User guide

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Renishaw silo lift

ORIGINAL INSTRUCTIONS

www.renishaw.com/additivemanufacturing

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Chapter 1 – Before you begin

1.1 Introduction

This chapter contains the warranty and changes to equipment statements that form part of the standard Renishaw terms and conditions. Details regarding copyright, trade marks and disclaimer information can be found on the back cover.

1.2 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.

1.3 Changes to equipment

Renishaw reserves the right to change equipment specifications without notice.

1.4 Patents

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

1.4.1 AM 250/AM 400

CA 2731121	EP 2318164	JP 2016-516886	US 8794263
CA 2738618	EP 2323787	JP 2016-517357	US 9114478
CA 2738619	EP 2331232	JP 5514210	US 9669583
	EP 2342042		
CN 102186554	EP 2620241	US 2014-0287080	WO2014/125258
CN 103357874	EP 2687305	US 2015-0352668	WO2014/125280
CN 105102160	EP 2875855	US 2016-0001401	WO 2016/079495
CN 105228775	EP 2956261	US 2017-0189961	WO 2016/079496
CN 105414544	EP 2956262	US 8753105	WO 2017/013454

1.4.2 RenAM 500M

CA 2731121	EP 2318164	JP 2016-516886	US 2011/0223349	WO2014/125258
CA 2738618	EP 2323787	JP 2016-517357	US 2014/0287080	WO2014/125280
CA 2738619	EP 2331232	JP 5514210	US 2014/0348969	WO 2016/079494
	EP 2342042		US 2014-0271965	WO 2016/079495
CN 102186554	EP 2620241		US 2015-0352668	WO 2016/079496
CN 103357874	EP 2687305		US 2016-0001401	
CN 105102160	EP 2875855		US 8753105	
CN 105228775	EP 2956261		US 8794263	
CN 105414544	EP 2956262		US 9114478	

1.4.3 RenAM 500Q/S

CA 2971675	EP 2318164	JP 2016-516886	US 2014-0287080	WO2014/125258
CA 2731121	EP 2323787	JP 2016-517357	US 015-0352668	WO2014/125280
CA 2738618	EP 2331232	JP 2016-527101	US 2016-0001401	WO2014/199134
CA 2738619	EP 2342042	JP 5514210	US 2016-0114432	WO 2016/079495
	EP 2620241		US 2017-0189961	WO 2016/079496
CN 102186554	EP 2687305		US 8753105	WO 2016102970
CN 103357874	EP 2875855		US 8794263	WO 2017/013454
CN 105102160	EP 2956261		US 9114478	WO 2017/085469
CN 105228775	EP 2956262		US 9669583	WO 2017/085470
CN 105414544	EP 3007879			
CN 105492188				

1.5 Declaration of conformity

Renishaw plc hereby declares that the RenAM 500Q/S is in compliance with the essential requirements and other relevant positions of

- the applicable EU directives
- the relevant statutory instruments under UK law

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

www.renishaw.com

1.6 REACH regulation

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

www.renishaw.com/REACH.

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

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

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Chapter 2 – Scope of supply

2.1 Introduction

The following chapter describes the items of equipment supplied with the Renishaw silo lift as standard, and the items available as options.

2.2 Standard equipment

The following equipment and services are supplied as standard when you purchase a Renishaw silo lift from Renishaw:

- Renishaw silo lift (Renishaw part no. A-5771-1000)
- *Renishaw silo lift* User guide (Renishaw part no. H-5800-4481)

2.3 Optional items

- Safe change filter lifting bracket (Renishaw part no. A-6521-3607)
- Extended forks kit (Renishaw part no. M-6561-1119)
- Substrate lifting plate (Renishaw part no. M-5771-0996)

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Chapter 3 – Introduction

3.1 Introduction

The aim of this chapter is to begin to describe the Renishaw silo lift and to explain some of the terms, language, related documents, safety information and text structure used within this User guide.

3.2 Summary

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

This User guide covers basic system operation and the relevant safety procedures for the Renishaw silo lift. The Renishaw silo lift is a simple piece of mechanical equipment but must be used correctly to ensure safe performance.

The system must only be operated in accordance with the instructions and advice contained in this manual. It must not be used by untrained staff who have not completed a suitable training course.

WARNING: Use of controls or adjustments or performance of procedures other than those specified herein may result in exposure to hazards.

3.3 Reference documentation

In addition to this User guide, also refer to the following documents for additional information about other aspects of your Renishaw AM system:

- *AM 250/AM 400* Site preparation guide (Renishaw part no. H-5800-0838)
- *AM 250/AM 400* User guide (Renishaw part no. H-5800-0704)
- *RenAM 500M* Installation guide (Renishaw part no. H-5800-3102)
- *RenAM 500M* User guide (Renishaw part no. H-5800-3103)
- *RenAM 500Q/S* Installation guide (Renishaw part no. H-5800-3692)
- *RenAM 500Q/S* User guide (Renishaw part no. H-5800-0838)

3.4 Definitions

The following definitions are used throughout this User guide:

Term	Definition
Client or end user	The organisation responsible for purchasing or using the equipment
Supervisor	An individual who is ultimately responsible for ensuring the safe operation and maintenance of the equipment
Trained operator	An individual working for the customer or end user who is competent to operate, maintain and clean the equipment safely. This is because they have been formally trained and assessed in the individual tasks required
Technician	An operator who is qualified to carry out a particular aspect of maintenance. This is because they have been formally trained and assessed by Renishaw in the individual tasks required
Service engineer	A Renishaw Service engineer or Renishaw trained person who is qualified and experienced to the highest level in repairing Renishaw equipment
Equipment	The scope of supply from Renishaw that the client has purchased
Manufacture or manufacturing	Any process where the equipment is commissioned, trialled, operated, maintained or cleaned
Must	Tasks, actions or activities that are essential for the safe operation of the equipment
Should	Tasks, actions or activities that are recommended for the safe operation of the equipment

3.5 Abbreviations

The following abbreviations are used throughout this User guide:

Term	Definition
AM	Additive Manufacturing
AM 250/ AM 400	AM 250/AM 400 single laser analogue additive manufacturing system
ANSI	American National Standards Institute
ATEX	ATmosphères EXplosives (explosive atmospheres)
BDO	Beam Delivery Optic
BSP	British Standard Pipe (thread type)
COSHH	Control of Substances Hazardous to Health
CSA	Cross Sectional Area
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
EMC	Electro-Magnetic Compatibility
ESD	Electrostatic Discharge
IEC	International Electrotechnical Commission
IEE	Institute of Electrical Engineers
IP	Internet Protocol
IPA	Isopropanol
ISO	International Organisation for Standardisation
LED	Light Emitting Diode
MAC	Media Access Control
MCB	Miniature Circuit Breaker
NFPA	National Fire Protection Association
PC	Personal Computer
PLC	Programmable Logic Controller
PPM	Parts Per Million
PV	Present Value
RenAM 500M	RenAM 500 single laser analogue or digital additive manufacturing system
RenAM 500Q	RenAM 500 quadruple laser digital additive manufacturing system
RenAM 500S	RenAM 500 single laser digital additive manufacturing system
SDS	Safety Data Sheet
SIL	Safety Integrity Level
SOP	Standard Operating Procedure
SP	Set Point
UPS	Uninterruptable Power Supply

3.6 Safety information in this User guide

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

3.6.1 Warning

An example of a Warning is as follows:

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

3.6.2 Caution

An example of a Caution is as follows:

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

3.6.3 Note

An example of a Note is as follows:

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

3.7 Contact details

Contact details for Renishaw are below:

Phone number:	+44 (0)1453 524 524 Hours of work: Monday to Friday 08:00 to 17:00 hr (UTC and DST)
Email:	am.support@renishaw.com
Service address:	Renishaw plc New Mills, Wotton-under-Edge Gloucestershire GL12 8JR, United Kingdom

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

www.renishaw.com/contact

Chapter 4 – Safety

4.1 Introduction

The Renishaw silo lift is safe to use when operated correctly. This aim of this chapter is to describe the general and specific safety recommendations to enable you to operate the silo lift safely.

4.2 General safety information

NOTE: Please refer to the User guide and Installation guide supplied with your AM system for AM system specific Health and Safety information.

- *AM 250/AM 400* Site preparation guide (Renishaw part no. H-5800-0838)
- *AM 250/AM 400* User guide (Renishaw part no. H-5800-0704)
- *RenAM 500M* Installation guide (Renishaw part no. H-5800-3102)
- *RenAM 500M* User guide (Renishaw part no. H-5800-3103)
- *RenAM 500Q/S* Installation guide (Renishaw part no. H-5800-3692)
- *RenAM 500Q/S* User guide (Renishaw part no. H-5800-3693)

4.3 Silo lift health and safety

4.3.1 Essential health and safety requirements

No formal licence or training is required for this type of machinery, although familiarisation training is recommended.

4.3.2 Safe working load

On every silo lift supplied there will be a specification and capacity plate, fitted in clear view of the operator, (see Chapter 6 “Silo lift specification”, for details). This plate will give information on the load capacity and any load centres to be adhered to.

These loads are designed as safe working loads and should never be exceeded.

NOTE: All equipment is designed, manufactured and tested in accordance with latest directives current at the time of manufacture. All finished equipment will clearly display a CE mark.

4.3.3 Safe handling operations (slinging points, mass of machinery and tools)

Should the silo lift need to be lifted from the ground, suitable webbing slings, chains or shackles can be fastened to the identified mast lifting lugs. For unladen weight, refer to the silo lift specification plate.

4.3.4 Hydraulic failure

In case of failure of the hydraulic equipment which results in a dramatic loss of oil in a relatively short period of time, every machine is fitted with a safety hydraulic check valve. This is positioned on the return to the tank feed from the lifting ram.

The valve restricts the flow of oil to a predetermined safe rate when failure occurs. This is done at a slower speed to enable time to clear the area from any potential hazards.

4.3.5 Personal protective equipment (PPE)

NOTE: Refer to the User guide supplied with your AM system for details of the PPE required when operating your Renishaw AM system.

NOTE: When operating the Renishaw silo lift in the vicinity of a Renishaw AM system, ESD dissipative safety footwear with toe protection is essential for ATEX zones, and recommended for all areas.

Chapter 5 – Overview

5.1 Introduction

This chapter contains images of the Renishaw silo lift and gives an overview of the user accessible system features.

5.2 Silo lift

The silo lift is a general hydraulic lifting and transportation device used to move heavy items to and from a Renishaw AM system (Figure 1).

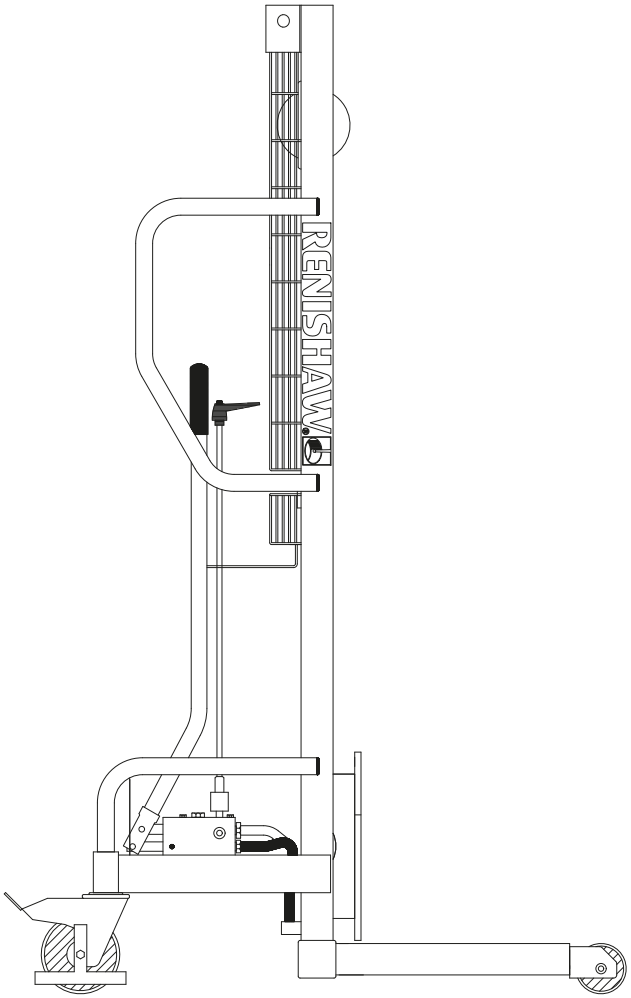

Figure 1 Silo lift – side view (shown without forks)

NOTE: Operator preventative maintenance is listed in Chapter 9 and Chapter 10.

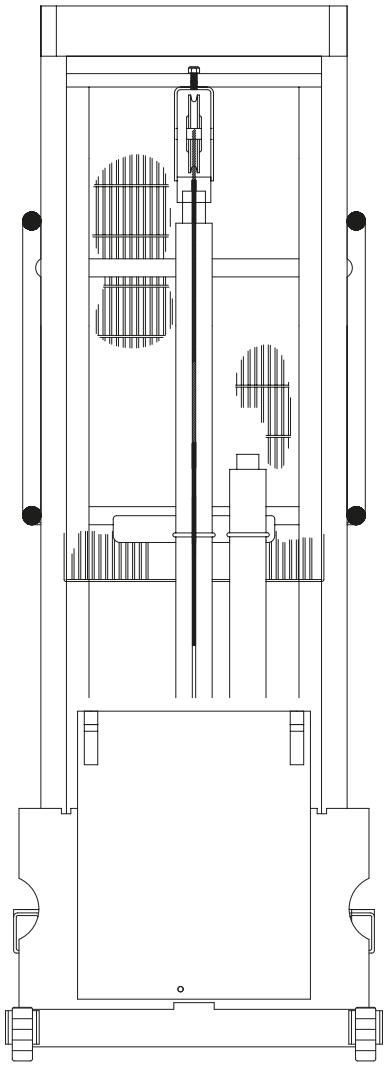

Figure 2 Silo lift – back view

The silo lift is manually operated and pedestrian propelled. It is designed to be raised, lowered, moved and steered by one operator. It features the following:

- A lifting mast
- Non-tilting design
- Load-bearing outriggers
- Fork arms
- A platform or other load-handling device

Chapter 6 – Silo lift specification

6.1 Introduction

This chapter describes the specification of the Renishaw silo lift. It contains information relating to the physical size of the lift and its capacity.

6.2 Specification

Technical specifications may change from time to time. Renishaw reserves the right to change any technical specification at any time. Any specification not listed in the table below is available upon request; see Section 3.7, “Contact details”, for the contact details of your local Renishaw office.

NOTE: All dimensions are quoted depth × width × height.

WARNING: Do not exceed the lift’s rated capacity of 200 kg at 200 mm (440 lb at 8 in) (Figure 3).

Dimensions without accessories	850 mm × 570 mm × 1 570 mm (33.5 in × 22.5 in × 62 in)
Rated capacity	200 kg @ 200 mm (440 lb @ 8 in)
Unladen weight	130 kg (287 lb)

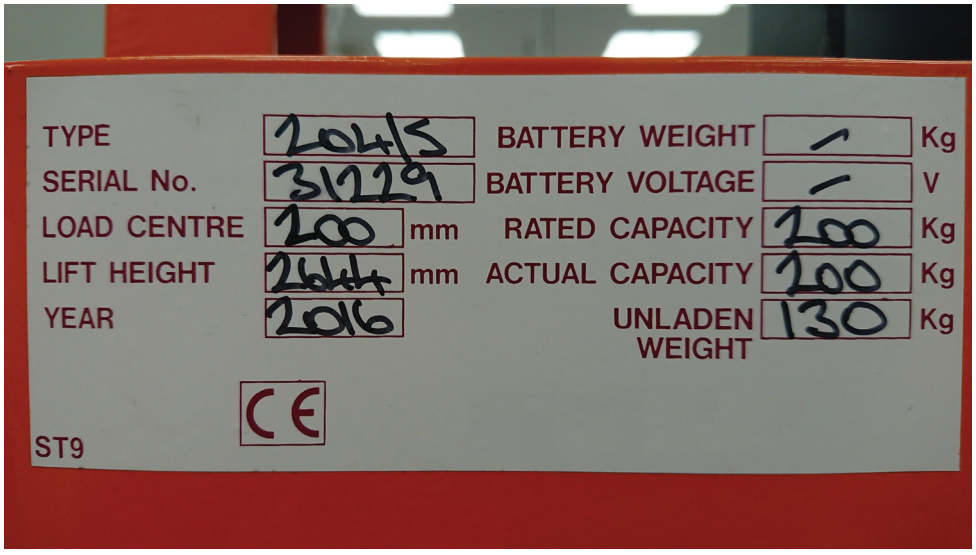

Figure 3 Renishaw silo lift identity plate

6.3 Capacity

6.3.1 Rated capacity

The rated capacity is the load in kilograms (given by the manufacturer) that the silo lift type is capable of transporting and/or lifting.

- It is equal to the load “Q1”, that the silo lift type is designed to carry and stack on fork arms or platform with a vertical mast, the maximum lift height of which is equal to the standard list height “H” and with a standard load centre distance “D”.
- Where a silo lift does not lift to the standard lift height “H”, it is given a rated capacity at its maximum lift height.
- Lift height: Height “H” from the ground to the upper face of the fork arm blades or load platform (Figure 4).
- Load centre: Distance “D” horizontally to the front face of the fork arm shank and vertically “D” to the upper face of the fork arm blades (Figure 4).

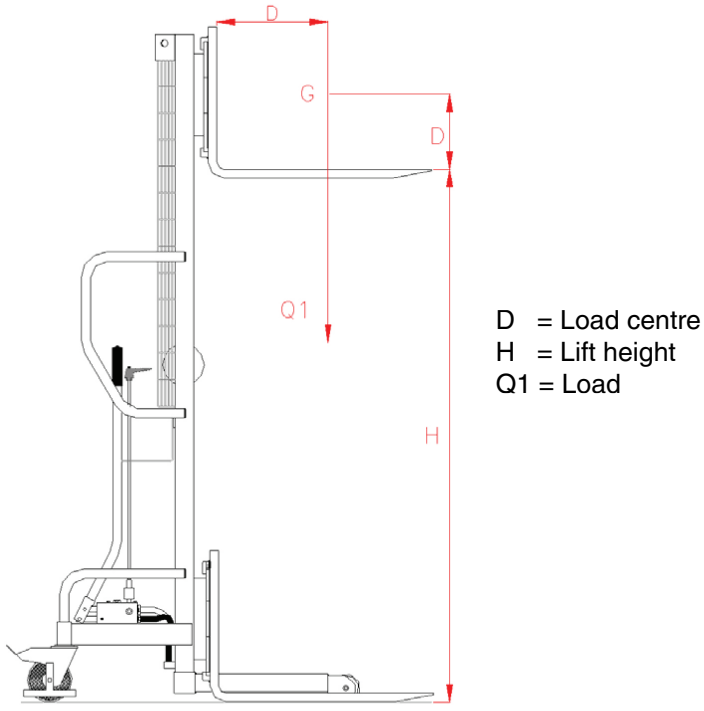

Figure 4 Renishaw silo lift load centre

6.3.2 Actual capacity

This is the maximum load in kilograms (depending on its attachment and elevating height) given by the manufacturer that the subject machine is a capable of transporting or lifting in normal operation.

Actual capacity will vary with the different types and heights of mast fitted, changes of fork arms or attachments and different load centre distances used in rating.

Chapter 7 – Functional description

7.1 Introduction

The aim of this chapter is to describe the Renishaw silo lift, its major systems and sub-systems.

The chapter is intended to provide a concise description of the function of the Renishaw silo lift.

7.2 Silo lift

The silo lift (Figure 5) is a general hydraulic lifting and transportation device used to move heavy items to and from a Renishaw AM system. It is a pedestrian propelled silo lift with a lifting mast, without tilt, with load-bearing outriggers, equipped with fork arms, a platform, or other load-handling device. The silo lift is designed to be manually pushed, pulled and steered by one pedestrian operator. It can be supplied with optional accessories which can be used to move a variety of items such as a large safe change filter when full of water or a powder silo.

Figure 5 Renishaw silo lift fitted with substrate lifting plate

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Chapter 8 – Operation

8.1 Introduction

The aim of this chapter is to describe how to operate the silo lift.

8.1.1 Silo lift general information

NOTE: It is recommended that any silo lift is fully serviced and inspected at regular intervals. By maintaining your silo lift regularly, you will prevent failures and thus reduce operating costs.

8.1.2 Foreseen use of the silo lift

The silo lift is a general hydraulic lifting and transportation device used to move heavy items relating to the Renishaw AM system. It is a pedestrian propelled silo lift with a lifting mast, without tilt, with load-bearing outriggers, equipped with fork arms, a platform, or other load-handling device. The silo lift is designed to be manually pushed, pulled and steered by one pedestrian operator.

An adaptor kit can be supplied, which can be used to move a variety of items such as a large safe change filter when full of water.

8.1.3 Operating conditions

The silo lift is designed to work under the following conditions unless otherwise stated:

- In an environment of 0 °C to +30 °C (32 °F to +86 °F).
- When laden, on a non-slip, hard, level floor without holes or obstacles with a maximum gradient of 0%.
- In suitable ambient lighting (recommended 50 lux minimum).

Unless otherwise stated, this silo lift is not designed to be used in hazardous environments, for example where there is danger of explosions from gas or dust.

WARNING: The operator must wear suitable safety footwear for their own protection.

8.1.4 Operator workstation

The silo lift should be operated at all times from the rear castor end where all the controls, specification and load plates are in clear reach and view of the operator.

8.1.5 Procedure in the event of an incident or breakdown

Report any incidents or breakdowns in accordance with local procedures.

8.1.6 Load table

Refer to the silo lift specification plate and supplied test certificate for load characteristics.

8.1.7 Instruction for lifting accessories, attachments and interchangeable equipment

Refer to the attachment's specification plate, supplied test certificate and, where applicable, any separate instructions or manual for the following information:

- Normal conditions of use
- Instructions for use, assembly and maintenance
- Limits of use

For details of the Renishaw supplied lifting accessories, attachments and equipment see Chapter 12, "Optional equipment".

8.1.8 General operating practice

It is the user's obligation to comply with the provisions relating to the "Safe use of Work Equipment, Provisions and Use of Work Equipment Regulations 1998", the "Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)" or any applicable local standards.

8.1.9 Compulsory rules

- 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 the 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 as when unladen.
- If the silo lift develops a fault or feels unsafe, suspend operations, park and report to supervisor.
- The silo lift should not be left unattended on a gradient.
- Be cautious of overhead limitations or obstructions.
- Be conscious of any swinging loads, slung from the spreader bar.

8.1.10 General rules

- Watch in the direction of travel and maintain good visibility over the path.
- Allow plenty of clearance when passing other vehicles, stationary objects and people at work.
- Always move at a reasonable speed and maintain control.
- Observe the rules in force within the company. Follow only the laid down route within the company.
- Walk slowly down gradients; the silo lift must be unladen and the gradient no more than 2%.
- When reversing, seek assistance if vision is obstructed.
- The operator should always ensure that there is sufficient headroom through which the silo lift can pass safely.

8.1.11 Forbidden practices

- Using the silo lift without authorisation.
- Exceeding the capacity of the silo lift.
- Using the silo lift for any purpose other than that for which it has been originally designed.
- Do not use on gradients due to possible excessive effort requirements and loss of control. If it is necessary to negotiate the silo lift up a gradient, then the silo lift must be unladen and the gradient should be no more than 2%.
- Do not allow anyone to stand or walk under elevated loads.
- Do not place arms, hands, legs or head between the mast upright and cross members or other working parts of the silo lift.

Any violation of the above rules will void the warranty.

8.2 Operating instructions

8.2.1 Driving and braking

NOTE: Visually check the silo lift before use. Ensure it is safe to use and there are no signs of damage or defects. Check the parking brakes on the rear castors and lifting mechanism are operating correctly.

The silo lift (Figure 6) 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.

Figure 6 Renishaw silo lift fitted with substrate lifting plate

8.2.2 Parking brake

The rear castors are fitted with foot brakes for parking purposes.

8.2.3 Operating licence

Operating a silo lift with pedestrian control does not require a special licence. However, as with any item of industrial machinery, it is necessary for authorised personnel to become familiar with its use and control before using it in any potentially hazardous environment.

8.2.4 Attachments

Where fitted, please refer to the attachment's Operating and instruction manual.

8.2.5 Carriage-mounted attachments

All carriage-mounted attachments should be hung centrally onto the fork carriage by the upper hangers and bolted to, or otherwise secured to the carriage plate.

Removing any attachment should be done using two people, or with the aid of extra lifting equipment, where available.

8.2.6 To lift a load

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

8.2.7 To lower a load

Open the manual control valve (Figure 7) by turning the release lever anticlockwise. This lever can be set at any required angle by depressing and turning the top button. It will lock automatically once the button has been released.

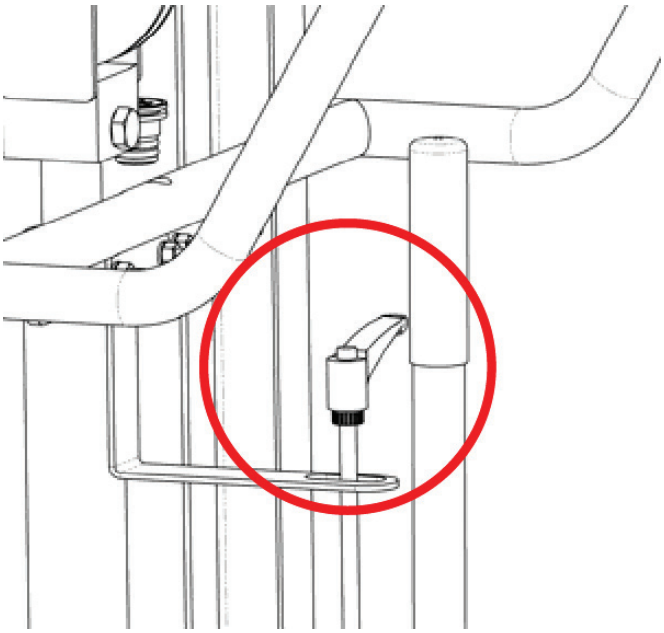

Figure 7 Manual lowering control valve

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.

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

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Chapter 9 – Preventative maintenance schedule

9.1 Introduction

The aim of this chapter is to provide a list of the preventative maintenance tasks that should be carried out to keep your Renishaw silo lift functioning correctly. Renishaw recommends that the Renishaw silo lift is maintained in accordance with the following maintenance schedule to ensure its reliability and availability.

It is important that the Renishaw silo lift is maintained so that its performance does not deteriorate to the extent that it puts people at risk or adversely impacts on any applicable warranty.

Operator preventative maintenance tasks are listed in this chapter.

Operator preventative maintenance tasks are prefixed with “PM” followed by a number, for example “PM-001”.

This chapter also contains Preventative maintenance checklists.

9.2 Personal protective equipment

WARNING: Ensure you are wearing the correct personal protective equipment: safety footwear and protective gloves before you start any maintenance task.

9.3 Definitions of maintenance

The definitions of maintenance tasks are as follows:

- Inspect – determine the general condition of the component, that is, conformity to required specification. Check for things such as, damage, wear, cracks, splits, leaks, scoring, distortion, looseness, corrosion and breaks
- Clean – remove all dirt and deposits
- Check – determine a particular nominated condition, for example, completeness of task, security, position or function
- Calibrate – restore the performance of an object or system to a defined state with a known tolerance using tools, equipment and a specification
- Replace – remove and discard the original part and provide a new specified part in its place
- Lubricate – apply the correct amount of a suitable lubricant to enable the smooth movement of a component or assembly
- Function test – prove the function of a system by carrying out a simple test
- Test – prove the correct operation and performance of a system by specified trial

9.4 Renishaw silo lift preventative maintenance schedule

The method statements for all operator preventative maintenance tasks are contained in Chapter 10, “Preventative maintenance tasks”.

Equipment	Maintenance activity	Frequency	Skill level	Task number
Silo lift wheels	Check	3 months	Operator	PM-001
Silo lift hydraulic circuit	Check	3 months	Operator	PM-002
Silo lift wire rope	Inspect	6 months	Operator	PM-003
Silo lift	Lubricate	6 month	Operator	PM-004
Silo lift lifting arms	Inspect	12 months	Operator	PM-005

9.5 Preventative maintenance records

It is essential that records are made and kept of any and all maintenance that is carried out on your Renishaw load hopper trolley. Good maintenance record keeping is essential to ensure that any modifications, repairs, system configuration modifications, etc, are known about. This can help with future upgrades, fault-finding, repairs, etc.

9.6 Preventative maintenance checklists

9.6.1 Three-month tasks

Equipment	Maintenance activity	Skill level	Task number	Complete Y/N?
Silo lift wheels	Check	Operator	PM-001	
Silo lift hydraulic circuit	Check	Operator	PM-002	

9.6.2 Six-month tasks

Equipment	Maintenance activity	Skill level	Task number	Complete Y/N?
Silo lift wire rope	Inspect	Operator	PM-003	
Silo lift	Lubricate	Operator	PM-004	

9.6.3 Twelve-month tasks

Equipment	Maintenance activity	Skill level	Task number	Complete Y/N?
Silo lift lifting arms	Inspect	Operator	PM-005	

Chapter 10 – Preventative maintenance tasks

10.1 Introduction

The aim of this chapter is to describe, in the form of a method statement, the preventative maintenance tasks that must be carried out on the Renishaw silo lift.

The list of preventative maintenance tasks and the frequency at which they must be carried out is contained in Chapter 9, “Preventative maintenance schedule”.

Preventative maintenance tasks are listed and numbered by skill type.

Operator preventative maintenance tasks are prefixed with “PM” followed by a number, for example “PM-001”. Operator preventative maintenance tasks can be carried out by a trained operator, technician or service engineer.

10.2 Maintenance and storage

10.2.1 Regular maintenance checks

NOTE: Every user shall ensure that equipment is maintained in an efficient state, in efficient working order and in good repair.

NOTE: Every user shall ensure that, where equipment has a maintenance log, the log is kept up-to-date.

NOTE: 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.

10.2.2 Frequency of maintenance

Equipment may need to be checked frequently to ensure that safety-related features are functioning correctly. A fault that affects production is normally apparent within a short time, however, a fault in a safety-critical system could remain undetected unless appropriate safety checks are included in maintenance activities.

The frequency at which maintenance activities are carried out should also take into account the following:

- Intensity of use – frequency and maximum working limits.
- Operating environment.
- Variety of operations – is the equipment performing the same task all the time or does this change?
- Risk to health and safety from malfunction or failure.

10.2.3 Maintenance recommendations

- Only qualified and recognised personnel should be permitted to maintain and inspect the silo lift.
- Brakes and steering mechanisms should be maintained in a safe operating condition.
- Safety guards and safety devices should be carefully and regularly inspected.
- The silo lift should be kept clean and free from dust contamination.
- Avoid applying excessive amounts of lubricant to prevent dust and dirt sticking to the silo lift.
- Care should be taken to see that any replacement parts are of a quality equal to that provided in the original equipment.
- Any modifications to the original design should be subject to consultation between the user and the manufacturer.
- Before commencing work on a silo lift, check with the operators (or other reliable source) that it has no unrecorded defects which could cause a hazard during the proposed work.
- Ensure that the ground under the silo lift is sufficiently strong to support the load created by any jack or lifting equipment.
- Ensure the parking brake is applied or, if the braking system is being worked on, chock the wheels.
- Always support the silo lift axle or chassis with blocks, should it be necessary to work with the wheels removed or raised above the floor.
- Before removing any parts or guards, ensure that the power source start-up system is isolated.
- Ensure that the only people allowed to remove and replace wheels and tyres have been trained in the correct method of doing this work.
- Ensure that all guards removed to facilitate service and repair work are replaced before returning the silo lift to operation.
- Check that all tools and loose parts have been removed before operating the silo lift.
- Ensure that personnel who test and operate a silo lift are authorised to do so and have studied the other relevant sections of this manual.
- Ensure that any work or alterations to the silo lift which will affect its original specification, are fully sanctioned by the manufacturer or authorised dealer.
- Before commencing any repair work on a silo lift that is still under warranty, contact your dealer or silo lift supplier.
- Ensure that no work or adjustments are attempted which are not in accordance with the manufacturer's instructions.
- Seek the manufacturer's advice and approval before attempting any work on the fork arms.

- Stop the silo lift before carrying out any adjustments.
- Watch for loose items, fastenings etc.
- Check the wheels and castors for wear and damage.
- Check for oil leaks.

10.2.4 Maintenance tasks

All preventative maintenance tasks for the silo lift are contained within this User guide.

Operator preventative maintenance is listed in Chapter 9 and Chapter 10.

10.3 Preventative maintenance tasks

PM-001 – Silo lift wheels – Check

1. See Chapter 4, “Safety”, for safety information about the silo lift.
2. On the silo lift, inspect the front and rear wheels.
3. Check the wheels for damage or excessive wear.
4. If necessary, replace damaged or worn wheels.
5. Ensure replacement wheels are of the same quality and specification as the original wheels.
6. For advice on repairs or to schedule a repair visit, contact your local Renishaw office using the contact details in Section 3.7, “Contact details”.
7. Record the completion of the maintenance task in the maintenance records.

PM-002 – Silo lift hydraulic circuit – Check

1. See Chapter 4, “Safety”, for safety information about the silo lift.
2. Fully lower the fork carriage to the ground.
3. Remove the filler cap from the hydraulic reservoir.
4. Check the hydraulic fluid level. Top up to the level of the filler cap, if necessary, using hydraulic fluid to ISO standard H022.
5. For advice on repairs or to schedule a repair visit, contact your local Renishaw office using the contact details in Section 3.7, “Contact details”.

PM-003 – Silo lift wire rope – Inspect

1. See Chapter 4, “Safety”, for safety information about the silo lift.
2. Fully lower the fork carriage to the ground.
3. Check the lifting wire rope for slack. Take up any slack in the wire rope by tightening the nut on the threaded end fitting which passes through the silo lift frame.
4. Check the alignment of the top roller. The top roller must be positioned so that the wire rope can pass smoothly and easily over it without disengaging. Adjust the position of the top roller as necessary.
5. Inspect the lifting wire rope for fraying or damage.
6. If the lifting wire rope is frayed or damaged in any way, the rope must be replaced.
7. For advice on repairs or to schedule a repair visit, contact your local Renishaw office using the contact details in Section 3.7, “Contact details”.
8. Record the completion of the maintenance task in the maintenance records.

PM-004 – Silo lift – Lubricate

1. See Chapter 4, “Safety”, for safety information about the silo lift.
2. Check the silo lift mast channels and ensure there is a thin even layer of grease on the contact surfaces.
3. If the mast channels need lubricating, apply lithium complex grease 873 using a brush.
4. Do not apply excessive lubricant to the mast channels.
5. For advice on repairs or to schedule a repair visit, contact your local Renishaw office using the contact details in Section 3.7, “Contact details”.
6. Record the completion of the maintenance task in the maintenance records.

PM-005 – Silo lift, lifting arms – Inspect

1. See Chapter 4, “Safety”, for safety information about the silo lift.
2. Inspect the silo lift lifting arms, ensuring there are no signs of damage or deformation. Pay particular attention to welded joints.
3. Ensure any lifting adaptors fitted to the silo lift are free of damage and deformation. Ensure they are securely attached to the silo lift.
4. Operate the lifting mechanism and ensure the arms raise correctly.
5. Operate the lowering mechanism and ensure the arms lower correctly.
6. For advice on repairs or to schedule a repair visit, contact your local Renishaw office using the contact details in Section 3.7, “Contact details”.
7. Record the completion of the maintenance task in the maintenance records.

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Chapter 11 – Spare parts

11.1 Introduction

Renishaw stock a vast range of spare parts and can make recommendations on any critical spares for your silo lift.

For spare parts or to arrange a service visit contact your local Renishaw office using the contact details in Section 3.7, “Contact details”.

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Chapter 12 – Optional equipment

12.1 Introduction

There are items of optional equipment available to purchase to increase the usability of your Renishaw silo lift.

They consist of a number of adaptor plates designed to be fitted to your silo lift to assist in lifting the large safe change filter, builds and silo of your Renishaw AM system.

12.2 Renishaw silo lift optional equipment

12.2.1 Lifting attachments and lifting accessories

The following lifting attachments and lifting accessories are available for the Renishaw silo lift:

- Extended forks kit (Renishaw part no. M-6561-1119) – see Section 12.2.2
- Safe change filter lifting bracket (Renishaw part no. A-6521-3607) – see Section 12.2.3
- Substrate lifting plate (Renishaw part no. M-5771-0996) – see Section 12.2.4

12.2.2 Extended forks set

12.2.2.1 Installation

The extended fork set (Figure 8) is installed on to the silo lift as follows:

1. Lift the extended fork set on to the silo lift lifting carriage.
2. The forks should be uppermost.
3. Adjust the position from left to right until the extended fork set is positioned centrally and the teeth engage.
4. At the base of the extended fork set in the centre, fit the screw that secures the extended fork set to the lifting carriage and tighten until secure.

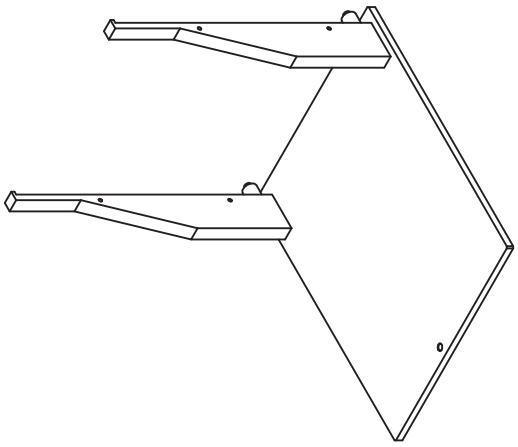

Figure 8 Extended forks kit and securing screw hole

12.2.2.2 Operation

Operation of the extended fork set is as follows:

1. Before using the extended fork set ensure it is in good condition and that there are no signs of damage, defects or deformity that could affect its safe use. Consider replacing the extended fork set if there are signs of damage, defects or deformity that could affect its safe use.
2. Install the extended fork set on the silo lift as above.
3. Operate the extended fork set and silo lift in accordance with the instructions in this User guide.

WARNING: Do not exceed the rated capacity of the extended fork set.

WARNING: Ensure that the castor brakes are applied on the silo lift when using the extended fork set.

12.2.3 Safe change filter lifting bracket

Figure 9 Safe change filter lifting bracket upper face

12.2.3.1 Installation

The safe change filter lifting bracket (Figure 9) is installed on to the silo lift as follows:

1. Place the safe change filter lifting bracket on to the silo lift standard fork set (Figure 10). The open end of the lifting bracket should be at the front. The filter support should be uppermost and the two lugs on the lifting bracket should be on the inside of the forks.

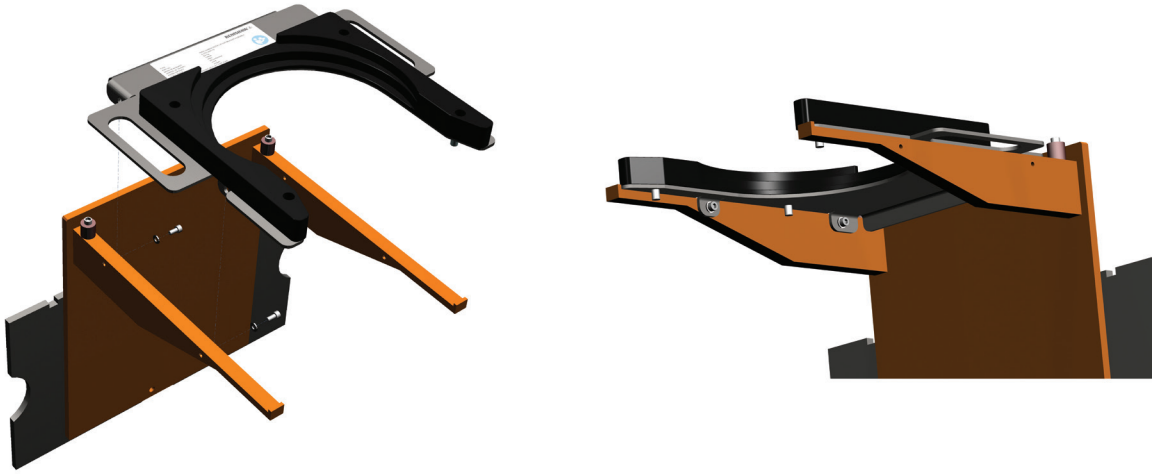

Figure 10 Safe change filter lifting bracket securing lugs and fasteners

2. On the underside of the lifting bracket are two lugs. Each lug has a 6 mm hole. Align the holes in the two lugs with the threaded holes in the standard or extended fork set.

3. Supplied with the lifting bracket are two M6 × 12 mm screws and plain washers. Fit the screws and washers through the holes in the lugs, into the threaded holes in the forks and tighten until secure (Figure 10).

12.2.3.2 Operation

Operation of the safe change filter lifting bracket is as follows:

1. Before using the lifting bracket, ensure it is in good condition and that there are no signs of damage, defects or deformity that could affect its safe use. Consider replacing the lifting bracket if there are signs of damage, defects or deformity that could affect its safe use. Before using the lifting bracket ensure that the filter support is securely attached.

2. Install the lifting bracket on the silo lift (see Section 12.2.3.1).

3. Lift an empty and clean safe change filter assembly into position on the lifting bracket.

WARNING: The safe change filter assembly weighs 15 kg (33 lb) when empty.

4. When using the lifting bracket to move safe change filters, avoid raising the height of the forks excessively.

5. Operate the safe change filter lifting bracket and silo lift in accordance with the instructions in this User guide.

6. Operate the safe change filter lifting bracket in accordance with the limitations on the safe change filter lifting bracket identity plate (Figure 11).

WARNING: Do not exceed the 60 kg (133 lb) rated capacity of the safe change filter lifting bracket (Figure 11).

WARNING: Ensure that the castor brakes are applied on the silo lift when using the safe change filter lifting bracket.

Figure 11 Safe change filter lifting bracket identity plate

12.2.4 Substrate lifting plate

12.2.4.1 Installation

The substrate lifting plate (Figure 12) is installed on to the silo lift as follows:

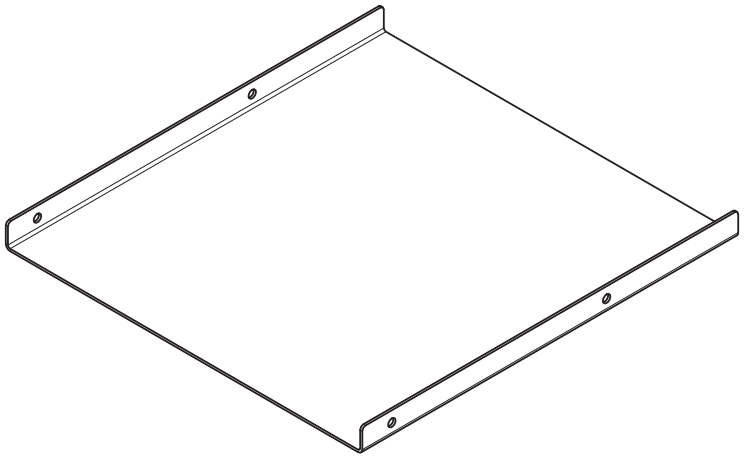

Figure 12 Substrate lifting plate – underside view showing four fixing holes

1. Lift the substrate lifting plate on to the silo lift forks.
2. Ensure the underside of the lifting plate is in contact with the top surface of the forks.
3. On each of the two edges of the lifting plate are two holes. Ensure that the holes are aligned with the threaded holes in the forks.
4. Using the four supplied screws and washers, secure the lifting plate to the forks and tighten as necessary.

12.2.4.2 Operation

Operation of the substrate lifting plate is as follows:

1. Before using the substrate lifting plate, ensure it is in good condition and that there are no signs of damage, defects or deformity that could affect its safe use. Consider replacing the substrate lifting plate if there are signs of damage, defects or deformity that could affect its safe use.
2. Install the lifting plate on the silo lift as above.
3. Operate the lifting plate and silo lift in accordance with the instructions in this User guide.

WARNING: Do not exceed the rated capacity of the extended fork set.

WARNING: Ensure that the castor brakes are applied on the silo lift when using the substrate lifting plate.

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

Part no.: H-5800-4480-02-A
Issued: 05.2022