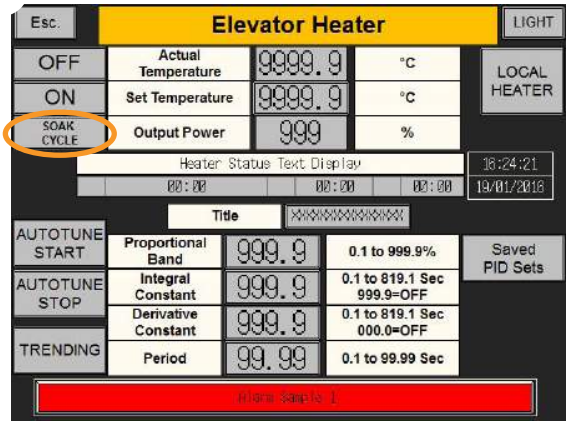


Figure 235 Press Soak Cycle

Heater > Soak Cycle

The heat soak process lasts for 40 minutes – this is to allow an even temperature throughout the build chamber.

Caution: Do not attempt to drive the z-axis until the heat soak process is complete. Always allow 30 minutes for the system temperature to stabilise before driving the z-axis if the heat soak process is aborted.

25.2 Heater tuning

25.2.1 Summary

The AM250/AM400 is fitted with a heated build plate, this will be factory set for optimum performance. If a significantly thicker build plate is used or the **Heater May Require Tuning** alarm message appears there is an **Autotune** function which will determine the settings required for the best heater response. (**Proportional Band**, **Integral Constant** and **Derivative Constant**).

Note: This requires level 2 access with software version 2.39 or greater, and level 3 access with earlier software versions.

Heater setup must be performed under an inert atmosphere and with the build plate installed, as both will affect the thermal characteristics.

25.2.2 System preparation

Install a build plate and setup the system, ensure there is no powder in the chamber.

Set the user oxygen threshold to 1000 parts per million and start the **Semi Automatic Chamber Preparation** with vacuum.

Leave the system to prepare.

25.2.3 Automatic tuning

Select **Heater** (Figure 236).

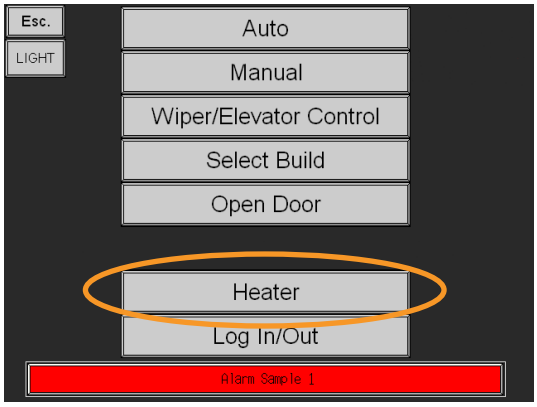


Figure 236 Select heater

Adjust the set **Set Temperature** to 100 °C.

Ensure the **Period** is 1 second.

Press **On** followed by **Autotune Start** (Figure 237).

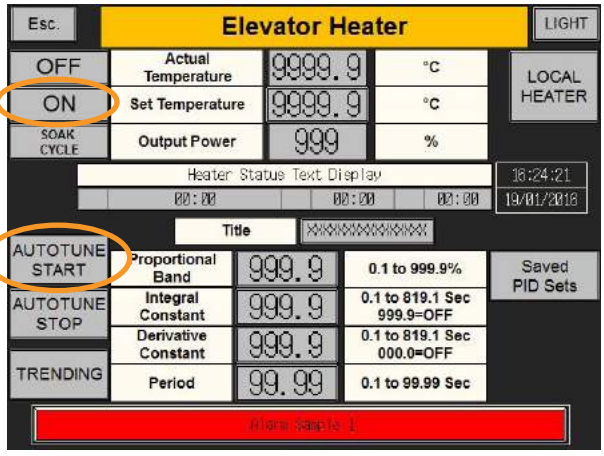


Figure 237 Set temperature to 100 °C, period 1, On, Autotune Start

The progress can be monitored by pressing **Trending** button to show the graph (Figure 238) which displays set-point (**SP**), present value (**PV**) and % demand (**MV**). The auto tune process will take approximately 10 to 20 minutes.

On completion of the auto tune process record the new **Proportional Band**, **Integral Constant**, and **Derivative Constant** will be saved.

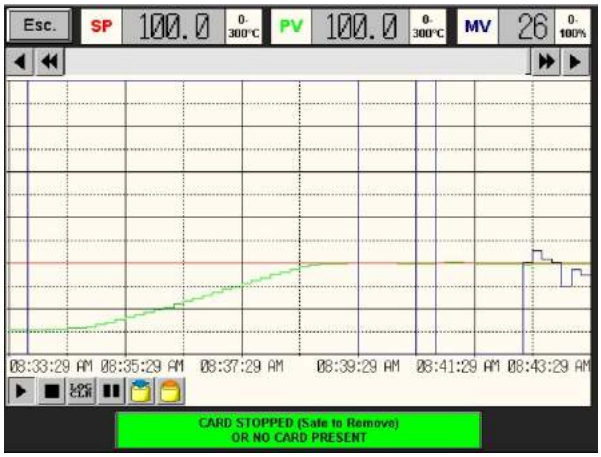


Figure 238 Temperature and demand graph

Leave for 40 minutes to settle, once stable the demand (**MV**) should only fluctuate slightly (Figure 239).

Figure 239 Stable temperature and demand

If the heater demand (**MV**) oscillates and does not quickly settle it may be necessary to repeat the process a 2nd or 3rd time (Figure 240 and Figure 241).

Figure 240 Demand oscillations

Figure 241 Demand oscillations hitting zero

25.2.4 Testing

The heater should be permitted to cool before testing, this may take several hours.

Change the set temperature to 170 °C.

Switch the heater **On**.

Open the graph by pressing **Trending**.

The duty of the heater should start at 100% and drop as the temperature reaches target value. Temperature should not overshoot the target temperature (Figure 242).

Figure 242 Demand at 100 % as temperature increases

Demand and temperature should then both stabilise.

Leave a further 40 minutes to heat soak, the demand and temperature should now both be stable as shown, (Figure 243).

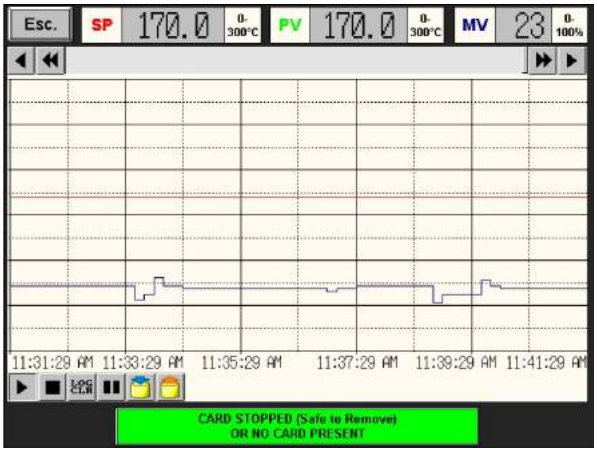


Figure 243 Consistent heater duty at 170 °C

Press **Off** on the Elevator Heater page and wait for the system to cool.

26 Transferring a build

26.1 Setting up a file transfer service

Install a suitable FTP transfer service.

Note: Renishaw recommend using WinSCP for file transfer. WinSCP is freeware.

Figure 244 WinSCP icon

Save your Renishaw system location with the following settings (Figure 245):

File protocol:	FTP (File Transfer Protocol)
Host name:	The IP (Internet Protocol) address can be found on the service menu of the AM system (this can be renamed to the assigned system name if required)
User Name:	AM-User
Password:	ampdam250 (case sensitive)

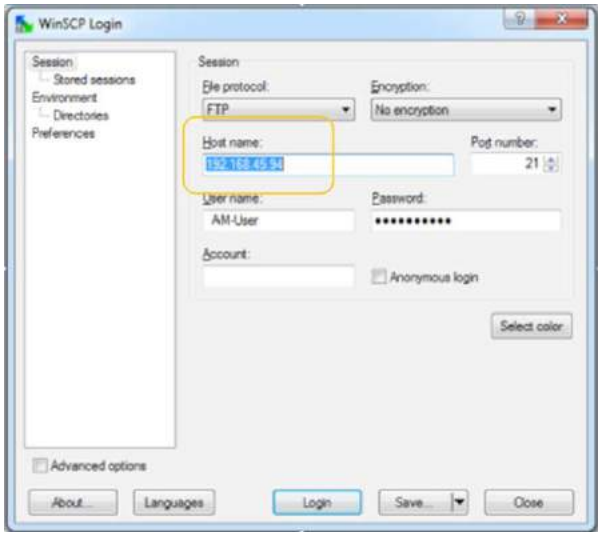


Figure 245 Login details

26.2 Sending a file to the system

Open WinSCP.

Select your system name from the network addresses and login (Figure 246):

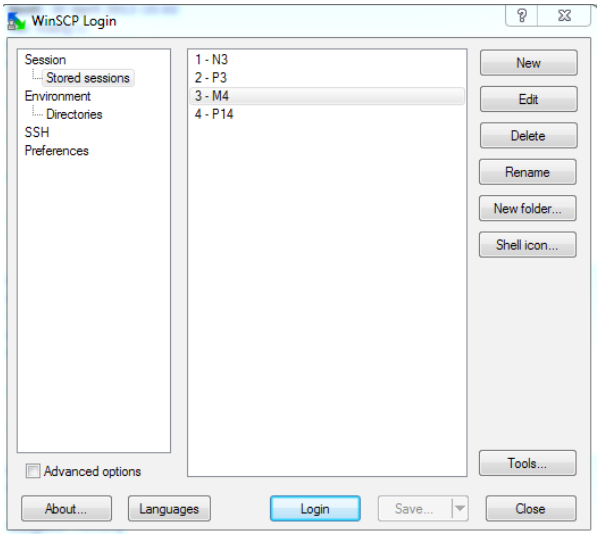


Figure 246 Select system

Navigate to the directory where your .mtt file is saved and drag the file into the **Builds** folder in the right hand column (Figure 247). Accept the prompt to copy.

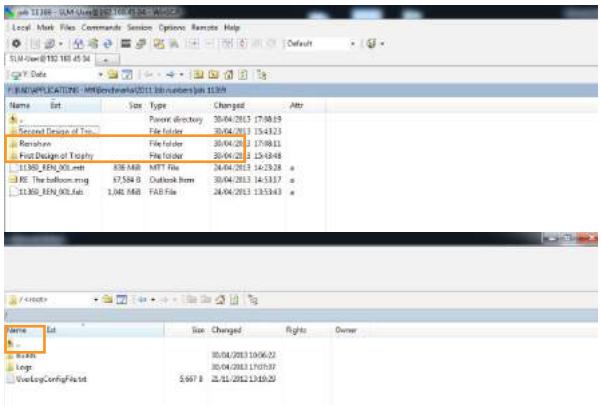


Figure 247 Drag file into build folder

26.3 Setting up FTP

If using a standalone computer connected to the system the passive FTP, which is usually set during the system setup, must be reset after a Windows update. Automatic updating of windows should also be switched off. If this is not done there may be communication failures when transferring builds.

Resetting the File Transfer Protocol

1. Open **Control Panel** (Figure 248) then **Internet Options** (Figure 249).

2. Select **Advanced** from the top bar menu.

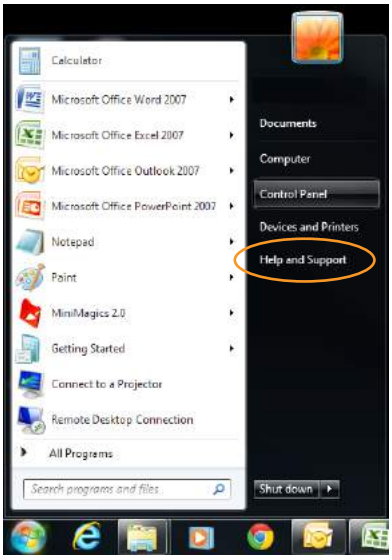


Figure 248 Control panel

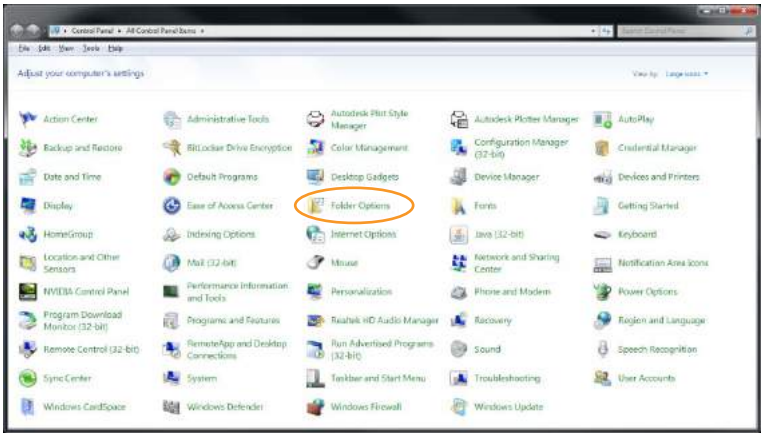


Figure 249 Internet options

3. Scroll to **Browsing**.

4. Deselect **Use passive FTP (for firewall and DSL modem compatibility)**.

Controlling future windows updates

To prevent Windows from automatically updating, and overwriting the FTP settings, complete the following steps:

1. Select **Control Panel**, then **Windows update**.

2. Select **Change settings** (Figure 250).

Figure 250 Select change settings in windows update

3. Using the drop down menu, select **Let me chose whether to download and install updates**. This will prevent Windows from automatically changing the FTP settings (Figure 251).

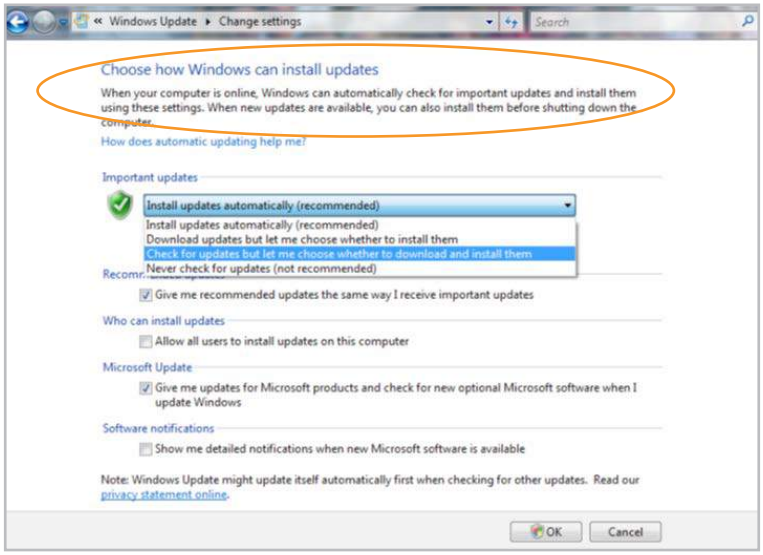


Figure 251 Select Let me choose whether to download and install updates

4. If manual updates are made, it may be necessary to reset the FTP settings again after the update.

26.4 Selecting a file from the list

Transferring a build onto the system is done via a local network connection from the file preparation PC to the system. Once completed, the build will appear in the **Select Build** menu (Figure 252).

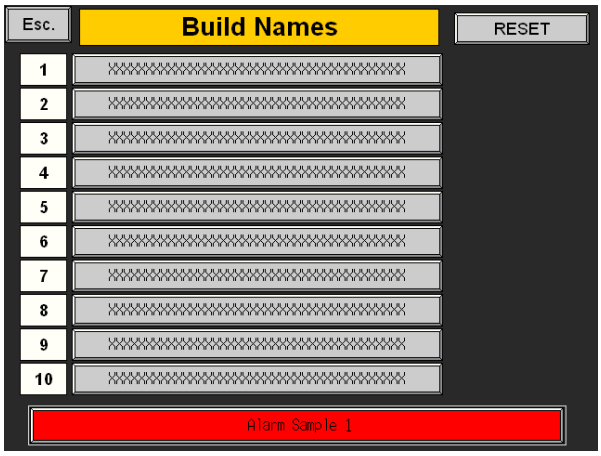


Figure 252 Select build menu

Note: Up to ten build files can be stored on the AM250/AM400 system.

27 Starting the build

Check that all the steps have been completed and all the necessary system checks are complete. In particular pay attention to:

- Powder level via the HMI
- Pressure of gas in the argon bottle
- Regulated argon pressure
- Condition of the chiller, ensuring that fluid levels are close to the upper level marker

27.1 Process checks

Confirm each of the steps have been completed before starting the build:

- Ensure the system has been cleaned down
- Login to AM250/AM400 control interface, open door
- Confirm chamber pressure is reading zero, if not see Section 18.3 – "Checking the pressure sensor"
- Transfer powder from supplier's container to system powder bottle
- Load powder
- Install substrate
- Assemble/install wiper. Dose powder to check for even distribution
- Heat soak procedure
- Install front and rear overflow bottles
- Install safe change filter assembly OR large safe change filter assembly
- Check argon cylinder pressure greater than 25 bar, supply pressure less than 2 bar
- Check the valve positions:
  Safe change filter/large safe change filter – 4 open (V4, V5, F1 and F2)
  Overflow bottles – 4 open (A1, B1, V2 and V3)
  Silo filling valve – 1 closed (V1)
- Select file and start build

27.2 Initiating the build

First of all double-check all the valve positions are correct. The system will not operate correctly unless:

- Safe change filter/large safe change filter – four valves are open (V4, V5, F1 and F2)
- Small rear overflow bottle – both bottle and pipe valves are open (A1 and V2)
- Large front overflow bottle – both bottle and pipe valves are open (B1 and V3)
- Silo – top valve is closed – even if a bottle is present (Figure 219) (V1)
- Silo – dosing valve is open (Figure 253) (IV1)

Figure 253 Silo top valve in closed position (V1)

The KF valve is open when aligned with the flow direction, and shut when the lever is 90° to the direction of flow (Figure 219).

Note: The silo dosing valve (IV1) is an exception to the rule and is open when perpendicular to flow (parallel to the ground – shown in inset of Figure 254).

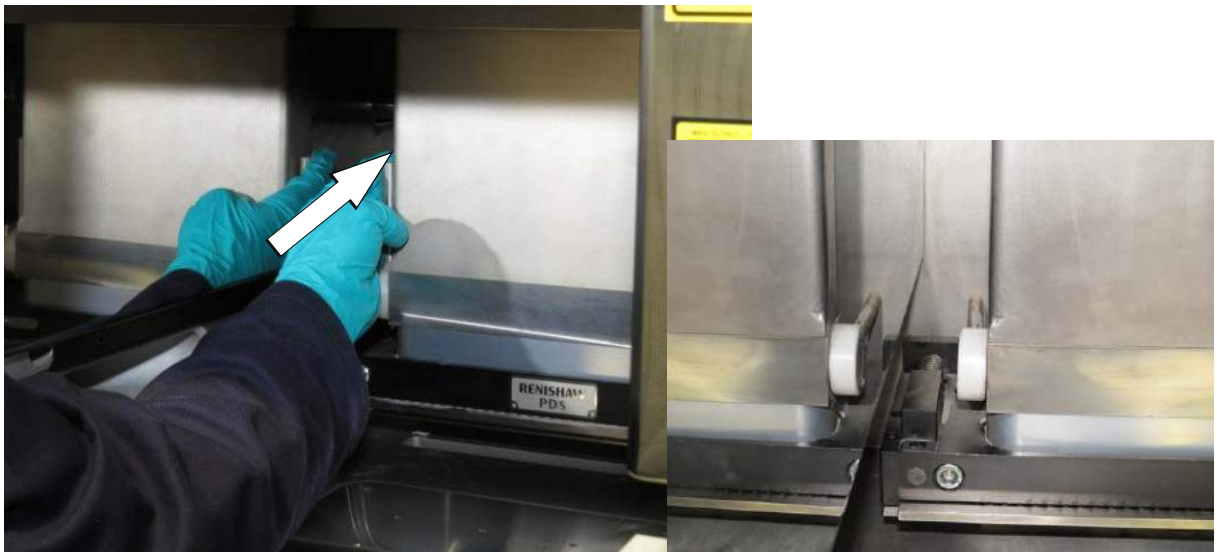


Figure 254 Open the silo dosing valve (IV1) by pushing away

From the main menu on the control interface, select **Select Build** (Figure 255).

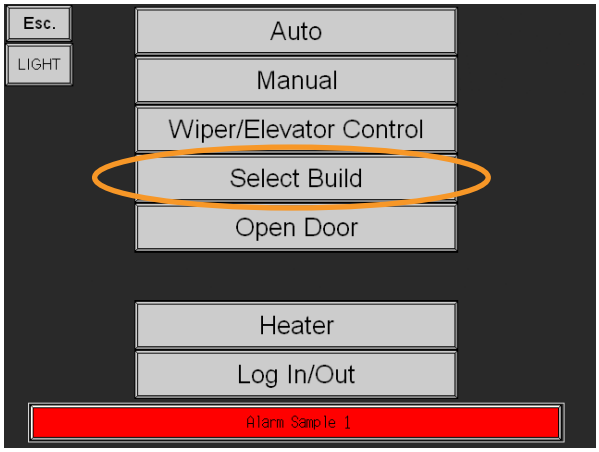


Figure 255 Main menu

Select the previously uploaded build name (Figure 256).

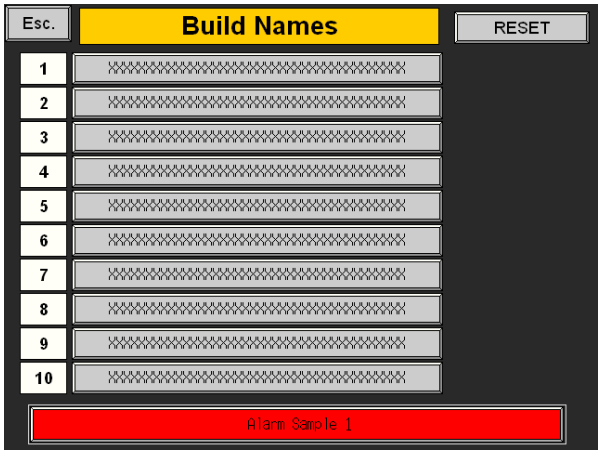


Figure 256 Select build name

Return to the main menu by pressing the Esc. button at the top left on the HMI. Select **Wiper/Elevator Control** (Figure 257).

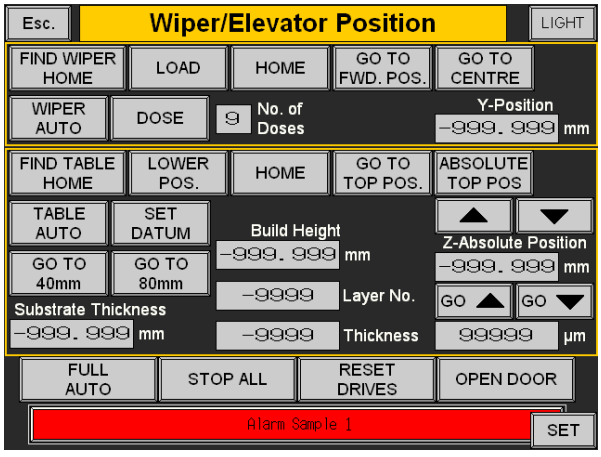


Figure 257 Wiper control screen

Select **Find Wiper Home**, ensuring that the wiper and substrate cannot collide.

Wiper/Elevator Control > Find Wiper Home

Ensure that the wiper installation has been performed correctly.

Once complete, press **Set Datum** on the control interface.

Wiper/Elevator Control > Set Datum

Press Esc and select the **Auto** menu (Figure 258) and press the **Play** button (Figure 259).

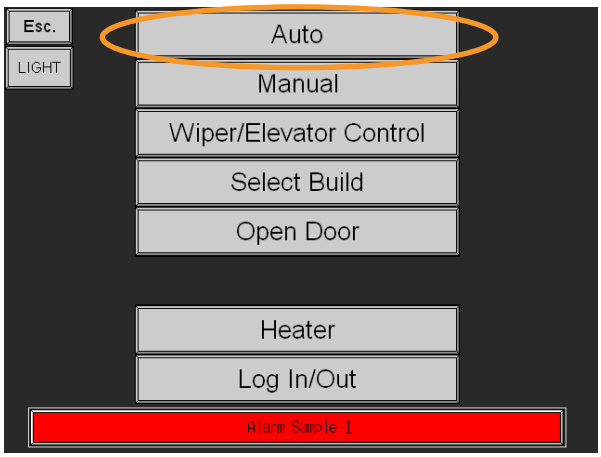


Figure 258 Select auto

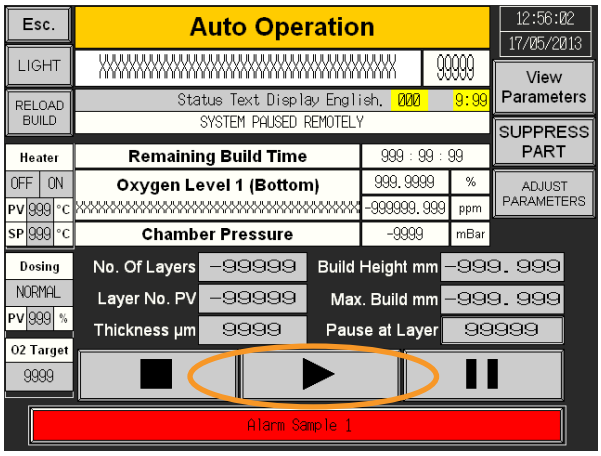


Figure 259 Press play

When prompted, ensure that the safe change filter valves (F1, F2, V4 and V5) are open and confirm this on the interface by pressing **Yes** (Figure 260).

Figure 260 Confirm by pressing Yes

27.3 Stabilising the atmosphere

At this point the system will start the process of creating the inert atmosphere. This takes between 10 and 15 minutes and throughout the process the HMI touch screen gives status updates.

Once the preset oxygen atmosphere threshold has been achieved, the system waits two minutes for the atmosphere to stabilise. If the threshold rises above the preset limit, the system will dose additional inert gas to achieve the required level and then wait a further two minutes.

27.4 Maintaining the build

WARNING: DO NOT REMOVE OR ATTEMPT TO CHANGE THE LARGE SAFE CHANGE FILTER WHILST A BUILD IS RUNNING. DO NOT OPERATE THE LARGE SAFE CHANGE FILTER VALVES (V4, V5, F1 AND F2) WHEN A BUILD IS RUNNING.

Note: Once the build has started, observe the first few minutes of the build process and check that the gas flow is correct from right to left, the quality of the part is acceptable, the powder is dosing correctly and the laser appears to be functioning correctly.

Once started, the system will then run automatically. Periodically the system operator will need to add new material and take away unused material that has been collected in the overflows.

The frequency of these activities is dictated by two factors:

- The cross sectional area of the part
- The amount of powder that is over-dosed

27.5 Setting the dosing percentage

Dosing is set via the HMI. Some degree of judgement is required for this value to be set, as it is dependent on the cross section of the part and also the layer thickness dictated by the materials file.

Typically, a build in 25 µm (0.001 in) layers requires a dose of around 40%. Thicker layers require a larger dose. The exact dose percentage depends upon the material being used, the part density on the build plate and part placement on the build plate. Experience of builds will guide you in selecting the correct dose percentage. The operator should aim to have powder in front of the wiper for the whole sweep and a small amount of powder wiped down the overflow. Overdosing will result in extra sieving, under dosing will only partially complete the build.

To set the dose, login at level 2 and select the **Service** button (Figure 261).

Following this, select the **User settings** button (Figure 262).

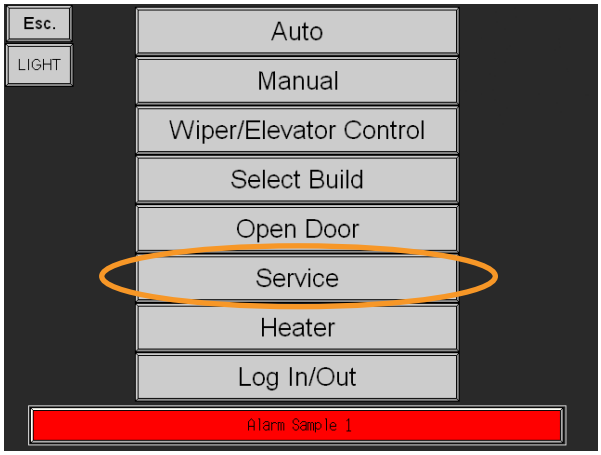


Figure 261 Select Service

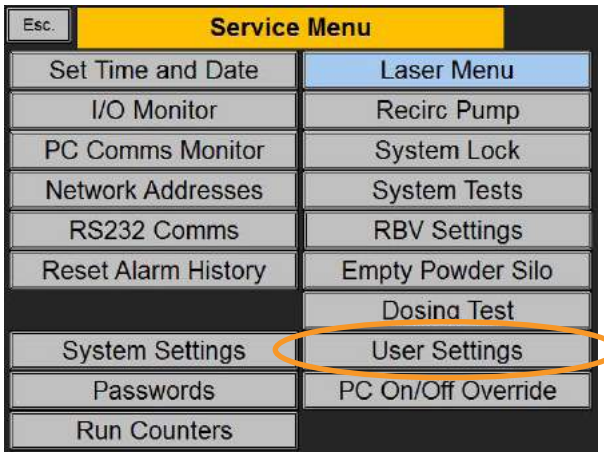


Figure 262 Select User settings

This then leads to the page that allows you to configure various settings including material, dosing, wiper speed and maximum oxygen threshold (Figure 263).

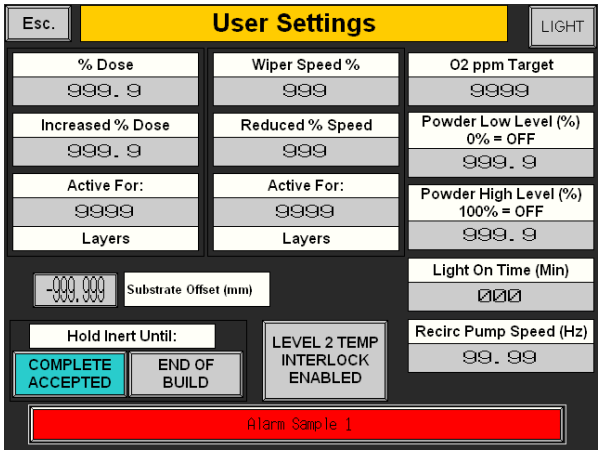


Figure 263 User-configurable settings

It is possible to amend the dosing percentage during the build.

For rapid powder delivery the dose can be setup to 300% – three fully open doses per wipe.

27.6 Restarting a build from a specific layer number

On the auto operation screen Layer No. PV (Present Value) will typically display the layer number. Alternatively divide the build height by the layer thickness (for example 6 mm in 50 µm layers = 6 / 0.05 = 120 layers).

If the last layer number is not known, Enter **Service Menu** (Figure 264).

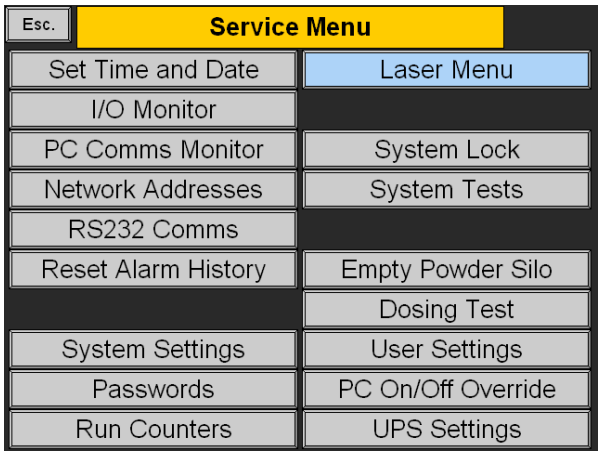


Figure 264 Service menu

Enter run counters menu, check the **Last layer number in previous build** value (Figure 265).

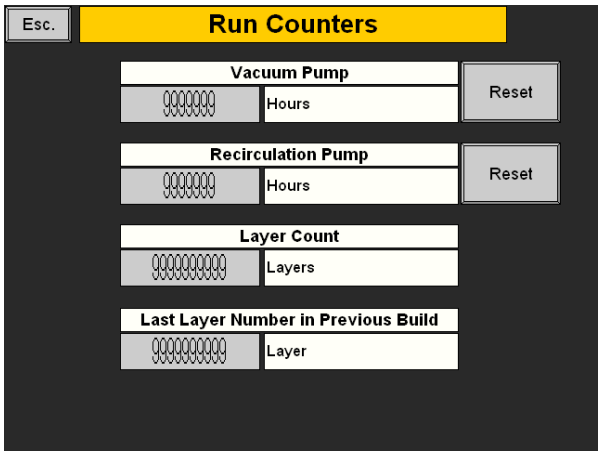


Figure 265 Run counters

From the menu select **Wiper/Elevator Control** enter the required start layer into **Layer No**. Reset the datum by pressing **Set Datum** (Figure 266).

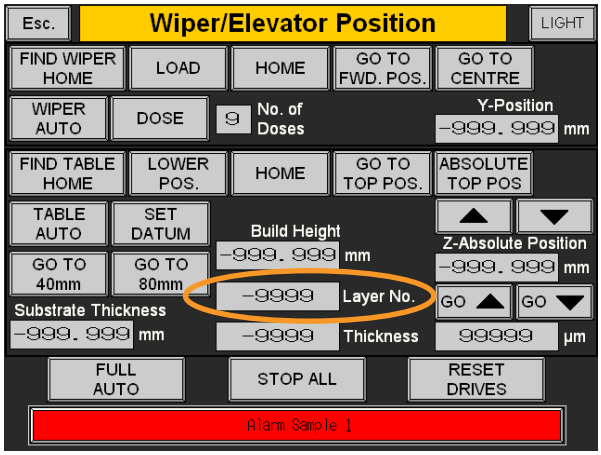


Figure 266 Enter layer number and set datum

In **Auto** press **Play**.

An on screen prompt will appear, confirm the **Start at Layer Number** figure is correct and press **Yes** (Figure 267).

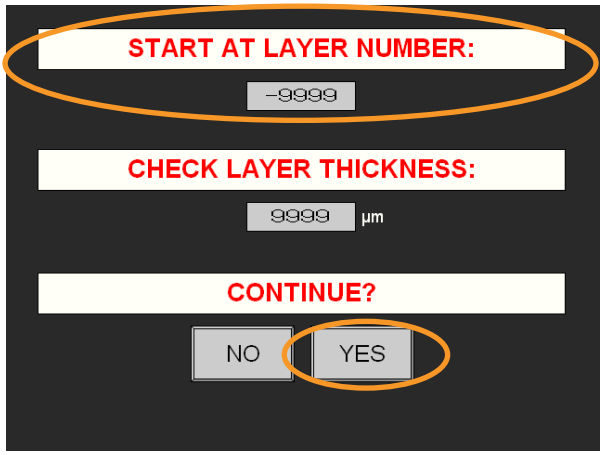


Figure 267 Check layer number and continue

Open safe change filter valves (F1, F2, V4 and V5) and proceed as a normal build.

27.7 Suppressing a part

In the **Auto** screen press **View Parameters** and then **Slice Preview** (Figure 268). Determine the number(s) of the part(s) to be suppressed (Figure 269).

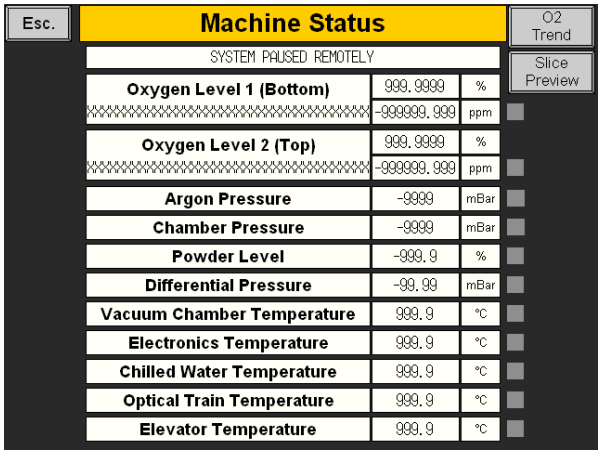


Figure 268 Slice preview

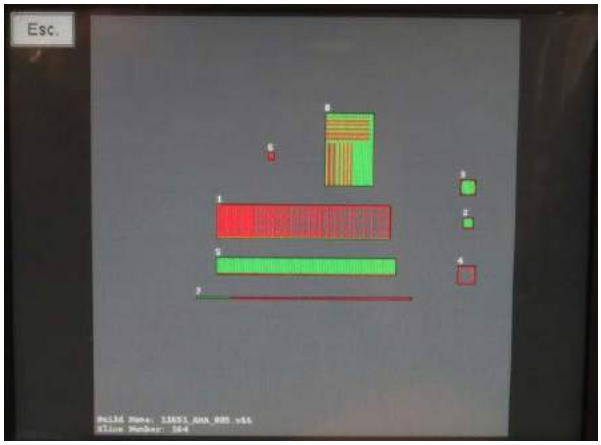


Figure 269 Check component numbers

In the **Auto** screen press **Pause**, additional functions will appear, press **Suppress part** (Figure 270).

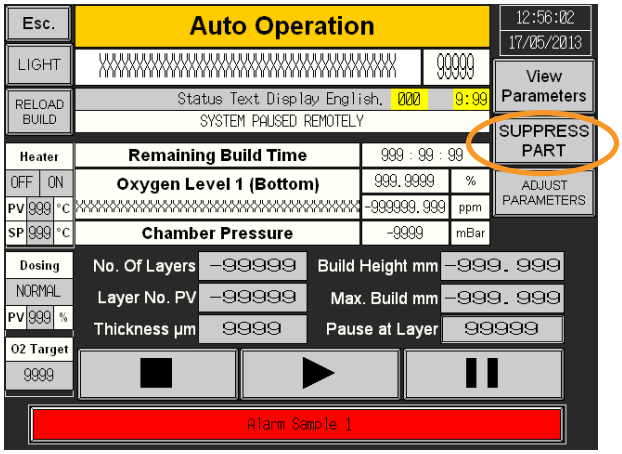


Figure 270 Suppress parts

Enter the part number into **Suppress part number** (Figure 271) follow the on screen prompts to suppress the part.

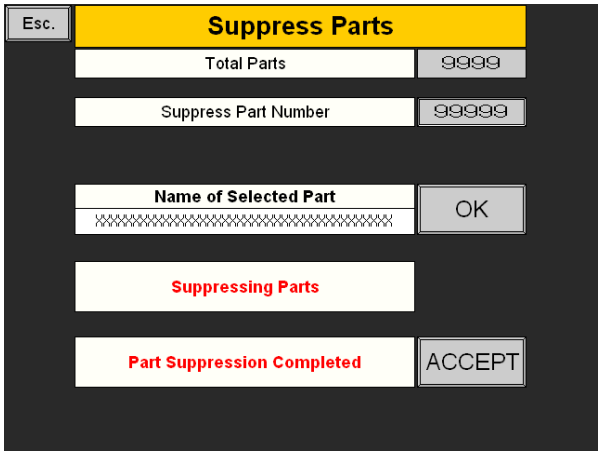


Figure 271 Suppress parts

Repeat if necessary for each part number.

Press **Escape** to exit the menu, press **Play** to re-commence the build (Figure 272).

27.8 Halting a build part way through

The Emergency Stop button should only be used to stop the build in an emergency. It will instantaneously halt the complete system, which will interfere with the software logic – it will not necessarily be possible to restart the build. The z-axis uses an incremental encoder, with a proximity sensor to provide an accurate home position. Using the Emergency Stop will require the home position of the z-axis to be re-taught.

Note: In the event of a breakdown or accident press the "Emergency Stop". Following assessment of the situation perform a restart procedure if safe, or call Renishaw AM service for support.

If a non-emergency shutdown is required, first select **Auto**, then press **Pause**, (Figure 272 and Figure 273).

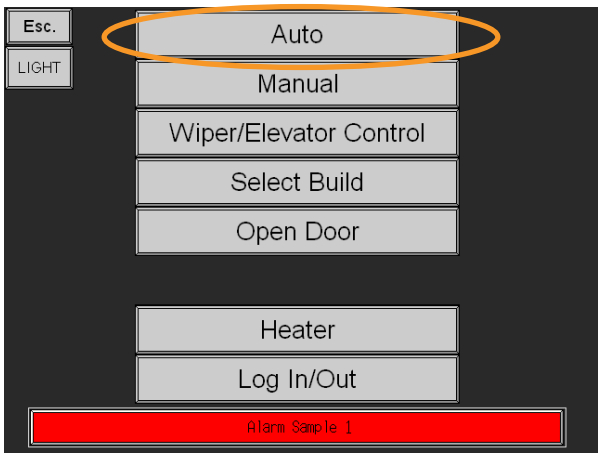


Figure 272 Select auto

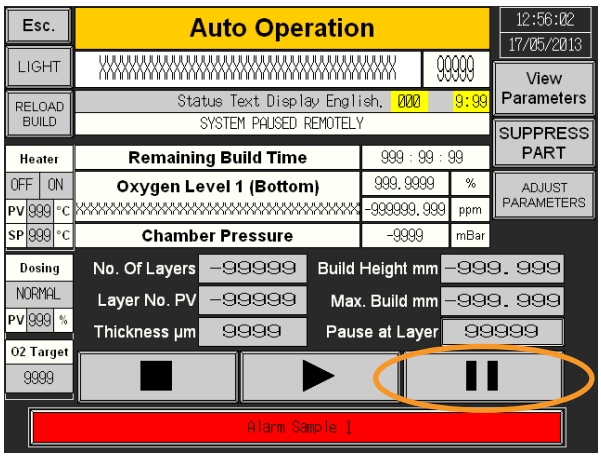


Figure 273 Press pause

28 Completing the build

28.1 Closing the filter valves

At the end of the process, confirm the build completion when prompted on the AM control interface (Figure 274).

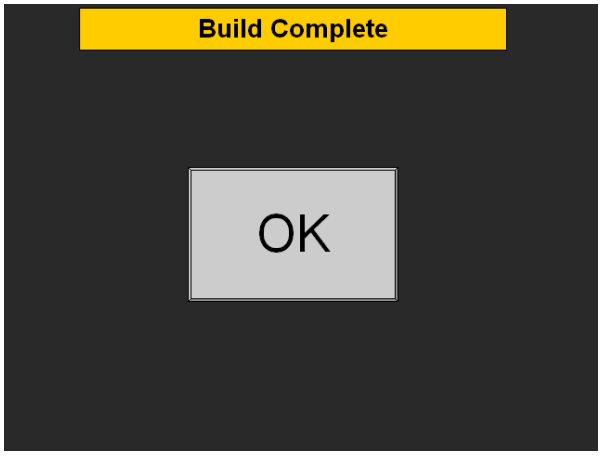


Figure 274 Build complete prompt in the control interface

You will then be prompted to close the safe change filter/large safe change filter valves, (V4, V5, F1 and F2) (Figure 275).

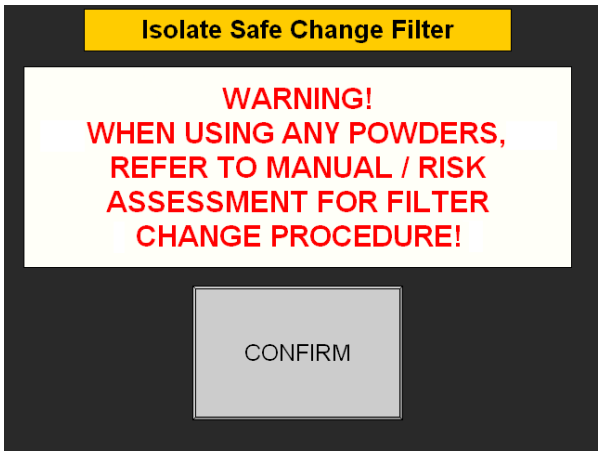


Figure 275 Isolate safe change filter

WARNING: THE FILTER WETTING (INERTING) PROCEDURE MUST BE FOLLOWED FOR ALL POWDER TYPES AND AFTER EVERY BUILD, SEE SECTION 22.

To close the four valves (V4, V5, F1 and F2), open the side door on the system to locate the safe change filter/large safe change filter and turn the levers so that they are at 90° to the direction of flow, (Figure 276).

Figure 276 Close safe change filter/large safe change filter upper and lower valves, (V4, V5, F1 and F2)

Confirm the filter valves (V4, V5, F1 and F2) have been closed (Figure 276) by selecting the following in the AM control interface.

> CONFIRM

The filter valves (V4, V5, F1 and F2) must remain closed until it is ready to be wet inerted. See Section 22 – "Safe change filter and large safe change filter", for details of the inerting and filter replacement process.

WARNING: THE SAFE CHANGE FILTER/LARGE SAFE CHANGE FILTER MUST BE REPLACED AFTER EVERY BUILD. SEE SECTION 22 "SAFE CHANGE FILTER AND LARGE SAFE CHANGE FILTER" FOR DETAILS.

28.2 Cool down

Wait for the heater temperature PV (Present Value) to reach room temperature before opening the door (Figure 277 and Figure 278).

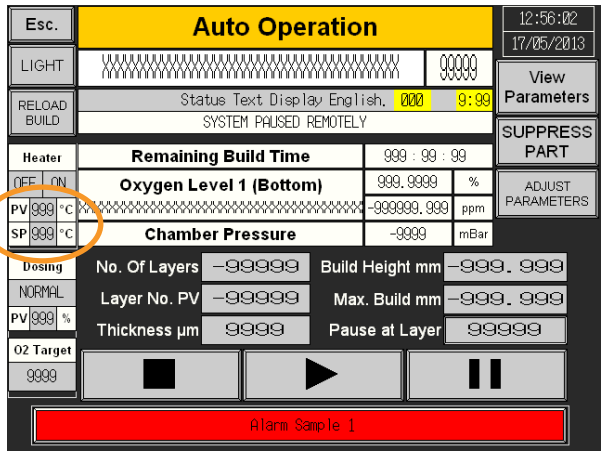


Figure 277 Allow PV to drop to < 40°C

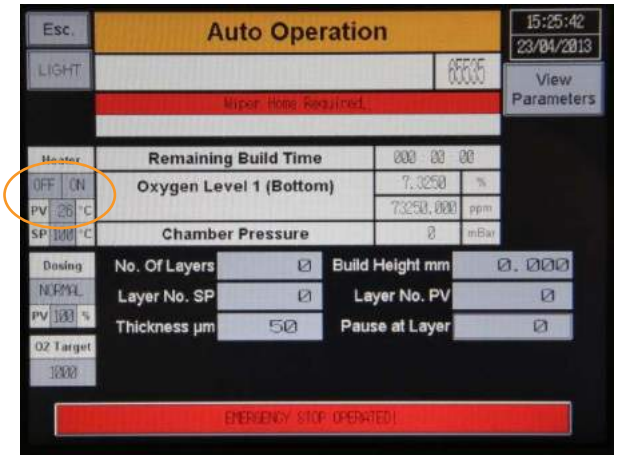


Figure 278 PV at 26°C

29 Removing the overflow bottle

The following procedure applies to both the large overflow bottle and small powder bottle.

WARNING: 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) BEFORE STARTING THIS TASK.

WARNING: WHEN REMOVING OVERFLOW BOTTLES ENSURE THE ATEX VACUUM CLEANER (WET SEPARATOR) IS AVAILABLE TO REMOVE ANY TRACE AMOUNTS OF POWDER RELEASED WHEN SEPARATING KF FLANGES.

Gently tap the overflow bottle until the remaining powder between the valves (A1 and V2 rear overflow) (B1 and V3 front overflow) has flowed into the bottle.

Close both valves (A1 and V2 rear overflow) (B1 and V3 front overflow); pull the levers to unlock, and then rotate by 90° to a horizontal position (Figure 279 and Figure 280). Open the latch on the quick-release clamp (L10 rear and L13 front overflow) in the middle of the two valves (A1 and V2 rear overflow) (B1 and V3 front overflow). Swing one collar of the quick-release clamp (L10 rear and L13 front overflow) off the engaged KF flanges at a time (Figure 281).

Figure 279 Tap the bottle, then close the valves (A1, V2, B1 and V3)

Figure 280 Valves (A1, V2, B1 and V3) in the closed position – perpendicular to flow

Figure 281 Open latch, remove first collar

Disengage the KF flanges of the two valves (A1 and V2 rear overflow) (B1 and V3 front overflow) (Figure 282).

Figure 282 Remove clamp

Detach the overflow pipe from the overflow bottle (Figure 283).

Figure 283 Remove bottle

Remove the centring ring seal, clean, check the condition, replace the seal as necessary and store with the quick-release clamp (L10 rear and L13 front overflow) (Figure 284).

Figure 284 Remove centring ring seal

30 Post-build powder handling

The large overflow bottle is too heavy for manual handling procedures, particularly loading the sieve and loading the system. For this reason it is necessary to decant powder from the large bottle into the small powder bottles.

WARNING: LARGE OVERFLOW BOTTLES WEIGH APPROXIMATELY 40 KG (88 LB) WHEN FULL OF POWDER. ENSURE SUITABLE MANUAL HANDLING PROCEDURES AND EQUIPMENT ARE IN PLACE AND ARE FOLLOWED.

WARNING: 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) BEFORE STARTING THIS TASK.

It is possible to avoid this step using only the small powder bottles as overflows, but this restricts the amount of unmanned operating time due to the smaller overflow capacity.

30.1 Powder transfer from large overflow to small powder bottle

To remove the powder in the large overflow bottle, you need to transfer the powder into small powder bottles.

Firstly place a centring ring on top of the large overflow bottle (Figure 285).

Figure 285 Locate centring ring

Then place an empty small powder bottle with the isolation valve (A1) closed on top of the large overflow bottle by engaging the KF flanges on the isolation valves (A1 and B1) of both bottles.

Once the flanges are engaged and the centring ring is sealed between the flanges, place one collar of a release clamp over both flanges.

Once the one collar is firmly in place over both flanges, swing the other collar round to seal the connection between both flanges and lock in place (Figure 286).

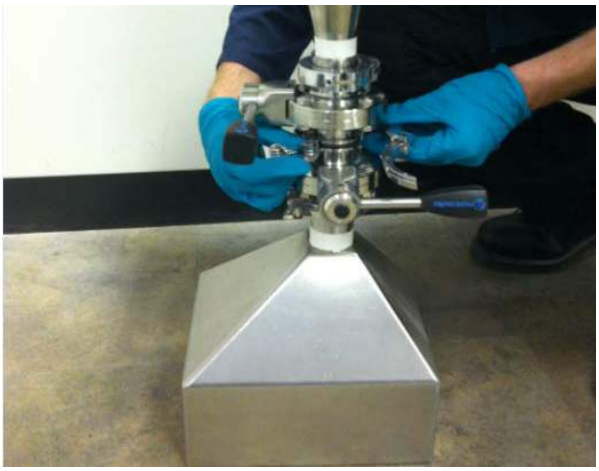


Figure 286 Attach clamp

WARNING: LARGE OVERFLOW BOTTLES WEIGH APPROXIMATELY 40 KG (88 LB) WHEN FULL OF POWDER. ENSURE SUITABLE MANUAL HANDLING PROCEDURES AND EQUIPMENT ARE IN PLACE AND ARE FOLLOWED.

Open the valves (A1 and B1) on both bottles and rotate them so the large overflow bottle is on top of the small powder bottle. As the large overflow bottle is heavy, this will require two people (Figure 287 and Figure 288).

Figure 287 Handle with care, the large overflow bottle is heavy

Figure 288 Open valves and rotate bottles

Tap the large overflow bottle to encourage the transfer of powder (Figure 289).

Figure 289 Tap to encourage powder transfer

Check the level of powder in the small powder bottle by tapping – if the sound is hollow (ringing), there is still space.

Once the small powder bottle is full, close the valve (A1) and leave the large bottle valve (B1) open (Figure 290).

Figure 290 When full, close small bottle valve (A1)

Rotate the bottles so that the small powder bottle is back on top of the large bottle (Figure 291).

Figure 291 Wait 10 seconds to allow powder to fall from coupling

Allow 10 seconds for the remaining powder between them to fall back into the large bottle, then close the valve (B1) on the large bottle, ensuring that both valves (A1 and B1) are closed (Figure 292).

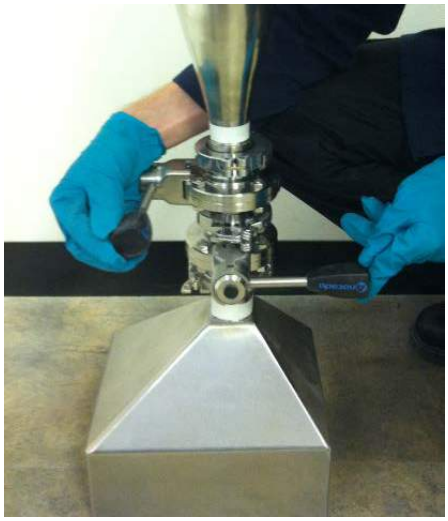


Figure 292 Ensure that both the valves (A1 and B1) are closed before disconnecting

Take a firm grip of the small powder bottle to secure in place and unlock the release clamp.

Remove one collar from the engaged flanges at a time, keeping a firm grip on the small powder bottle.

Disengage the flange on the small powder bottle from that of the large overflow bottle.

The small powder bottle now contains powder and is ready to be installed to the sieve.

Repeat this process until the large overflow bottle is empty, and then install it back onto the AM250/ AM400 system.

30.2 Powder removal from build volume

WARNING: THE VACUUM PUMP SHOULD NOT BE STARTED IF THE CHAMBER CONTAINS POWDER. IF MANUALLY VACUUMED THE VENT VALVE MUST NEVER BE OPENED – TURN THE GAS VALVE ON TO RETURN PRESSURE TO ATMOSPHERIC.

WARNING: THE BUILD CHAMBER WILL CONTAIN LARGE AMOUNTS OF POWDER AT THIS STAGE. ENSURE THAT THE CORRECT PPE IS BEING WORN BEFORE OPENING THE CHAMBER DOOR.

WARNING: ENSURE THAT THE OVERFLOWS AND POWDER BOTTLES ARE EMPTY OF POWDER.

Open the door and vacuum the contaminated powder from the front, left and right hand sides of the chamber as shown in (Figure 293) using the ATEX vacuum cleaner (wet separator). For selection and correct use of the ATEX vacuum, see Section 14.2 – "ATEX vacuum cleaner (wet separator)".

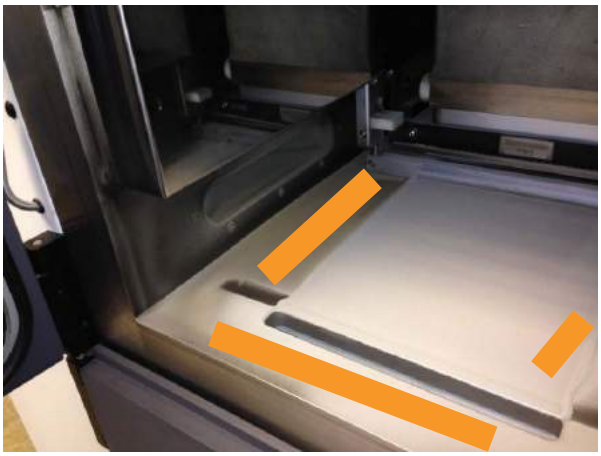


Figure 293 Front, left and right hand side of chamber after build

Place the appropriate brush/tools within the chamber ready for clean-down.

Close the chamber door and re-inert chamber to an oxygen level of less than 7%, before beginning system clean-down. Open the manual control interface (Figure 294):

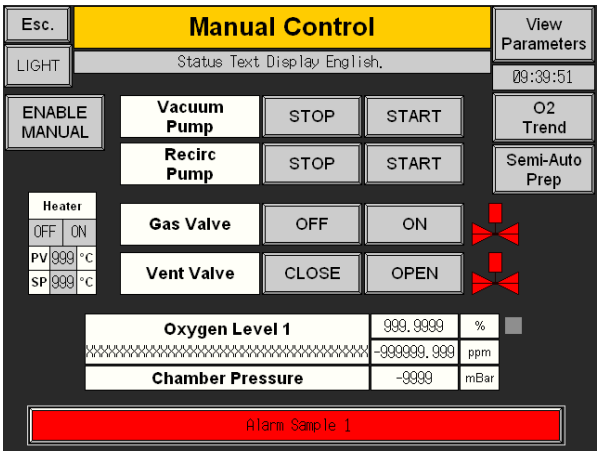


Figure 294 Manual control, open vent turn gas on

Manual > Enable Manual

Vent valve > OPEN

Gas valve > ON

When oxygen levels return to below 7% on the top and bottom sensor turn off gas valve and close vent valve.

WARNING: REMOVING THE OXYGEN FROM THE CHAMBER IS THE SAFEST METHOD OF HANDLING THE POWDER, AS IT MINIMISES THE RISK OF IGNITION.

To remove the powder from the build volume, the build platform needs to be raised in stages so that one large overflow bottle capacity can be removed at a time. To raise the build platform in stages, select the following on the control interface (Figure 295):

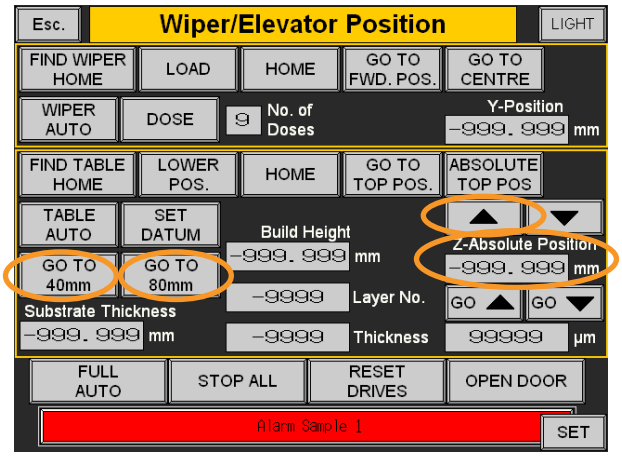


Figure 295 Elevator control screen

Wiper/Elevator Control

Raise the elevator in intervals of approximately 40 mm, using either the ^ up arrow, or by entering the desired height into build height. For the last two steps use the **GO TO 80 mm** and **GO TO 40 mm** buttons.

After raising the elevator, follow the steps to open the glove box and clear the powder, using the chamber gloves. Before moving the elevator it is essential that hands are removed from the chamber. Hold the glove box shut to make the interlock switch, allowing elevator movement. It is not necessary to insert the retaining bolts for each step.

At each stage, open the glove hatch door on the AM250/AM400 system to remove the powder from the build volume. To open the glove hatch door, insert the red safety keys into the retaining knob and then unscrew the bolts (Figure 296).

Figure 296 Opening the glove hatch door

On opening the door, an alarm **Glove hatch open** will initiate on the AM250/AM400 system (Figure 297).

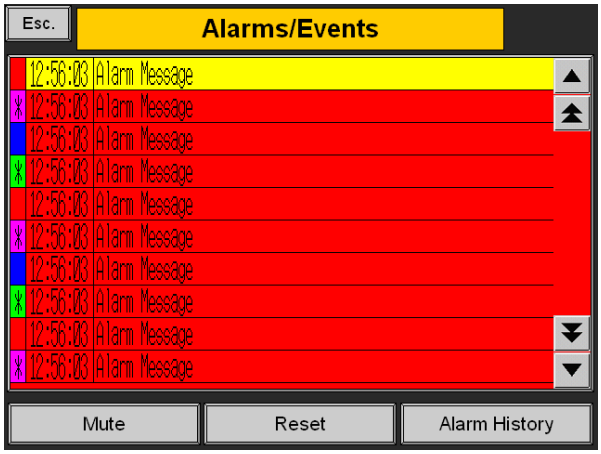


Figure 297 Alarm/Events window in control window

To mute the alarm, select the following on the control interface (Figure 297):

Alarm > Mute

To allow operation using the gloves, it is necessary to reduce the pressure inside the chamber. Insert your hands into the chamber through the gloves (Figure 298).

Figure 298 Allow to cool before inserting hands into chamber gloves

To remove the powder from the build volume, use a 19 mm (3/4 in) round brush to push the powder down the front overflow (Figure 299).

Figure 299 Brush powder down the front overflow

Caution: Do not touch the laser lens window during powder removal.

WARNING: CHECK THE SUBSTRATE TEMPERATURE BEFORE OPENING THE GLOVE BOX TO ENSURE THAT IT IS BELOW 40 °C (100 °F).

Continue to brush the powder down the front overflow until the large overflow bottle is full. To check, tap the bottle to give an indication of the hollow capacity remaining (Figure 300).

Figure 300 Tap bottle to check capacity

Once full, close the valves on the large overflow bottle (B1) and overflow pipe (V3) (Figure 301).

Figure 301 Close valves on bottle (B1) and pipe (V3) (shown here in open position)

Remove the large overflow bottle and ensure that the valve (B1) remains closed.

To remove the powder in the large overflow bottle, it needs to be transferred into the small powder bottles. See Section 30.1 – "Powder transfer from large overflow to small powder bottle".

Install the empty large overflow bottle back onto the AM250/AM400 system.

You can now continue to remove the powder from the build volume.

Raise the build platform another stage, then repeat the procedure to remove the powder, until all of the powder has been removed from the build volume.

When the top position is reached, raise the substrate out of the build volume by selecting the following on the control interface (Figure 302):

Wiper/Elevator Control > Substrate Thickness > 0 mm

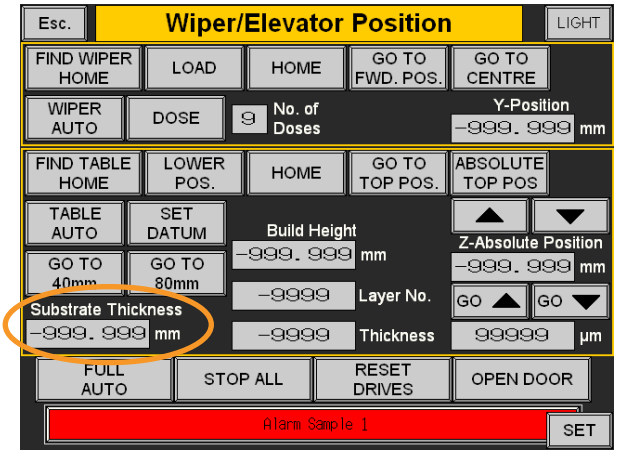


Figure 302 Enter 0 into Substrate thickness

Replace the brush.

Take a 5 mm hexagon key. Place the short end of the hexagon key into one of the four bolts (Figure 303). Turn the hexagon key anti-clockwise to loosen the bolt. Until it can be removed, store it on the side of the chamber. Repeat the procedure for all four bolts.

Caution: Substrate fastening bolts must be checked after every use for damage and wear, replace damaged or worn bolts as necessary. Regardless of damage or wear, bolts should be replaced on a regular basis.

Figure 303 Removal of substrate from build platform

Once all the bolts have been removed, lift the substrate and tip the remaining powder inside the build parts down the front overflow (Figure 304).

Figure 304 Tip powder out of part down the overflow

Ensure that you have a firm grip on the substrate and shake the substrate to allow entrapped powder to be removed from the built parts.

Once all the powder that can be removed from the build volume and built parts has been deposited down the front overflow, place the substrate back down on the z-axis platform.

Clean off any powder remaining on the gloves using the brush. Pull the gloves inside out, and either roll each one up tightly (Figure 305), or place the palms on top of each other and roll both gloves up together (Figure 306).

Caution: If gloves are not tightly rolled, they can inflate into the build chamber.

Figure 305 Roll individual gloves tightly for storage

Figure 306 Roll gloves tightly for storage

Close the glove hatch and screw in the retaining bolts, applying pressure to the hatch door to keep hatch valves closed (Figure 307).

Note: Pressure must be applied to the hatch door whilst replacing the retaining bolts to prevent an alarm on the control interface.

Figure 307 Push glove hatch closed whilst tightening retaining bolts

30.3 System clean-down – build chamber

Open the build chamber door on the AM250/AM400 system.

For selection and correct use of the ATEX vacuum, see Section 14.2 – "ATEX vacuum cleaner (wet separator)".

Use the brush and vacuum to remove any powder residue from the recirculation manifold (Figure 308).

Figure 308 Brush powder out of recirculation manifold

Brush any remaining powder on the chamber platform down the front overflow (Figure 309).

Figure 309 Brush the remaining powder down the overflows

To allow access to the powder at the back of the chamber, remove the wiper blade assembly. Firstly bring the wiper forward in the control interface by selecting either of the following (Figure 310):

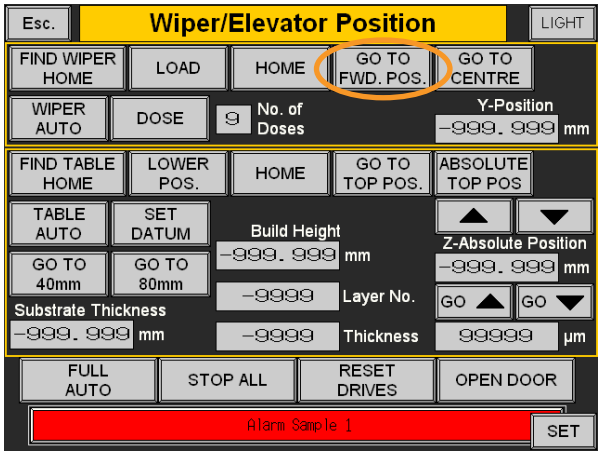


Figure 310 Go to forward position

Wiper/Elevator Control > GO TO FWD POS.

Or Wiper/Elevator Control > GO TO CENTRE

Open the chamber door on the AM250/AM400 system. Loosen the left and right M6 upper locking bolts using a 5 mm hexagon key (Figure 311).

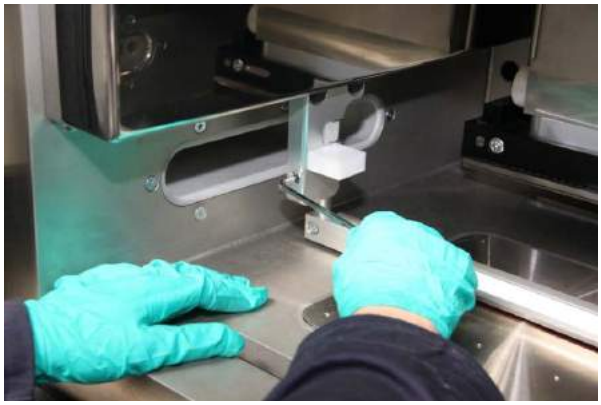


Figure 311 Loosen M6 upper locking

Turn the thumb screws on the wiper arms clockwise by four quarter turns to raise the wiper arms approximately 1 mm (0.04 in). This will allow sufficient clearance between the build platform for the next build setup (Figure 312).

Figure 312 Turn clockwise to raise the wiper blade

Remove the M6 lower wiper retaining bolts connecting the wiper blade assembly to the wiper arms using a 5 mm hexagon key (Figure 313 and Figure 314).

Figure 313 Slacken lower bolt

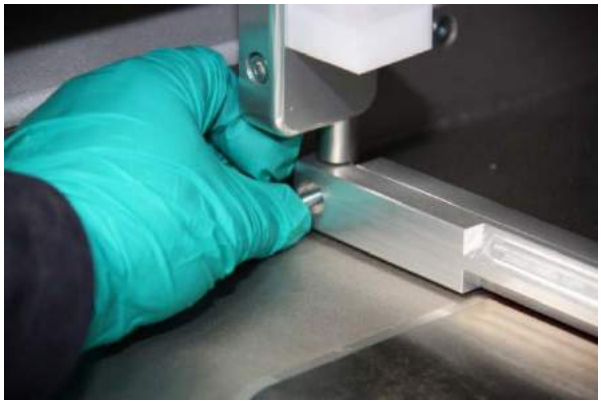


Figure 314 Slacken lower bolt

Place the parts into a magnetic tray (Figure 315).

Figure 315 Magnetic tray

Remove the wiper blade assembly from the wiper arms.

Take a brush and brush any powder remaining on the wiper blade assembly down the front overflow (Figure 316).

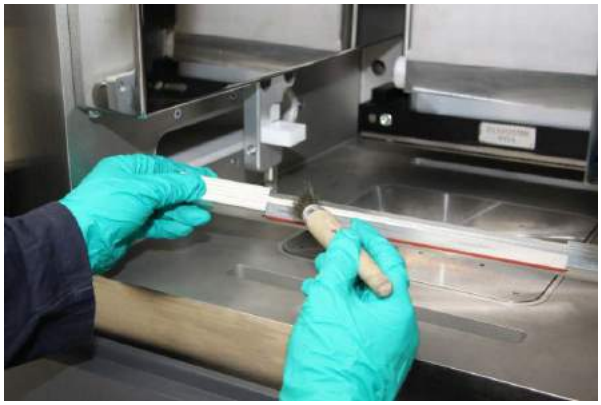


Figure 316 Brush off powder

Once the powder has been removed from the wiper blade assembly, remove it from the system and place it on a work bench. See Section 24.1 – "Installing the wiper blade".

Once the wiper assembly has been removed, brush the powder at the back of the chamber, which was behind the wiper, down the back overflow (Figure 317).

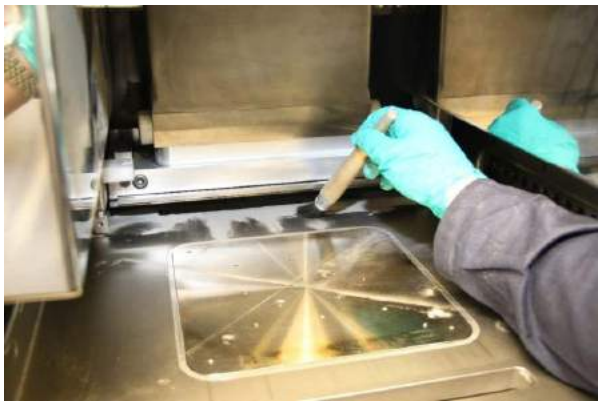


Figure 317 Brush powder down the rear overflow

Using the ATEX vacuum cleaner (wet separator) and attachments, remove any excess powder residue from the internal surfaces of the system (Figure 318 and Figure 319). On AM250 systems equipped with PlusPac and on AM400 systems a Window Protection System (WPS) is fitted. This has a different arrangement of lens protective window and gas pipes in the top of the upper chamber, (Figure 319).

Figure 318 Vacuum interior of the chamber

Figure 319 Vacuum interior of the AM250 PlusPac and AM400 chamber

Insert a fine bladed screwdriver into the bolt holes on the chamber platform and prod to loosen any compacted powder (Figure 320), then remove the loosened powder using the ATEX vacuum cleaner (wet separator). Ensure that the bolt holes on the build platform are completely clear of powder before continuing.

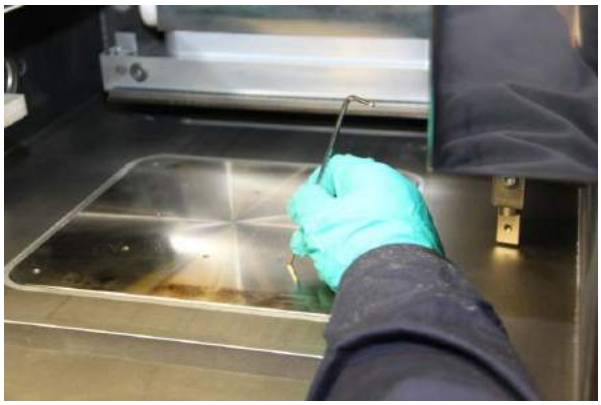


Figure 320 Prod bolt holes to loosen compacted powder and then vacuum

When as much of the powder and residue as possible has been removed with the brush and vacuum, the next step is to clean all the build chamber surfaces with the Class 3 isopropanol, (Figure 321).

Caution: Do not touch the laser lens window during chamber cleaning.

Apply the isopropanol to a disposable cloth and wipe down the internal surfaces in the chamber from top down, starting from the chamber ceiling (Figure 321).

Figure 321 Clean with isopropanol from the top down

The internal surfaces need to be clear of any powder residue and black deposits (metal condensate) (Figure 322).

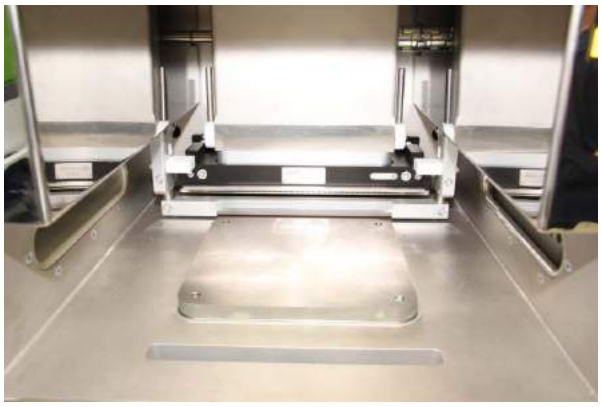


Figure 322 Remove all powder and deposits

Clean the door seal using a cloth and cleaning solution (Figure 323).

Figure 323 Clean door seal with cloth and cleaning solution

It may be necessary to clean the gloves with isopropanol (Figure 324).

Figure 324 Clean gloves with isopropanol

WARNING: AFTER EVERY CLEAN-DOWN OF THE DOOR, INSPECT THE PROTECTIVE GREEN ACRYLIC FILTER. IF THE FILTER DAMAGED STOP USING THE AM250/AM400 SYSTEM AND CONTACT RENISHAW FOR A REPLACEMENT FILTER.

30.4 Cleaning the lens protective window – AM250

Note: If your system is an AM250 without PlusPac follow the procedure in Section 30.4 to clean the lens protective window. If your system is an AM250 with PlusPac or an AM400 use the procedure in Section 30.5.

30.4.1 Lens protective window inspection

Caution: The lens protective window is made from fused silica, and has an optical coating that will scratch if handled incorrectly.

Caution: The lens protective window needs to be completely clear, removing all soot and leaving no smudges that can affect laser beam coupling efficiency and focus.

Regularly visually examine the condition of the lens protective window. Over time the lens protective window will degrade and will require replacement in order to maintain system performance and part quality. Care and attention when cleaning will significantly improve the life of the lens protective window.

Removal of the lens protective window for cleaning is the recommended method to ensure maximum life.

30.4.2 Removing the lens protective window

- Always use a clean workbench, clean hands and gloves.
- Never place the lens protective window on a hard surface, only ever handle using the outer rim of the lens protective window as this portion is not used.
- When wiping, apply minimal force to avoid scratching.
- Never use dry wipes to clean the lens – this will result in static, which will attract more contaminate.
- Only use the cleaning liquids specified (P-OPTA-0101).
- Only use the lens cleaning tissues specified (P-WI02-0002).
- Do not use tools to clean or handle the lens protective window.

Caution: The lens protective window is not fixed in the outer housing. Keep the housing level to avoid tipping the lens protective window out.

Caution: The lens protective window is fragile and high value and should be handled with care.

Caution: Removing the lens protective window exposes the lens and optics to the environment. This should only ever be done following a thorough clean-down and the time open should be minimised – Renishaw recommend a second lens protective window or bung is reassembled as soon as possible.

Ensure that the build chamber has been thoroughly cleaned by following the instructions in Section 30.3.

Take a lens cleaning tissue and apply isopropanol. Wipe the outer aluminium lens housing until it is clean, avoiding touching the lens (Figure 325).

Figure 325 Clean the outer housing

Place bubble wrap or similar packing material in the base of the chamber as a precaution against dropping the lens protective window (Figure 326).

Figure 326 Use bubble wrap as a precaution

Remove the four M8 bolts using a 6 mm hexagon key, starting with the rear ones first. Before removing the last bolt, support the housing with your other hand (Figure 327).

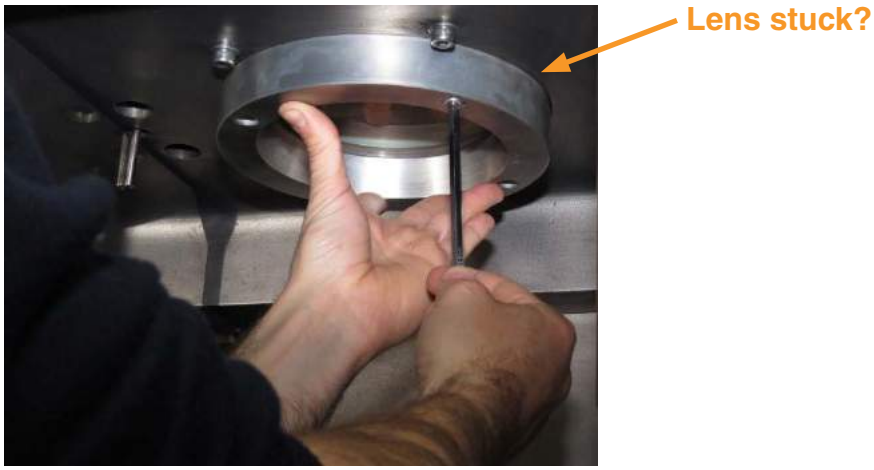


Figure 327 Support before removing last bolt

Caution: It is possible for the lens to stick to the chamber roof o-ring – check the lens is in the housing before completely withdrawing.

Gently remove the lens protective window, only handling the housing, and keeping it horizontal.

As you lower the lens housing check to ensure the lens is in the housing and not stuck to the chamber roof.

This will expose the laser optics. It is recommended to have a replacement lens protective window ready to replace immediately. If this is not possible, minimise the length of time the lens protective window is off. Close the chamber door.

30.4.3 Lens protective window cleaning

Place the outer housing onto a clean workbench – it will be used to support the lens protective window during the cleaning process.

There will be layer of grease around the outer edge of the lens from the sealing o-ring. Apply optic cleaner (P-OPTA-0101) to a folded lens cleaning tissue (part number P-WI02-0002) and use it to clean the outer edge of the lens protective window (Figure 328).

Figure 328 Wipe outer

Hold the lens protective window to the light to look for dust or particles.

Any loose particles can be blown off using clean dry air, either from a aerosol or manual blower (Figure 329). Keep the nozzle at least 100 mm from the lens protective window (Figure 330).

Figure 329 Manual blower

Figure 330 Blow loose particles if using clean dry air from > 100 mm

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Caution: Do not use compressed air lines, as they may contain oil or water which will contaminate the lens protective window.

Ensure that you are wearing clean gloves at this stage.

Place a lens cleaning tissue on the lens protective window surface and dampen the back edge of the tissue with optic cleaner (Figure 331).

Figure 331 Place tissue on lens protective window and apply cleaner

Without lifting, slowly draw the lens cleaning tissue across the lens protective window. This should be done at approximately 20 mm/sec (1 in/sec) so that the liquid evaporates behind the tissue, leaving no streaks (Figure 332).

Figure 332 Slowly draw the tissue across the lens

After several wipes, inspect the lens protective window against a light. If there are particularly stubborn stains, take a wipe and fold it several times, then apply optic cleaner (Figure 333).

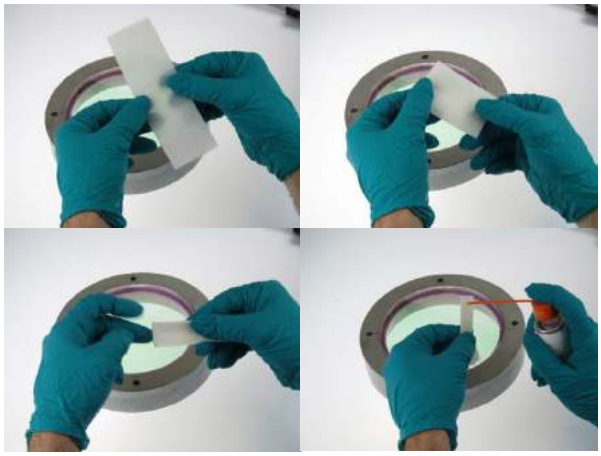

Figure 333 Fold several times, apply cleaner

Gently wipe the lens protective window applying minimal pressure. Do not use back-and-forth or circular motions (Figure 334).

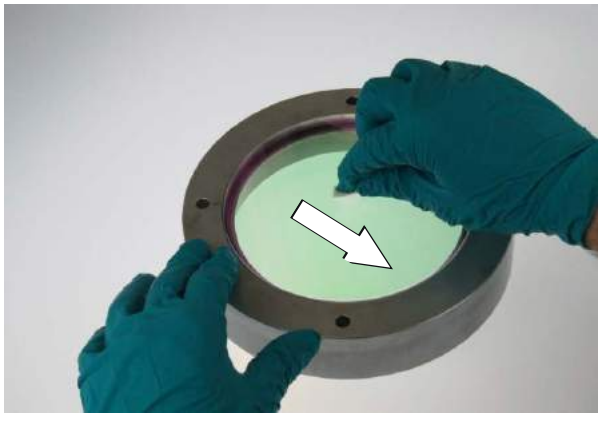

Figure 334 Gently wipe the lens protective window

Once complete, there should be no streaks left on the lens protective window.

30.4.4 Clean both sides

Pick up the housing, whilst supporting the lens protective window around the rim, and tip it until it frees (Figure 335).

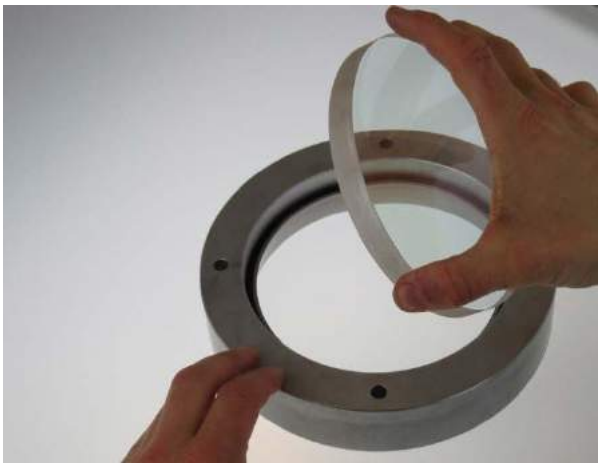

Figure 335 Tip to remove the lens protective window

Turn it so that the cleaned face is down, and replace in the housing. Only handle the lens using the outer edge (Figure 336). It may help to remove gloves when handling the clean lens to aid handling.

Figure 336 Replace in housing clean face down

Repeat the cleaning process on the other face.

30.4.5 Reassembly of the lens protective window

Inspect the o-ring for damage, replace if necessary.

Apply a small smear of high vacuum grease (part number 769 890 000) to the sealing o-ring.

For reassembly, follow the assembly steps in reverse.

Tighten all four bolts finger tight using the long end of the hexagon key (Figure 337).

Figure 337 Reassemble bolts finger tight

Tighten to approximately 10 Nm (7.4 lbf/ft) following the sequence in (Figure 338).

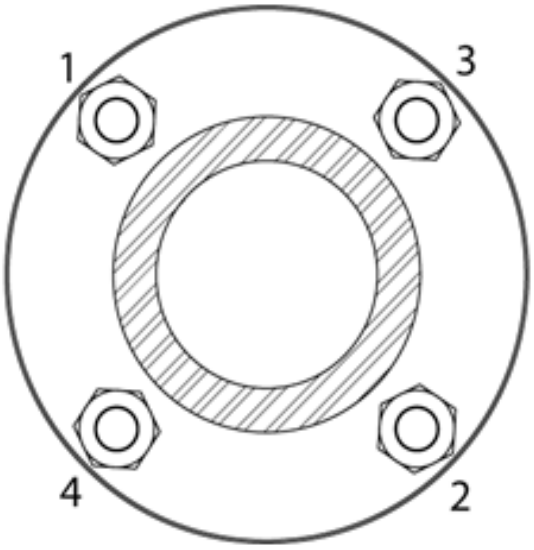

Figure 338 Tighten in sequence

30.5 Clean the window protection system – AM250 with PlusPac and AM400

30.5.1 Clean the lens protection assembly – AM250 with PlusPac and AM400 only

Note: If your system is an AM250 with PlusPac or an AM400 use the procedure in Section 30.5 to clean the window protection system. If your system is an AM250 without PlusPac follow the procedure in Section 30.4.

30.5.1.1 Lens protection assembly inspect

Caution: The lens protection assembly is made from fused silica, and has an optical coating that will scratch if handled incorrectly.

Caution: The lens protection assembly needs to be completely clear, removing all soot and leaving no smudges that can affect laser beam coupling efficiency and focus.

Regularly visually examine the condition of the lens protection assembly. Over time the lens protection assembly window will degrade and will require replacement in order to maintain system performance and part quality. Care and attention when cleaning will significantly improve the life of the lens protection assembly window.

Removal of the lens protection assembly window for cleaning is the recommended method to ensure maximum life.

30.5.1.2 Removing the lens protection assembly

- Always use a clean workbench, clean hands and gloves.
- Never place the lens protection assembly on a hard surface. Only handle using the outer rim of the lens protection assembly as this portion is not used.
- When wiping, apply minimal force to avoid scratching.
- Never use dry wipes to clean the window – this will result in static, which will attract more contaminate.
- Only use the cleaning liquids specified (P-OPTA-0101).

- Only use the lens cleaning tissues specified (P-WI02-0002).
- Do not use tools to clean or handle the lens protection assembly.

Caution: Removing the lens protection assembly exposes the system optics to the environment. This should only ever be done following a thorough clean-down of the build chamber and the time open should be minimised – Renishaw recommend purchasing a second lens protection assembly or a bung and fitting it as soon as possible after removing the lens protection assembly.

1. Ensure that the build chamber has been thoroughly cleaned by following the instructions in Section 30.3.

2. Take a lens cleaning tissue (part number P-WI02-0002) and apply optic cleaner (P-OPTA-0101). Wipe the lens protection assembly metal housing, (arrowed) (Figure 339) until it is clean. Avoid touching the window.

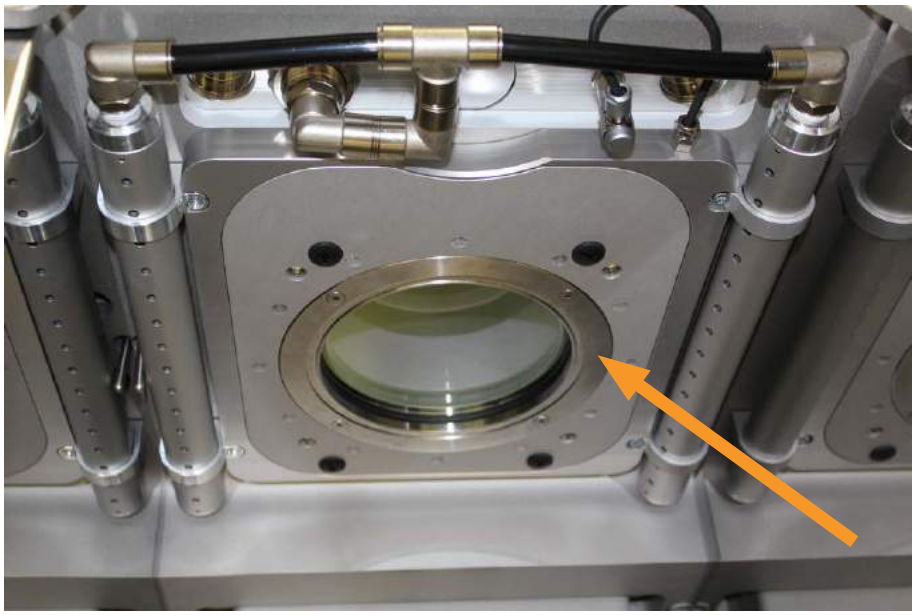

Figure 339 Window protection system lens outer housing

3. Place bubble wrap or similar packing material in the base of the chamber as a precaution against dropping the lens protection assembly.

4. Remove the four M4 bolts (circled) (Figure 340) using a 3 mm (0.125 in) hexagon key. The lens protection assembly is a bayonet fit and will not fall out of the system when the bolts are removed.

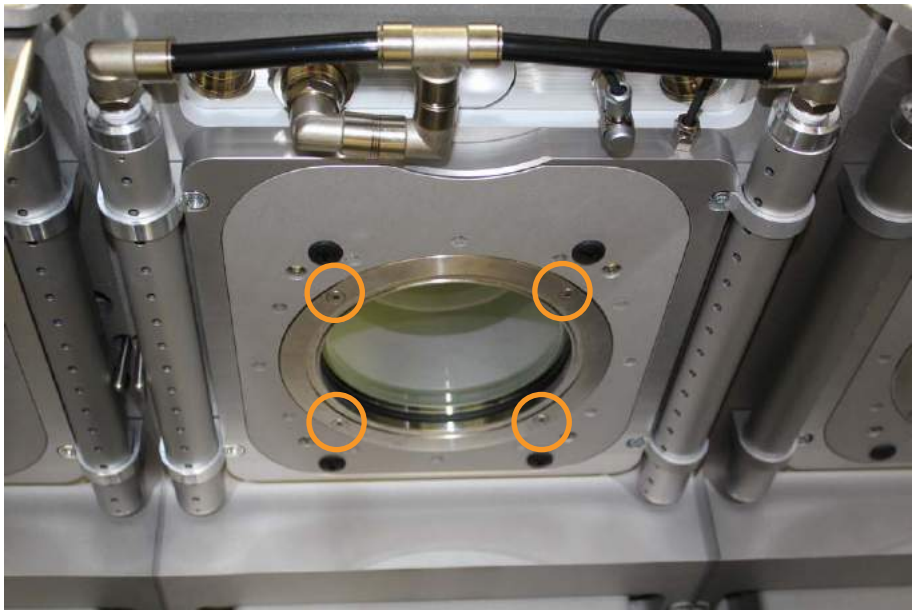

Figure 340 Window protection system mounting bolts

5. Rotate the lens protection assembly anti-clockwise and remove it from the system. The lens protection assembly is bolted together and will remain in one piece when it is removed from the system.

6. Removing the lens protection assembly will expose the system optics. It is recommended to have a replacement lens protection assembly or a bung ready to fit immediately. If this is not possible, minimise the length of time the lens protection assembly is removed and close the build chamber door.

30.5.1.3 Window cleaning

1. Place the lens protection assembly onto a clean workbench. It is not necessary to dismantle the lens protection assembly for a post-build clean.

2. Apply optic cleaner (P-OPTA-0101) to a folded lens cleaning tissue (part number P-WI02-0002) and use it to clean the metal lens housing.

3. Hold the lens protection assembly up to the light to look for dust or particles.

4. Any loose particles can be blown off using clean dry air, either from an aerosol (Figure 341) or manual blower (Figure 342). Keep the nozzle at least 100 mm (4 in) from the lens surface.

Figure 341 Blow loose particles using clean dry air from a distance of > 100 mm

Figure 342 Manual blower

Caution: Do not use a compressed air line to clean the lens protection assembly window, as it may contain oil or water which will contaminate the window.

5. Put on clean gloves.
6. Place a lens cleaning tissue on the surface of the window and dampen the back edge of the wipe with optic cleaner.
7. Without lifting, slowly draw the lens cleaning tissue across the surface of the window. This should be done at approximately 20 mm/sec (1 in/sec) so that the liquid evaporates behind the tissue, leaving no streaks.
8. After several wipes, inspect the window against a light. If there are particularly stubborn stains, take a wipe and fold it several times, then apply optic cleaner.
9. Gently wipe the window applying minimal pressure. Do not wipe back-and-forth or in a circular motions.
10. Once complete, there should be no streaks left on the window.
11. Repeat the process for the other side of the window.

30.5.1.4 Refitting the lens protection assembly window

Caution: Do not touch the surface of the window.

1. Put on clean gloves.
2. Fit the lens protection assembly to the top of the build chamber.
3. Align the lens protection assembly bayonet lugs with the recesses in the top of the build chamber.
4. Raise the lens protection assembly to engage the bayonet lugs, and twist clockwise until it will rotate no further. The lens protection assembly will rotate by 15 to 20°.
5. Refit the four M4 bolts that secure the lens protection assembly in place, (Figure 343) and tighten with a 3 mm (0.125 in) hexagon key to 5 Nm.

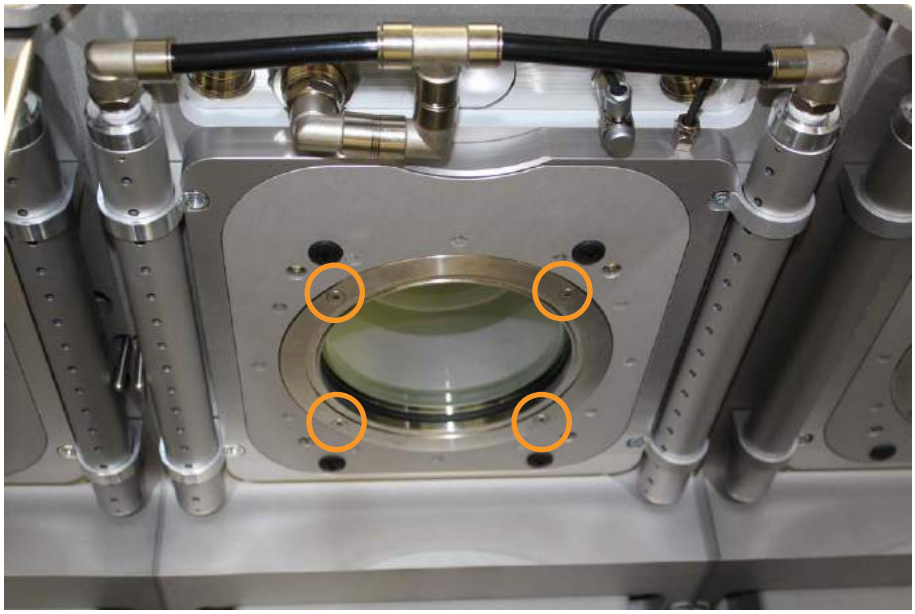

Figure 343 Lens protection assembly securing screws

Note: You may need to move the lens protection assembly a little in order to align the bolt holes correctly. Take care not to touch the surface of the window or release the lens protection assembly from its bayonet fit.

30.5.2 Deep clean of the lens protection assembly – AM250 with PlusPac and AM400 only

1. Remove the lens protection assembly in accordance with Section 30.5.1.2. It is necessary to dismantle the lens protection assembly for a deep clean.

Caution: Removing the lens protection assembly exposes the system optics to the environment. This should only ever be done following a thorough clean-down of the build chamber and the time open should be minimised – Renishaw recommend purchasing a second lens protection assembly or a bung and fitting it as soon as possible after removing the lens protection assembly.

2. Place the lens protection assembly onto a clean workbench.
3. Using a 2.5 mm (0.0984 in) hexagon key remove the four bolts that secure the lens protection assembly together and separate the lens protection assembly.
4. Apply optic cleaner (P-OPTA-0101) to a folded lens cleaning tissue (part number P-WI02-0002) and use it to clean the two halves of the lens protection assembly. Remove all traces of condensate from the lens protection assembly metal housing.
5. Clean both sides of the window in accordance with Section 30.5.1.3.
6. Refit the window into the lens protection assembly housing.

7. Refit the four bolts that secure the lens protection assembly housing together and tighten with a 2.5 mm (0.0984 in) hexagon key to 5 Nm.

8. Refit the lens protection assembly in accordance with Section 30.5.1.4.

30.6 System clean-down – lower chamber

Before the system is ready for the next build, the bottom chamber must be cleaned of any powder or process by-product.

In normal operation a small amount of powder may bypass the build platform seals, if significant quantities are experienced it may indicate seal wear – contact your Renishaw service team.

Keep the top chamber door open and then open the bottom chamber door on the AM250/AM400 system. Use a 19 mm (3/4 in) round brush and ATEX vacuum cleaner to remove all the powder residue and process by-product from the bottom chamber (Figure 344). For selection and correct use of the ATEX vacuum, see Section 14.2 – "ATEX vacuum cleaner (wet separator)".

Figure 344 Vacuum out lower chamber

Apply isopropanol Class 3 to a disposable cloth and clean-down all surfaces in the bottom chamber (Figure 345).

Figure 345 Clean with isopropanol

Clean the door seal by vacuuming away loose powder and finally using a cloth and cleaning solution (Figure 346).

Once the bottom chamber is clean, the AM250/AM400 system is ready for installation of assemblies and setup of the next build process.

Figure 346 Clean door seal

30.7 System clean-down – material changeover

When changing to a new material type additional cleaning will be required to ensure traces of the previous material are removed and cross contamination does not occur. Alloys of a similar composition may be tolerant to residual powder, if in doubt Renishaw recommends this cleaning procedure is followed in full.

Before starting cleaning; the filter, all powder, and all powder bottles should be removed.

Renishaw supply a changeover kit, which contains a spare set of components. This enables a set to be dedicated to each material, reducing cleaning time.

- Thoroughly clean the build chamber, by following Sections 30.2 and 30.3
- Clean the lens:
  for AM250 follow Section 30.4
  for AM250 with PlusPac and AM400 follow Section 30.5
- Clean the lower chamber, Section 30.6
- Remove the side covers, and clean the wiper drive, Section 30.7.1
- Remove the silo, dismantle, clean, reassemble and re-install, Sections 32.1 to 32.4 and 32.8
- Remove, exchange and re-install the dosing mechanism Sections 32.5, 32.6 and 32.7
- Further cleaning of the top chamber will be required once silo, covers and doser have been removed
- Remove and clean (or replace) the system hoses, pipe work and fittings, Section 30.7.2
- Clean the overflow manifolds, Section 30.7.3
- Clean the recirculation pump as far as is practical, Section 30.7.4
- A sieve for each material is preferable, alternatively clean the sieve, Section 14.3.3 to 14.3.5
- Clean the exterior and interior of the system
- Once satisfied reassemble all components.

30.7.1 Clean the wiper drive

Drive the wiper to its mid position, using the HMI interface.

Now remove the two side covers.

Remove the bottom rear screw, followed by bottom front screw.

Support the cover whilst removing the screw on the front face.

Slide the cover forward and out.

Using an ATEX approved vacuum, clean any loose powder from the drive mechanism, pay particular attention to the drive belts.

Clean the belts, pulleys, and arms using a cloth and isopropanol alcohol. (Figure 347).

Figure 347 Clean drive mechanism

Avoid using isopropanol alcohol on the guide rails, as they are lightly lubricated.

WARNING: DO NOT OPERATE THE SYSTEM WITH GUARDS/COVERS REMOVED.

30.7.2 Replace and clean hoses and pipework

All system hoses and pipework that have powder or powder processing waste passing through them must be cleaned or replaced as necessary.

Remove swing clamps to release the hose assembly.

If a changeover kit is being used, replace the hoses and pipes and label all pipes with material type.

Replace swing clamps to reattach the hose assembly.

Alternatively clean the hoses, pipework and fittings.

Using a screwdriver remove the worm drive hose clamps.

Remove the stainless steel KF flanges from each end of the pipes.

Using a cloth and isopropanol alcohol, clean the inner bore of the hoses, pipework and fittings.

Reassemble: reinsert the stainless steel KF flanges, tighten the worm drive hose clamps to retain the pipe.

30.7.3 Clean the overflow manifolds

Use the ATEX vacuum cleaner (wet separator) and a long brush to clean any loose powder from the manifolds.

As far as is practical, clean the internal surfaces of the manifolds and tube using a cloth and isopropanol alcohol.

30.7.4 Clean the recirculation pump

Using the ATEX vacuum cleaner (wet separator), clean any loose powder from around the recirculation pump. As far as is practical clean inside the pump inlet and outlet to remove powder from inside the pump.

Clean the external surfaces, inlet and outlet using a cloth and isopropanol alcohol.

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31 Heat treatment

31.1 Introduction

It is outside the scope of this user guide to define heat treatment methods and processes for AM parts once they have been built. However the following considerations should be made:

- Thick sections may have higher stress and require a normalisation or annealing heat treatment.
- Builds with a large cross sectional area will have a longer period between laser passes and require heat treatment.
- Some materials, such as titanium alloy may have higher internal stress following build and require heat treatment as soon as the build finishes.
- Almost all alloys will oxidise at elevated temperatures. It is essential that heat treatment is carried out under vacuum or inert gas. For metals that are susceptible to nitrogen embrittlement it is essential that the inert gas is argon (titanium and INCONEL® for example).
- Renishaw can supply furnace foil wrap (part number 845500000). This is used to provide an extra layer of protection when used in conjunction with an inert gas box.

For detailed furnace programming and operating instructions, refer to the User guide for your furnace and applicable local procedures.

31.2 Wrapping parts prior to heat treatment

Renishaw recommends that parts are wrapped in furnace foil wrap as follows:

Ensure enough foil is used to wrap the part, (Figure 348).

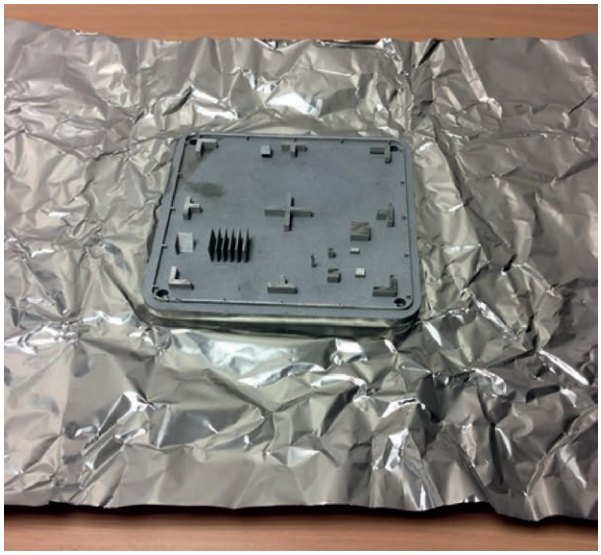

Figure 348 Amount of foil to wrap the part

Fold and cover approximately $^{1}/_{4}$ of the part, (Figure 349).

Figure 349 Fold and cover

Flip the part over and fold the remaining foil under, (Figure 350).

Figure 350 Fold remaining foil under

Crimp any open ends of the foil parcel, (Figure 351).

Figure 351 Crimp any open ends

Flip the part over again, (Figure 352).

Figure 352 Flip part over again

Fold over the edges, (Figure 353).

Figure 353 Fold over edges

The part is now fully wrapped, (Figure 354).

Figure 354 Part now fully wrapped

Place the fully wrapped part in a furnace box, (Figure 355).

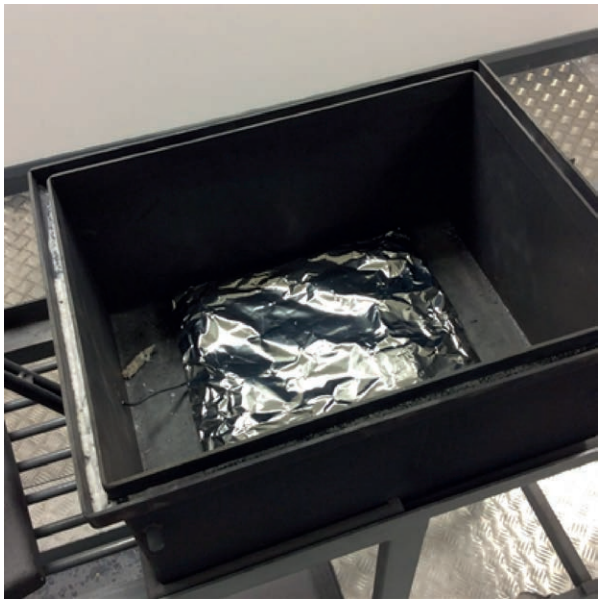

Figure 355 Place part in furnace box

With the part in the furnace box cover with an additional piece of furnace foil that extends to the edges of the furnace box, (Figure 356).

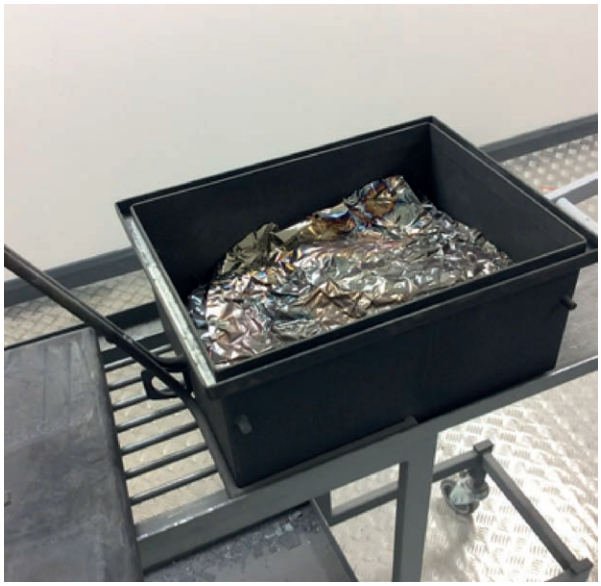

Figure 356 Cover the wrapped with foil

Fit the lid to the furnace box and place the part in the furnace, (Figure 357).

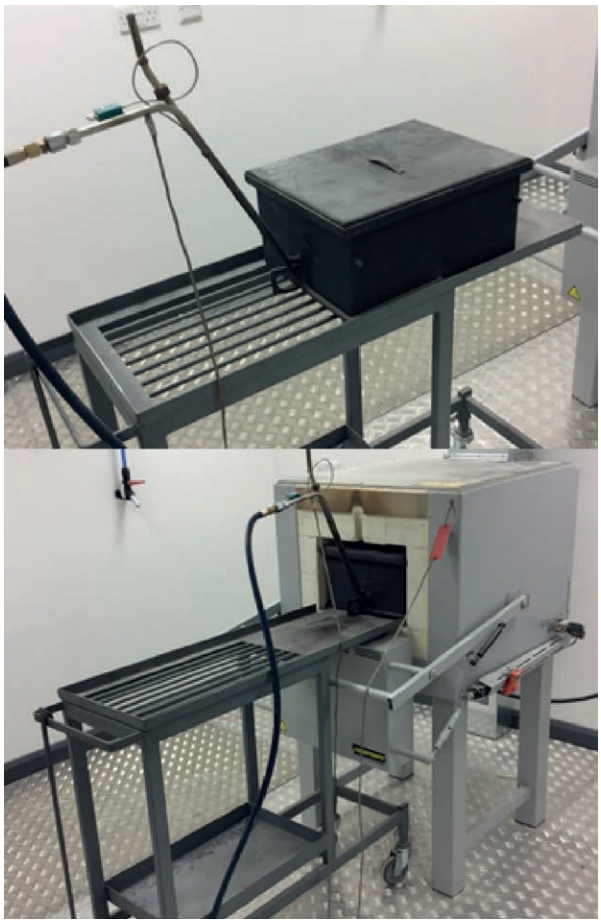

Figure 357 Place the part in the furnace

32 Silo and dosing mechanism removal/exchange

One of the main features of the Renishaw AM250/AM400 is the relative ease by which the system can be switched between different materials by removing the silo and using the powder changeover kit which includes overflow pipes and valves etc.

If the silo is to be exchanged for one dedicated to a different material, then skip step 32.1.

WARNING: ALWAYS WEAR THE CORRECT PERSONAL PROTECTIVE EQUIPMENT BEFORE STARTING – GLOVES/GAUNTLETS, 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) AND RESPIRATORY MASK.

32.1 Emptying the silo

Dose all the powder out of the silo into overflow bottles for storage under inert atmosphere. Follow the procedure for dosing mechanism removal.

Once empty, close the valve (IV1) on the silo nose by moving the levers into the vertical position (Figure 358).

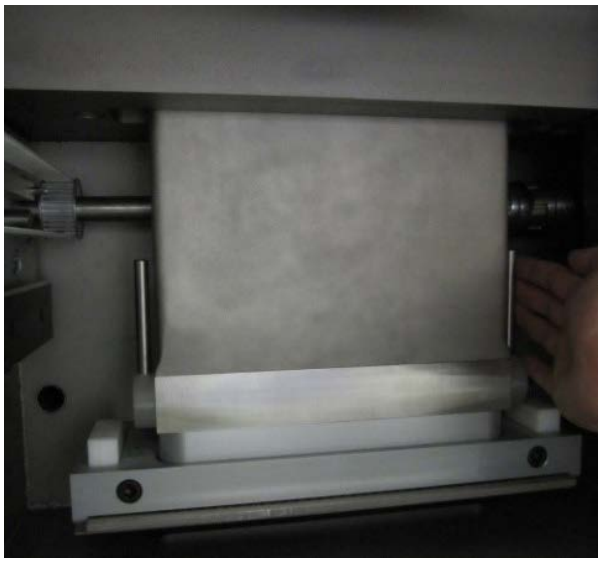

Figure 358 Valve (IV1) in the closed position on silo nose

32.2 Removing the silo

WARNING: REMOVING THE SILO OPENS THE CLASS 1 LASER ENCLOSURE. THE AM250/AM400 SYSTEM MUST BE SHUTDOWN AND ELECTRICALLY ISOLATED BEFORE REMOVING THE SILO.

Disconnect the powder level sensor lead on the top panel of AM250/AM400 system (Figure 359).

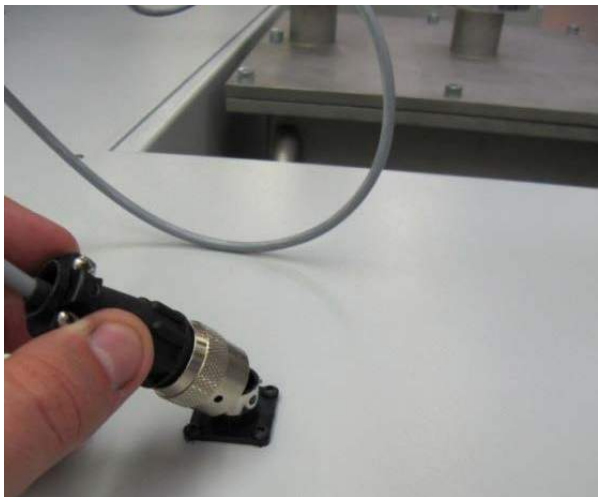

Figure 359 Disconnection of the powder level sensor

WARNING: THE SILO WEIGHS 44.4 KG (97 LB) WHEN EMPTY.

The silo is heavy and should be emptied before removal. A suitable lifting method must be identified and risk assessed – gantry crane, lifting trolley or multi-person lift. Renishaw recommend using a Renishaw silo changeover lift part number M-5771-1000.

Tor remove the silo from the AM250/AM400 system, remove the four M8 bolts from the silo flange using a 6 mm hexagon key (Figure 360).

Figure 360 Remove the four bolts

Lift the silo vertically from the AM250/AM400 system.

Once the silo is raised completely out of its assembly position, lower and store safely.

WARNING: WHEN THE SILO IS CLEAR OF THE AM250/AM400 SYSTEM, ENSURE THAT THE SILO IS LOWERED TO JUST ABOVE GROUND LEVEL TO MINIMISE RISK OF IT FALLING.

32.3 Disassembling and cleaning the silo

Renishaw recommend maintaining a separate silo for each material. However it is possible to clean the silo.

WARNING: ALWAYS WEAR THE CORRECT PERSONAL PROTECTIVE EQUIPMENT BEFORE STARTING – GLOVES/GAUNTLETS, 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) AND A RESPIRATORY MASK.

Wipe down all external components with isopropanol and a cloth.

Open the latch and remove the clamp (L3) on the powder sensor (Figure 361). Carefully remove the powder sensor, valve and o-rings.

Figure 361 Disassembly of powder sensor clamp (L3)

Open the latch and remove the clamp (L2) and o-ring on the silo isolation valve (V1) (Figure 362).

Remove the eight M8 bolts from the silo lid using a 6 mm hexagon key (Figure 363).

Figure 362 Removing the silo isolation valve (V1) clamp (L2)

WARNING: THE SILO LID IS HEAVY. ENSURE THAT THE CORRECT MANUAL HANDLING PROCEDURE IS FOLLOWED WHEN LIFTING IT.

Figure 363 Removing the silo lid

Remove the silo lid (Figure 361). Clean with isopropanol and a disposable cloth (Figure 364).

Figure 364 Clean lid with isopropanol

Clean the inside of the silo with isopropanol and a disposable cloth, ensuring that the silo nose is thoroughly clean (Figure 365). Leave the disassembled silo for approximately 24 hours to ensure it is fully dry.

Figure 365 Cleaning inside of the silo with isopropanol

Take the opportunity to clean the back wall of the process chamber (this is normally hidden behind the silo nose).

WARNING: ENSURE THAT THE SILO REMAINS SECURE THROUGHOUT THE CLEANING PROCESS AT THE MINIMUM HEIGHT ABOVE GROUND LEVEL.

32.4 Assembling the silo

Ensure disassembling and cleaning the silo has been completed, see Section 32.3 "Disassembling and cleaning the silo".

Fit the lid to the silo. Align the lid, so that edge of the lid with a KF flange closest to its edge is aligned with the vertical face of the silo, (Figure 366).

Figure 366 Aligning the silo lid with the vertical face of the silo

Fit the eight M8 bolts and tighten them finger tight.

Using a 6 mm hex key and a torque wrench, tighten the eight M8 bolts to 10 to 16 Nm. Use the tightening sequence in (Figure 367).

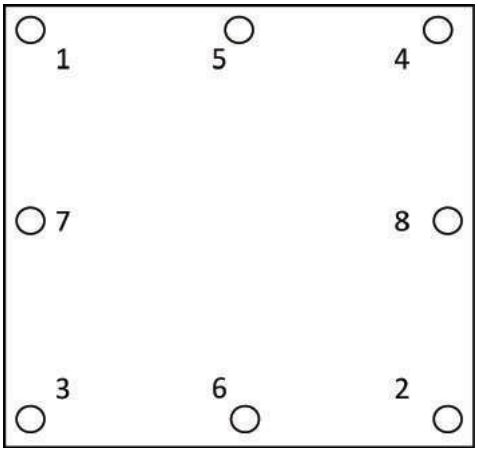

Figure 367 Silo lid tightening sequence

Place an centring ring on both KF flanges of the silo lid.

Locate the powder sensor over the centring ring on the outer flange, and secure with a swing clamp (L3).

Fit the silo isolation valve (V1) to the central boss on the lid using a centring ring and swing clamp (L2).

Ensure the silo isolation valve (V1) is closed (lever at 90° to the flow direction).

32.5 Removing the dosing mechanism

WARNING: ALWAYS WEAR THE CORRECT PERSONAL PROTECTIVE EQUIPMENT BEFORE STARTING – GLOVES/GAUNTLETS, 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) AND A RESPIRATORY MASK.

If the silo is still assembled, close the valve (IV1) on the sides of the silo inside the build chamber nose – levers in the upright position.

Empty the powder remaining in the dosing mechanism by selecting the following on the user interface (Figure 368 and Figure 369):

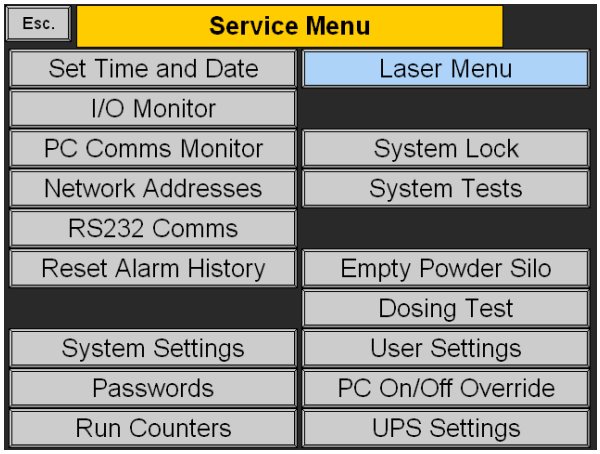

Figure 368 Empty powder silo

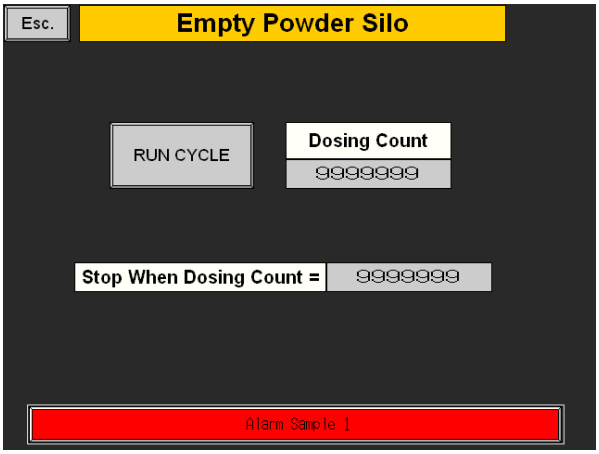

Figure 369 Enter 250 and run cycle

Service Menu > Empty Powder Silo > Stop When Dosing Count = 250 > Run Cycle

Observe the dosing mechanism. Once empty, the cycle can be stopped by toggling:

> Run Cycle

Ensure that the system has been cleaned down.

Either remove or raise the silo by approximately 50 mm (2 in) to gain access.

Figure 370 Support doser

Support the dosing mechanism to prevent it from dropping. It may help to insert some packing material or a cloth (Figure 370).

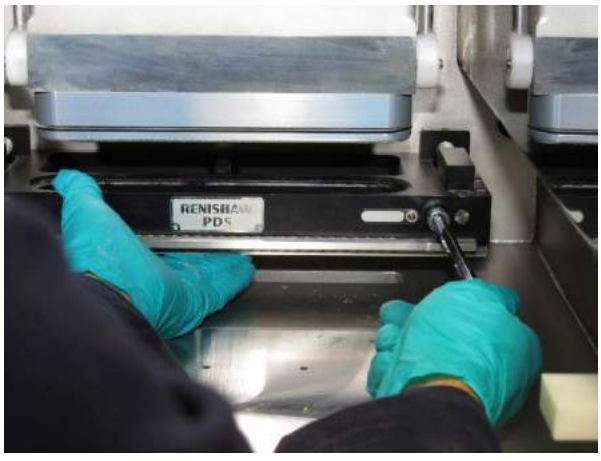

Figure 371 Removal of dosing mechanism bolts

Remove the two M10 bolts on the front face of the dosing mechanism using an 8 mm hexagon key (Figure 371).

Pour any remaining powder in the dosing mechanism down the front overflow.

Remove the dosing mechanism from the AM250/AM400 system, ready for storage (Figure 372).

Figure 372 Remove dosing mechanism for storage

32.6 Exchange the dosing mechanism

Renishaw recommend that you keep a separate dosing mechanism for each different material type you intend to use in your AM250/AM400 system. Renishaw recommend you label your dosing mechanisms to avoid cross contamination of materials between dosing mechanisms.

Caution: Renishaw recommend that you DO NOT disassemble your dosing mechanism. The dosing mechanism is a complex piece of equipment and errors is disassembly/assembly will affect the quality of built parts.

Exchange the dosing mechanism for the dosing mechanism assigned to the material you intend to use next.

32.7 Re-install the dosing mechanism

With the silo removed or elevated clear by at least 50 mm (2 in), and with the dosing strip facing into the build chamber, offer the dosing mechanism up to the threaded holes in the rear of the chamber. It may help to insert some packing material to support one end (Figure 373).

Figure 373 Locate dosing mechanism at rear of chamber

Locate the two M10 bolts in the threaded holes and tighten using an 8 mm hexagon key to approximately 16 Nm (11.8 lbf/ft) (Figure 374).

Figure 374 Tighten bolts

Gently lower the silo. It will engage with the doser (Figure 375). Insert and tighten the four silo mounting bolts on the rear of the system.

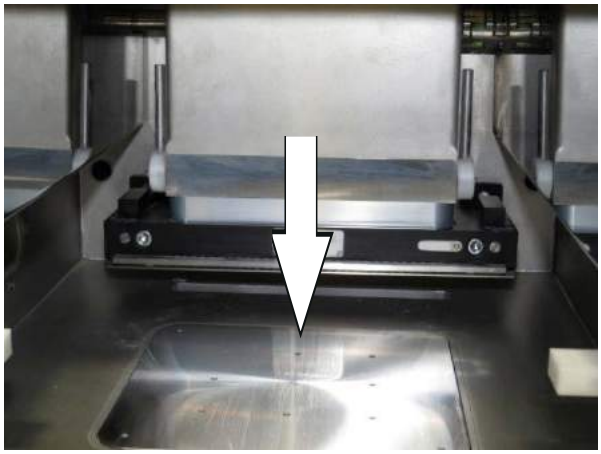

Figure 375 Lower the silo into the dosing mechanism (shown with the valve (IV1) closed)

Open the doser isolation valve (IV1) by pushing away until it is horizontal and clicks into place (Figure 376).

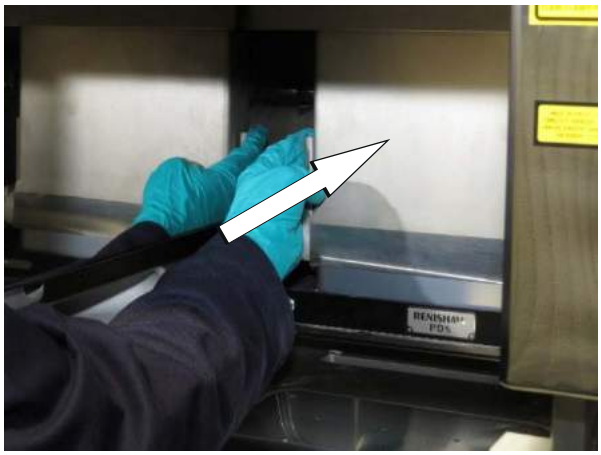

Figure 376 Open the doser isolation valve (IV1)

32.8 Re-installing the silo

WARNING: THE SILO MUST BE SECURED TO THE SILO LIFT BRACKET AT ALL TIMES.

WARNING: THE SILO SHOULD ONLY BE RAISED ON INSTALLATION WHEN IT IS BEHIND THE AM250/AM400 MACHINE.

WARNING: THE SILO WEIGHS 44.4 KG (97 LB) WHEN EMPTY.

After the silo has been assembled see Section 32.4 "Assembling the silo", lift the silo by locating the top face under the lugs on the silo lift.

Without raising the silo on the silo lift, move the silo lift to the rear of the AM250/AM400 system.

Pump the handle to raise the silo, until there is clearance between the bottom of the silo assembly and the AM250/AM400 system.

Move the silo lift towards the AM250/AM400 into the correct position for silo installation – so that the silo nose is above the aperture, (Figure 377).

Figure 377 Silo positioned for installation

Lower the silo into position. As the silo assembly reaches its final position ensure that the nose locates correctly into the dosing mechanism and that the equalising pipes locate into the corresponding holes in the rear of the machine.

Lower the silo lift and move clear of the AM250/AM400 system.

Install the four M8 bolts, tighten the bolts using a 5 mm hex key and a torque wrench to 16 Nm.

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33 Inspection and maintenance

33.1 AM250/AM400 system maintenance

WARNING: WHEN LOGGED INTO THE SYSTEM AT LEVEL 4 FOR MAINTENANCE ACTIVITY, CERTAIN TASKS WILL RESULT IN CLASS 2 LASER EMISSIONS. WHERE THIS OCCURS THE TASK WILL IDENTIFY THIS, AND DESCRIBE THE STEPS TO BE TAKEN TO MINIMISE ANY POSSIBLE EXPOSURE.

Renishaw recommend that the AM250/AM400 is maintained in accordance with the following maintenance schedule. There are some differences in the maintenance for an AM250 and an AM250 with PlusPac/AM400 – these are identified where they are applicable.

WARNING: ENSURE YOU ARE WEARING THE CORRECT PPE BEFORE YOU START ANY MAINTENANCE: 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) BEFORE STARTING THIS TASK.

33.1.1 Operator maintenance

Work to be carried out	Daily	Weekly	Monthly	6 monthly	Other
Visual inspection of the entire system	×	×	×	×	
Check the function of the safety devices		×	×	×	
Inspect the green filter glass for damage	×*	×	×	×	
Safety stickers and warnings are complete and clearly legible (sections 6.2 and 7)		×	×	×	
User guide is kept near the system in an easily accessible place		×	×	×	
Visual inspection of the door seal, check for leaks		×			
Visual inspection of the hoses, check for leaks		×			
Visual inspection of metal bottle seals, check for leaks		×			
Clean the process room	×				
Clean the glass of the lens protective cover – AM250 only – see Section 30.4	×*				
Clean the window protection system lens – AM250 with PlusPac and AM400 only – see Section 30.5.1	×*				

Work to be carried out	Daily	Weekly	Monthly	6 monthly	Other
Deep clean of the window protection system lens – AM250 with PlusPac and AM400 only – see Section 30.5.2				×	
Clean the entire unit		×			
Clean the working room		×			
Safe change filter exchange – see Section 22.2 OR Large safe change filter exchange – see Section 22.3	*				
Check the wiper	×*				
Exchange of bottles under each overflow funnel	×*				
Powder safety checks				×	
Check of inert gas supply	×				
Gas safety check				×	
Check of gas cylinder (optional for fire suppression system)	×				
Check display of oxygen content (= 21%)	×				
Check level of chiller coolants – see Section 14.1.1	×				
Check around chiller for chiller fluid leaks	×				
Chiller cooling fins – see Section 14.1.2		×			
Check chiller temperature settings – see Section 14.1.2		×			
Dehumidifier – see Section 14.5	×	×	×		
Replace system filters – see Section 33.3			×		
Remove silo to clean build chamber back wall – see Section 32				×	
Replace system batteries – see Section 33.6					3 years

*Or after every build

33.1.2 Renishaw trained service engineer maintenance

WARNING: THE FOLLOWING WORK CAN ONLY BE CARRIED OUT BY A RENISHAW TRAINED SERVICE ENGINEER.

Work to be carried out	6 monthly	12 monthly
General maintenance		
Check for hardware upgrades, install as required	×	
Inspect/operate safe change filter/large safe change filter isolation valves (F1 and F2), clean/replace as necessary	×	
Check large safe change filter pressure relief valve, ensure dust cap in place	×	
Inspect door seals and replace if necessary	×	
Inspect glove box seals, and replace if necessary	×	
Inspect chamber gloves, and replace if necessary	×	
Inspect armovin pipework, and replace if necessary	×	
Inspect cooling fan filters, and replace if necessary	×	
Confirm cooling fan operation, replace fan if necessary	×	
Inspect observation window (laser filter)	×	
Inspect and replace self centring rings (KF joints, powder flasks)		×
Check door catch for correct operation and wear, replace as required		×
Check for process emission build up in areas such as behind the silo, manifolds, pipework, behind wiper covers. Clean if required		×
Electrical maintenance		
Functional check of emergency stop	×	
Functional check of main door interlock	×	
Functional check of glove box interlock	×	
Removal of main door interlock cover panel - test and inspect wiring		×
Inspect main power cable	×	
Inspect electrical panel, check components for damage and wiring integrity	×	
Inspect PC, optical scanner control box and laser cabling	×	
Check lighting	×	
Inspect bonding cables for damage, replace as required	×	
Perform electrical continuity test on panel work and bonding		×
Check electrical continuity to earth	×	
Clean/vacuum electrical cabinet internal components/surfaces		×
Chiller maintenance		
Inspect all pipes and connections	×	
Flush chiller unit		×
Flush AM machine		×
Reset pump run and fan hours		×
Check levels and top-up chiller with correct ratio of glycol	×	
Inspect for leaks	×	

Work to be carried out	6 monthly	12 monthly
Check pump seals, replace if leak rate exceeds 3 cc/hr, 8000 hours, or 1 years use		×
Control computer maintenance		
Check PC software revision, upgrade to latest revision	×	
Check HMI software revision, upgrade to latest revision	×	
Check PLC software revision, upgrade to latest revision	×	
Check battery backup and replace as necessary		×
Run registry cleaning software, perform configuration file housekeeping		×
Clear temporary and unused files from the hard drive		×
Defragment the hard drive		×
Clean/replace PC air intake filter		×
Z-axis maintenance		
Inspect and recoat the thermocouple with heat transfer paste		×
Inspect and clean trapezoidal screws	×	
Inspect couplings	×	
Inspect wiring	×	
Check process plate absolute top position is 0.7 mm ± 0.1 mm at corners	×	
Check operation of position sensors	×	
Teach the home position	×	
Inspect the top plate for flatness and damage	×	
Drive to bottom position - inspect the build volume bore for scoring/damage	×	
Replace the z-axis seals		×
Torque test the z-axis to build chamber retaining bolts		×
Recoater maintenance		
Inspect and clean/replace belts if required	×	
Inspect and clean thumbwheel	×	
Inspect couplings	×	
Check powder delivery system contact position	×	
Check concentric and eccentric bearing for wear	×	
Check parallelism (< 100 micrometre)	×	
Oxygen sensor maintenance		
Replace 25 mm centre ring on the top sensor	×	
Replace top sensor		×
Replace bottom sensor		×
Gas system		
Inspect area around vac pump for leaks	×	
Check the vacuum pump oil level sight glass	×	
Replace the vacuum pump oil and filter		×
Check the pressure relief valve operating pressure	×	
Carry out gas line pressure drop test	×	
Carry out vacuum pressure test	×	
Carry out chamber positive pressure test	×	

Work to be carried out	6 monthly	12 monthly
Window protection system		
Remove the lens, clean and inspect in detail for damage/scratching. Replace as required	×	
Inspect the pneumatic hoses for damage	×	

33.2 Anciliary equipment maintenance

In addition to the AM250/AM400 system maintenance, ancillary equipment must also be maintained as follows:

- See Section 14.4.3 "Regular inspection and maintenance" for details of the silo lift maintenance.
- See Section 14.1.2 "Basic chiller maintenance" for details of the chiller maintenance.
- See Section 14.2.1 "ATEX vacuum cleaner (wet separator) safety checks" for details of the ATEX vacuum cleaner (wet separator) safety checks.
- Refer to the manufacturers User guide for details of the ATEX vacuum cleaner (wet separator) maintenance, see Section 37 Appendix D "Supplier manuals" for information on the make, model and manufacturer.
- Refer to the manufacturers User guide for details of the powder recovery system (sieve) maintenance, see Section 37 Appendix D "Supplier manuals" for information on the make, model and manufacturer.
- Refer to the manufacturers User guide for details of the laser system maintenance, see Section 37 Appendix D "Supplier manuals" for information on the make, model and manufacturer.
- Refer to the manufacturers User guide for details of the dehumidifier maintenance (AM400 only), see Section 37 Appendix D "Supplier manuals" for information on the make, model and manufacturer.
- If additional ancillary equipment, for example a furnace, has been purchased; refer to the manufacturers User guide for details of any maintenance requirements. See Section 37 Appendix D "Supplier manuals" for information on the make, model and manufacturer.
- Refer to the manufacturers User guide for details of gas detection system maintenance.

WARNING: THERE MAY BE APPLICABLE LOCAL LEGISLATION REGARDING MAINTENANCE REQUIREMENTS FOR CERTAIN EQUIPMENT ON THE AM250/AM400. REFER TO ANY APPLICABLE LOCAL LEGISLATION REGARDING MAINTENANCE OF EQUIPMENT FOR DETAILS.

33.3 System and air filter maintenance

There are six filters on the AM250 and five filters on the AM400 system. They need to be cleaned monthly to ensure full working efficiency and air flow through the system. The AM400 filters are larger than the filters fitted to AM250.

33.3.1 AM250 filters

There are two on the top panel and four are located on the back, (Figure 378).

Figure 378 Rear of AM250 showing air filters

33.3.2 AM400 filters

There are four filters located on the right hand end and one filter on the back in the top right corner above the argon vent, (Figure 379).

Figure 379 Rear and right hand side of AM400 showing air filters

33.3.3 Cleaning AM250/AM400 filters

Using a screwdriver, unclip the machine cover carefully, (Figure 380) from the AM250/AM400.

Figure 380 Lever off cover with screwdriver

Once unclipped from the AM250/AM400 system, disassemble the filter from the cover.

Discard the used filter and clean the casing using a vacuum cleaner, (Figure 381).

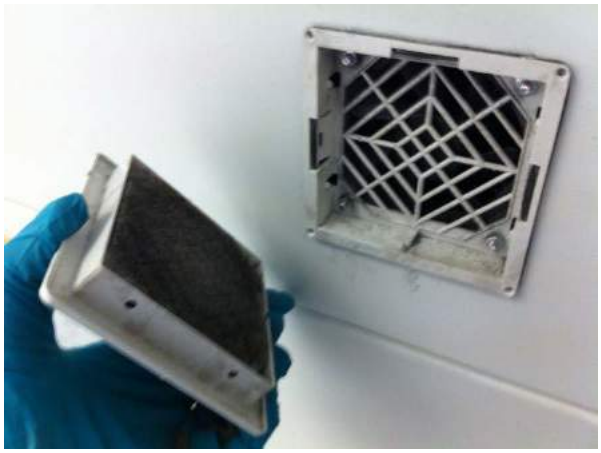

Figure 381 Contaminated filter assembly

Fit a new filter (part number 792460000 - AM250 and part number M13FPFK - AM400).

Fit the cleaned filter assembly back into the AM250/AM400 system.

33.4 Gas safety checks

Carry out a safety check of the gas system and ensure it is in working condition with no leaks. Replace and damaged or defective parts as required. Keep records of when the gas safety check is carried out.

WARNING: GAS REGULATORS CANNOT BE CALIBRATED AND MUST BE REPLACED AT THE END OF THEIR LIFETIME. THE LIFETIME IS DETERMINED BY THE MANUFACTURER OF THE REGULATOR BUT IS TYPICALLY FIVE YEARS.

33.5 Powder safety checks

Renishaw recommend that you develop a maintenance regime for your powder, powder storage and powder handling areas. Periodically check that powder is being stored correctly in line with applicable Safety Data Sheets and powder suppliers recommendations. Periodically powder storage and handling areas must be deep cleaned to remove all powder traces. Metal powder is very fine and can find its way into very small spaces where it can accumulate with the consequential risk of explosion. Deep cleaning of areas and equipment, including but not restricted to trunking, ducting, ceiling tiles, flooring, furniture, etc must be done to remove all traces of powder.

33.6 AM250/AM400 system batteries

The AM250/AM400 system contains a number of non-rechargeable lithium batteries. These batteries have a shelf life of 5 years (at 25 °C), however replacement is recommended at least every 3 years.

WARNING: BEFORE CARRYING OUT ANY MAINTENANCE ACTIVITIES ON THE AM250/AM400 SYSTEM THAT REQUIRES OPENING THE ELECTRICAL CABINET OR REMOVING THE PC, THE AM250/AM400 SYSTEM MUST BE ELECTRICALLY ISOLATED, AND CAPACITORS ALLOWED TO DISCHARGE. WHEN OPENING THE PC OR HANDLING PRINTED CIRCUIT BOARDS ESD PRECAUTIONS SHOULD BE CARRIED OUT – EITHER TOUCH A GROUNDED PIECE OF METAL TO DISCHARGE STATIC ELECTRICITY FROM YOUR BODY, OR USE A GROUNDING WRIST STRAP.

The lithium batteries provide power to the backup memory of system parameters and settings, removing a battery may wipe the backup memory. Ensure backup data is available.

WARNING: CAUTION SHOULD BE TAKEN WHEN HANDLING AND DISPOSING OF BATTERIES:
DO FOLLOW BATTERY DISPOSAL ADVICE AND ANY INTERNAL WASTE MANAGEMENT PROCESSES AND PROCEDURES.
DO NOT EXPOSE THE BATTERIES TO HIGH TEMPERATURES INCLUDING DIRECT SUNLIGHT OR INCINERATE.
DO NOT TRY TO RECHARGE A PRIMARY (NON-RECHARGEABLE) CELL.
DO NOT CRUSH, DISASSEMBLE BREAK OPEN OR ABUSE THE BATTERIES.
NEVER USE A BATTERY THAT HAS BEEN DROPPED ON THE FLOOR OR OTHERWISE SUBJECT TO SHOCK AS IT MAY LEAK.
DO NOT SHORT-CIRCUIT THE BATTERY.

Renishaw recommend that batteries are only replaced by experienced technicians.

33.6.1 HMI human machine interface battery

Battery Type: CR14250SE-R

1. The battery for the HMI is located on the back of the HMI screen within the top electrical cabinet.

2. To access this battery, open the door to the top electrical cabinet.

3. The battery is located in the bottom right hand corner of the HMI, (Figure 382).

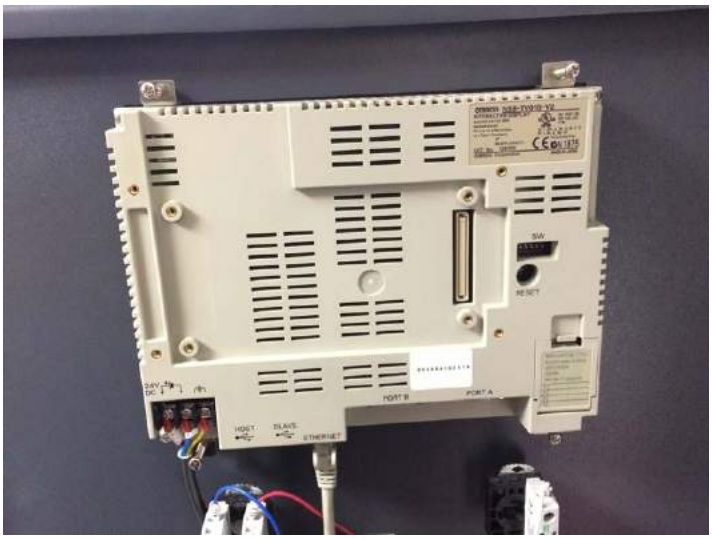

Figure 382 Rear of HMI screen

4. Press down on the tab securing the battery compartment lid and open the battery compartment, (Figure 383).

Figure 383 Battery mounted on battery compartment lid

5. Remove the battery and fit a replacement, (Figure 384).

Figure 384 Battery removed from compartment lid

6. Close the battery compartment lid.

33.6.2 PC battery

Battery type: CR2320

1. The battery for the PC is located within the PC case, near the cooling fan.
2. Before removing the battery, ensure the BIOS settings have been recorded as the PC will reset once the battery is removed.
3. Open the lower electrical cabinet door to find the front of the PC case.
4. To access the battery, the PC must be removed from the AM250/AM400 system and its case opened.
5. If necessary note and record the location of the connections at the rear of the PC case, (Figure 385).

Figure 385 PC connections

6. Remove the connections from the rear of the PC, (Figure 307).

7. On the front of the PC use a 5 mm hexagon key and remove the four retaining screws that secure the PC, (Figure 386).

Figure 386 PC retaining screws

8. The PC can now be removed from the AM250/AM400 using the two handles on the left and right sides of the front of the PC case. As the PC slides out, support its weight to ensure it does not fall and become damaged, this may be a two-person lift.

9. Remove the screws securing the case and remove the case, (Figure 387).

Figure 387 Case retaining screws

10. The battery is located near the cooling fan, (Figure 388) circled and (Figure 389) circled.

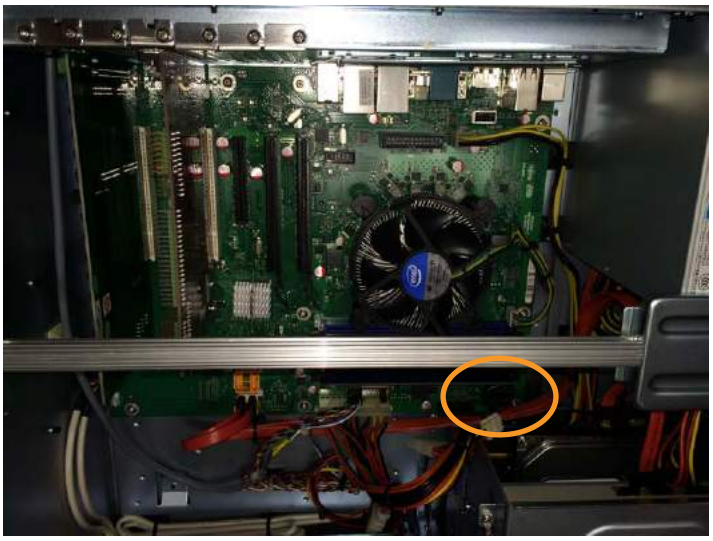

Figure 388 Battery location

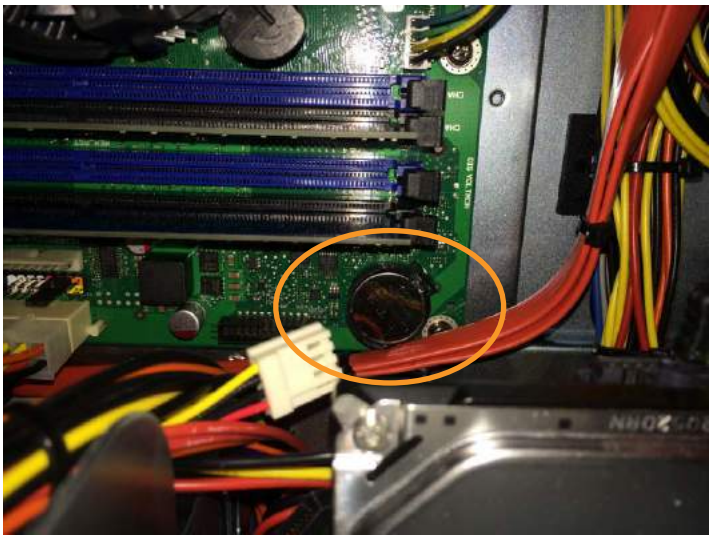

Figure 389 Battery location

11. Remove the battery from the motherboard and replace with a new battery.

12. Refit the PC case and secure with the retaining screws. Refit the PC back into the AM250/AM400 and secure with four screws. Refit the connections at the rear of the AM250/AM400 using any notes made during removal.

33.6.3 Oxygen sensor board batteries

Battery type: CR2430 x 2

1. The batteries for the oxygen sensor control boards are located within the top electrical cabinet.

2. Open the cabinet door.

3. Both batteries can be seen at the bottom left and right hand sides of the cabinet, behind plastic covers, (Figure 390).

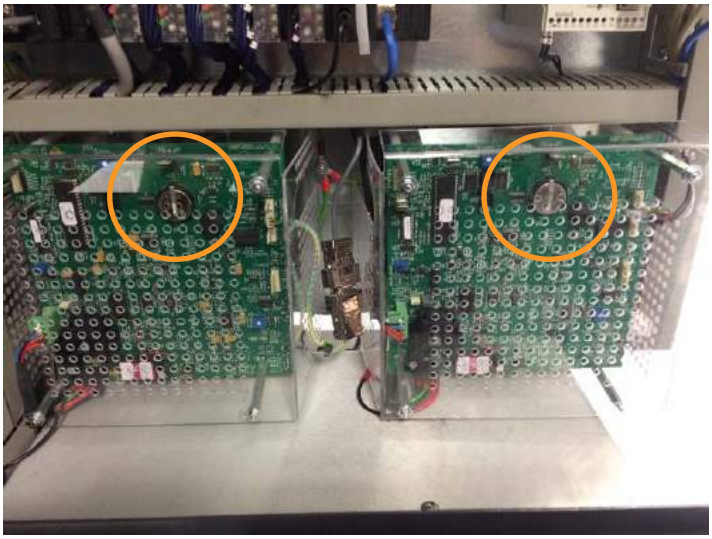

Figure 390 Oxygen sensor board batteries

4. Remove the four retaining nuts/washers on each cover to gain access to the batteries, (Figure 391).

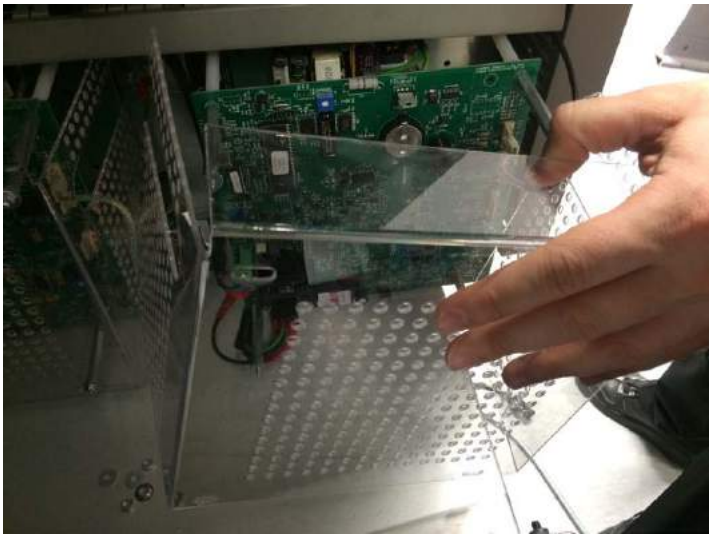

Figure 391 Removing the board covers

5. Remove and replace the batteries, (Figure 392).

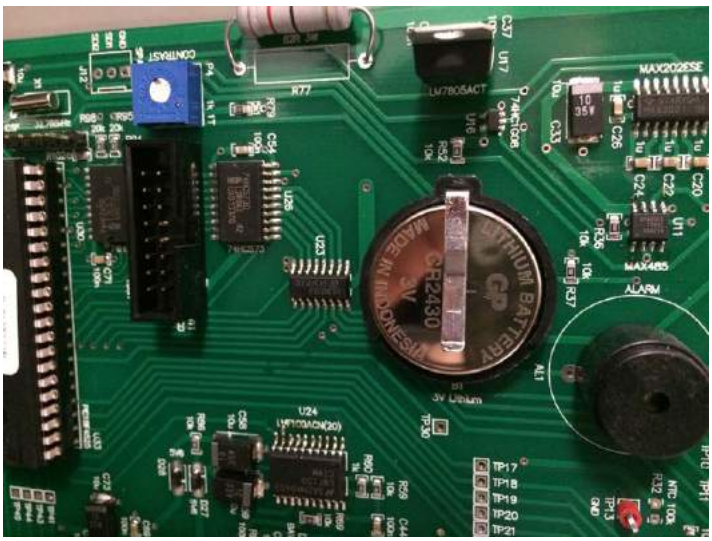

Figure 392 Oxygen sensor board battery

6. Replace the covers and tighten the four retaining nuts/washers. Do not tighten the nuts excessively as the plastic covers may become damaged.

33.6.4 PLC battery

Battery type: CR14250SE-R (Omron part number CJ1W-BAT01)

Note: If the battery is replaced within five minutes (at 25 °C) of switching Off power to the PLC, memory backup should be maintained.

1. The battery for PLC is located within the rear electrical cabinet. Open the cabinet door.

2. The PLC is the second module on the left hand side of the rack, (Figure 393).

Figure 393 PLC battery location

3. Lift the flap in the top left hand corner to access the battery, (Figure 394).

Figure 394 PLC battery location

4. Replace the battery and close the battery flap.

5. Power up the PLC and check it is working correctly.

33.7 Decommissioning

There are no known residual risks associated with the AM250/AM400 systems. However when decommissioning the system the following steps must be taken:

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

WARNING: 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) BEFORE STARTING THIS TASK.

- Clean the system of any residual dirt/process emissions
- Shut off the inert gas supply and open the gas inlet valve to depressurise the system
- Remove the inert gas supply hose
- Follow the PC shutdown procedure
- Isolate electrical power to the AM250/AM400 system
- Drain down the system coolant, refer to any applicable PPE requirements

REFER TO ANY APPLICABLE PPE REQUIREMENTS FOR HANDLING SYSTEM COOLANT.

- AM400 only disconnect the dehumidifier supply hoses

It is the users 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.

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34 Appendix A – AM250/AM400 build plate drawings

To regrind or remanufacture AM250/AM400 build plates, please see the drawings in the following sections:

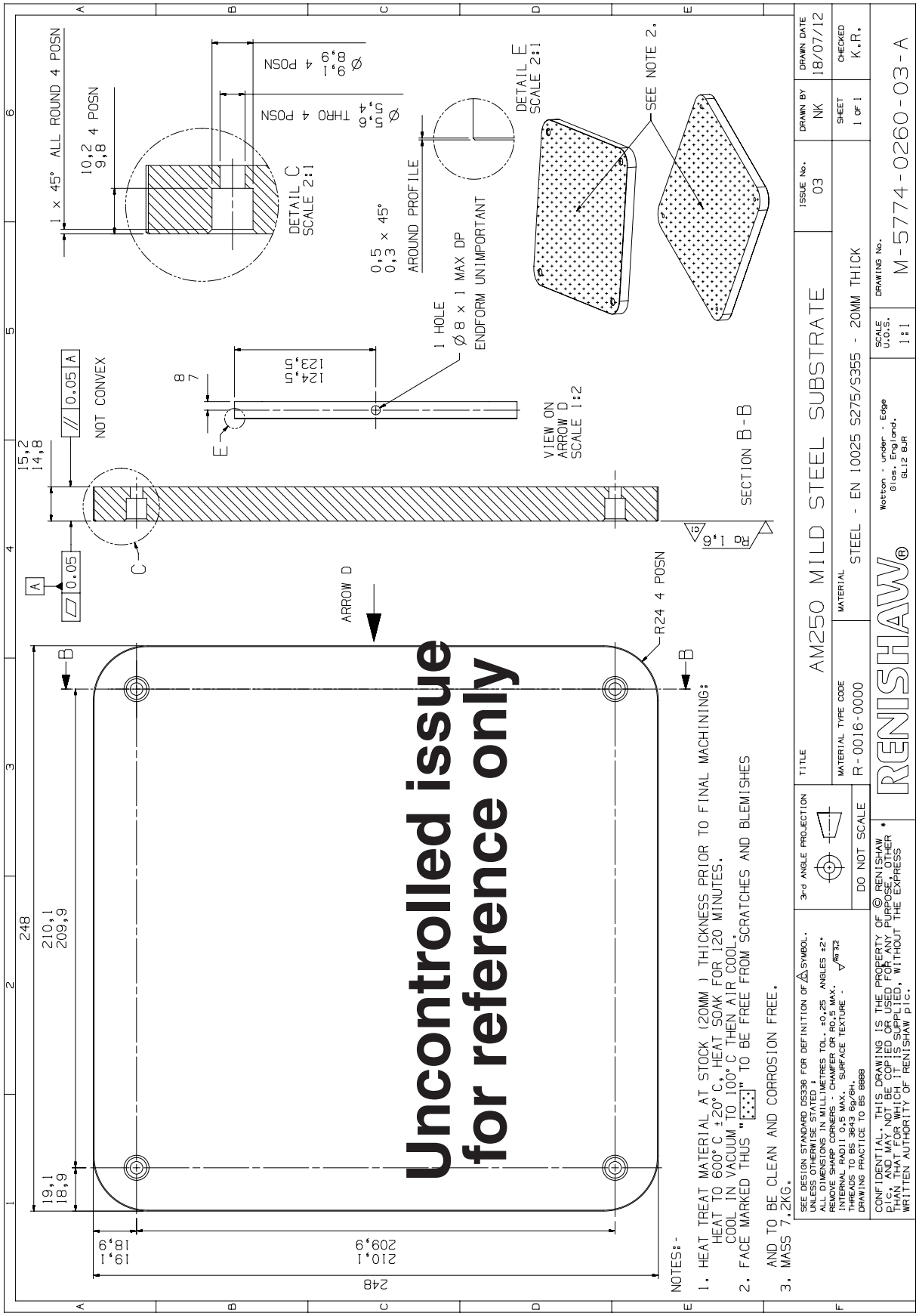
34.1 – mild steel build plate

34.2 – stainless steel build plate

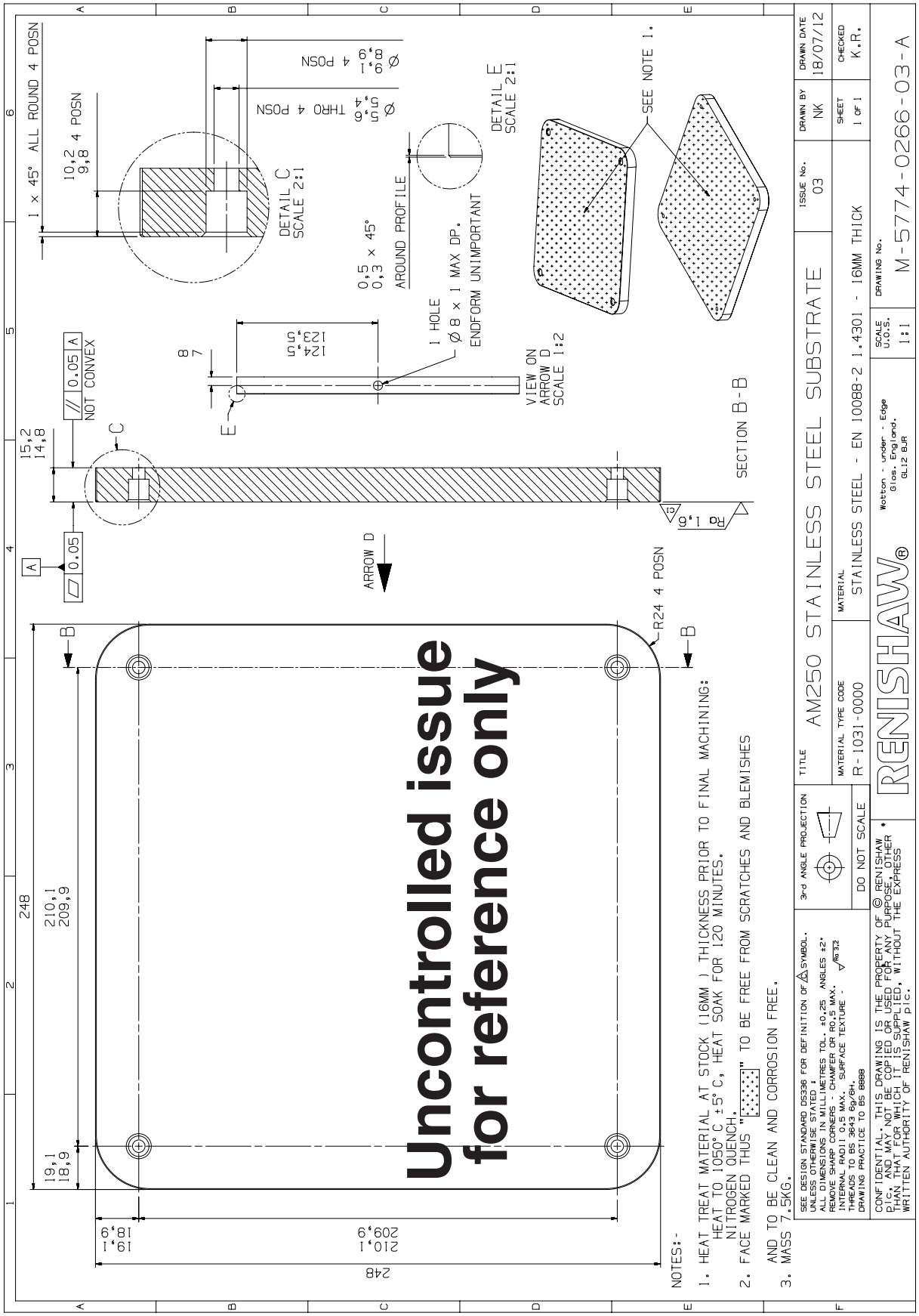
34.3 – titanium build plate

34.4 – aluminium build plate

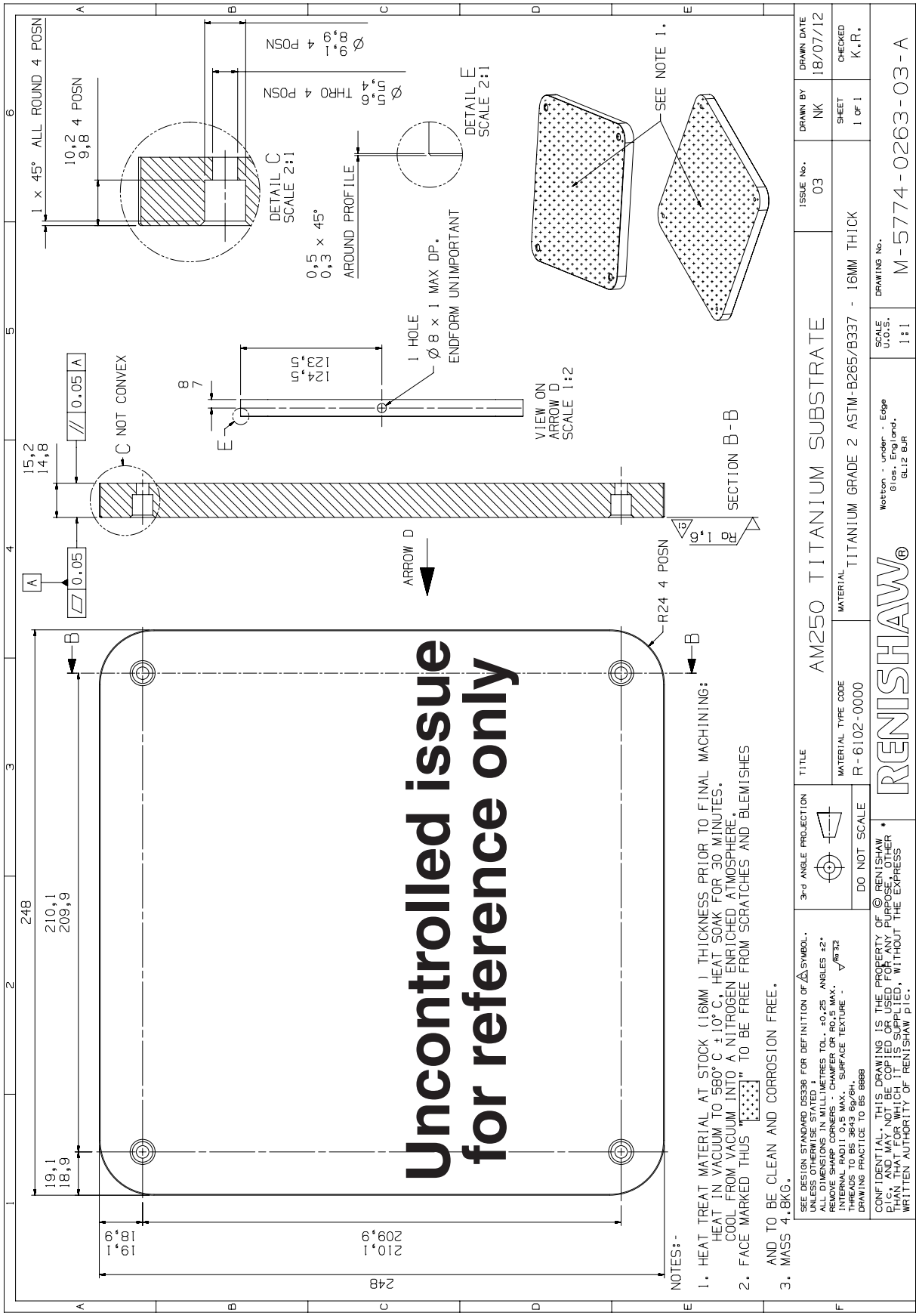
34.1 Mild steel build plate



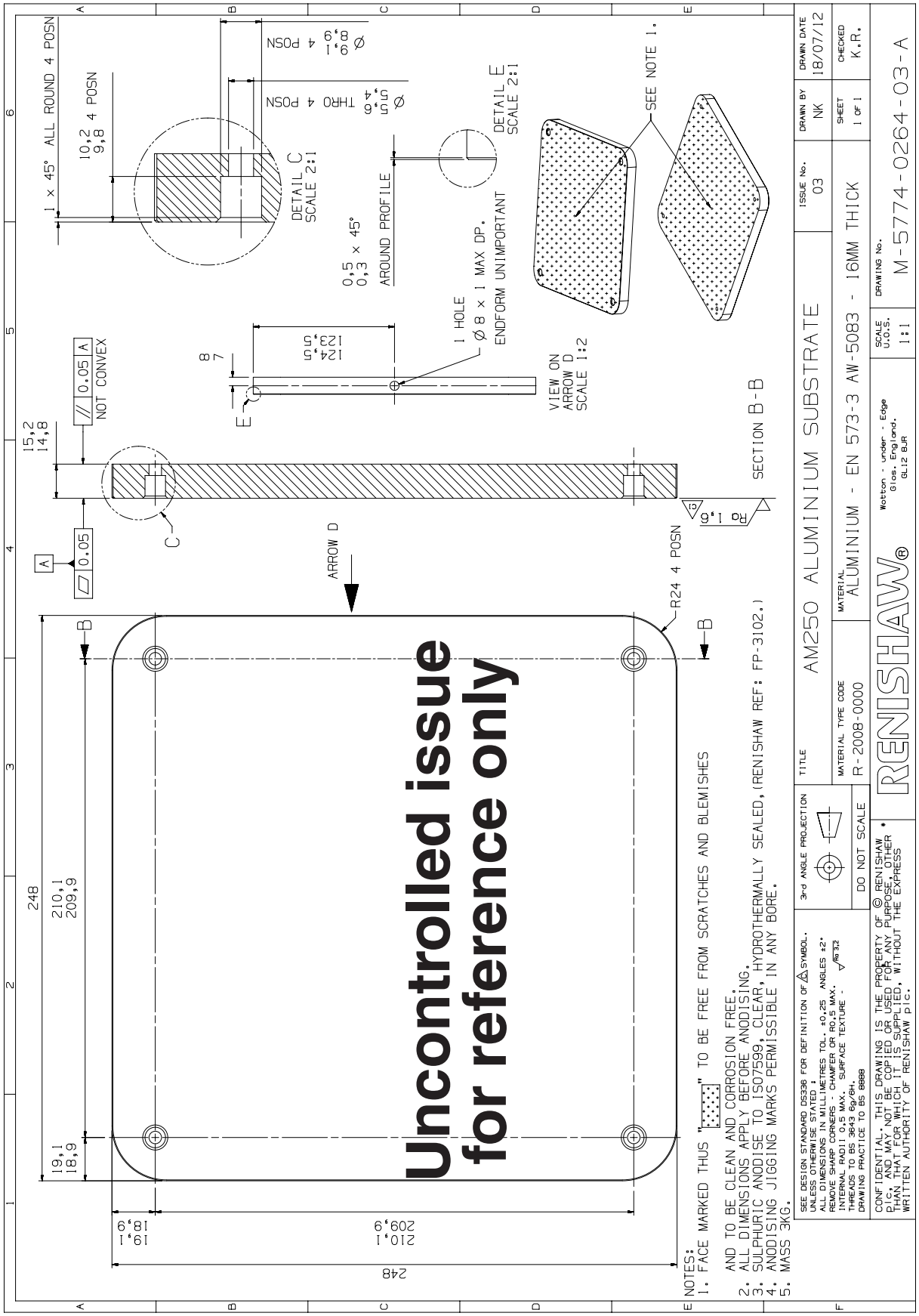
34.2 Stainless steel build plate



34.3 Titanium build plate



34.4 Aluminium build plate



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35 Appendix B – part numbers of spares

Caution: Renishaw strongly recommend that only Renishaw supplied parts are fitted to the AM250/AM400 system.

35.1 Consumables

Part number	Description
768 880 002	Oil for vacuum pump 1177 2 L
769 110 000	SV25B exhaust filter
769 890 000	High vacuum grease
P-BG01-006	Safe change filter (small)
A-5774-6000	Safe change filter, kit of 6 (large)
A-5771-0410	Stainless steel 316L powder
A-5771-0404	Cobalt chrome powder
A-5771-0402	INCONEL® 625 powder
A-5771-0406	Titanium Ti6Al4V powder (subject to export control regulations)
A-5771-0405	INCONEL® 718 powder
A-5771-0403	Aluminium AlSi10Mg powder
A-5771-0408	Stainless steel 17-4 powder
P-LU08-0004	Vacuum or storage drum additive – Hydra-Sol-MAG
792 322 000	Vacuum additive – Defoamer
792 460 000	Fan filter AM250 (box of 6)
M13FPFK	Fan filter AM400 (box of 6)
M-5774-0886	Wiper blade - 1 m
P-HX04-0001	Glycol chiller additive – concentrate
P-HX04-0003	Nalco chiller additive – pre-mixed
A-5771-0001	248 mm × 248 mm × 16 mm boxes of 3 mild steel substrate
A-5771-0003	248 mm × 248 mm × 16 mm individually boxed mild steel substrate
A-5771-0004	248 mm × 248 mm × 16 mm boxes of 3 stainless steel substrate
A-5771-0005	248 mm × 248 mm × 16 mm individually boxed stainless steel substrate
A-5771-0006	248 mm × 248 mm × 16 mm boxes of 3 titanium substrate
A-5771-0007	248 mm × 248 mm × 16 mm individually boxed titanium substrate
A-5771-0008	248 mm × 248 mm × 16 mm boxes of 3 aluminium substrate
A-5771-0009	248 mm × 248 mm × 16 mm individually boxed aluminium substrate
A-5774-0057	Optical lens cleaning kit
P-WI02-0002	Lens cleaning tissue (25 pack)

35.2 Wear and tear parts

Part number	Description
M-5774-0516	Oxygen sensor
790 500 000	Oxygen sensor + configure file
M-5774-0628	Fused silica protective window
A-5774-5016	Window protection system retrofit kit
A-5771-0160	Lens protection assembly window
P-TL50-0117	AM chamber gloves
790 110 000	Sieve mesh for PRS400-M 63 µm
790 112 000	Sieve mesh for PRS400-V 63 µm
P-SL01-0021	Wiper belts (cut to size)
M-5774-0785	Bottom vacuum chamber lip seal 10 mm (4 m)
M-5774-0785	Top vacuum chamber lip seal 10 mm (3 m)
P-PF26-0027	Glove box seal (1 m)
P-BG15-0003	Over pressure door seal (1 m)
P-RS14-0008	Ø4 mm o-ring cord
P-RS14-0009	Ø6 mm o-ring cord
798 400 000	S/s centring seal with viton o-ring (used in 796531001 & 793310000)
A-5774-0297	Wiper blade assembly
A-5774-0344	Doser Kit
P-RS04-0013	NW25 Centring seal, aluminium nitrile

35.3 Spare parts

Part number	Description
795 940 000	Heated build platform
795 960 000	Build platform bottom
P-HA01-0004	Over centre door latch (black finish)
P-KN02-0025	Security lobe knob
P-SW14-0006	Glove box safety switch
P-VP01-0001	Sv25b vacuum pump
P-PC01-0036	HMI screen
A-5774-0333	System PC
M-5774-0176	Height adjuster shaft
M-5774-0177	Height adjuster thumb wheel
P-SW13-0003	Wiper limit switch
P-FA02-0032	Gas recirculation pump assembly
P-FS01-21A0	Fuse 1 A build chamber illumination

35.4 Kits and assemblies

Part number	Description
791 851 001	Accessories tool kit
791 851 001	US Accessories tool kit
A-5774-0296	Powder bottle kit
A-5774-0286	Powder bottle assembly (complete)
A-5774-0287	Powder overflow assembly (complete)
A-5774-0301	Safe change filter assembly (standard)
A-5778-0340	Safe change filter assembly (large)
799 359 200	Standard sign off kit
799 357 001	Aluminium sign off kit
799 351 001	Titanium sign off kit
793 630 000	PRS400-M powder change kit
793 631 000	PRS400-V powder change kit
A-5774-0302	Silo retrofit kit
A-5774-0346	Powder decanting kit
A-5774-0340	Chiller fitting kit
A-5774-0298	Doser retrofit kit

Please contact Renishaw for a full description of the content of the kits and assemblies.

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36 Appendix C – Safety Data Sheets

36.1 Safety data sheets

For Safety Data Sheets on Renishaw's own range of powdered materials, refer to the Renishaw website:

www.renishaw.com/en/amdatasheet

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37 Appendix D – supplier manuals

37.1 Suppliers manuals

The AM250, AM250 with PlusPac and AM400 all use items of third party equipment. Some of this equipment is essential and some is optional. All this equipment has user documentation available, including but not limited to: description, operation, maintenance, service, fault finding, spare parts and upgrade. Much of this information is available in the language of your choosing. The following equipment is used by the Renishaw AM250 and AM400 systems:

Equipment	Model identification	Equipment manufacturer and website
Argon gas regulator	8000 series (UK only)	BOC – www.boconline.co.uk
Bead blaster	Euroblast 4AM	Guyson – www.guyson.co.uk
Bead blast extractor	Euroblast C400	Guyson – www.guyson.co.uk
Dehumidifier - air dryer – AM400 only	IDFA4E-23-A	SMC – www.smcworld.com
Furnace	N41	Nabtherm Laboratory – www.nabertherm.com
Powder level sensor	Flex61	Vega – www.vega.com
Sieve – mechanical	MS400_MS4344	Russell Finex – www.russellfinex.com
Sieve – vibrasonic	MS400_MS4345	Russell Finex – www.russellfinex.com
Silo lift	204/S	Wilmat – www.wilmat-handling.co.uk
Water chiller – AM250 and AM250 PlusPac	HRS024-A-20-T	SMC – www.smcworld.com
Water chiller – AM400	HRS050-A-20	SMC – www.smcworld.com
Wet separator – vacuum cleaner	NA7	Ruwac – www.ruwac.de
Wet separator – vacuum cleaner	NA35	Ruwac – www.ruwac.de

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