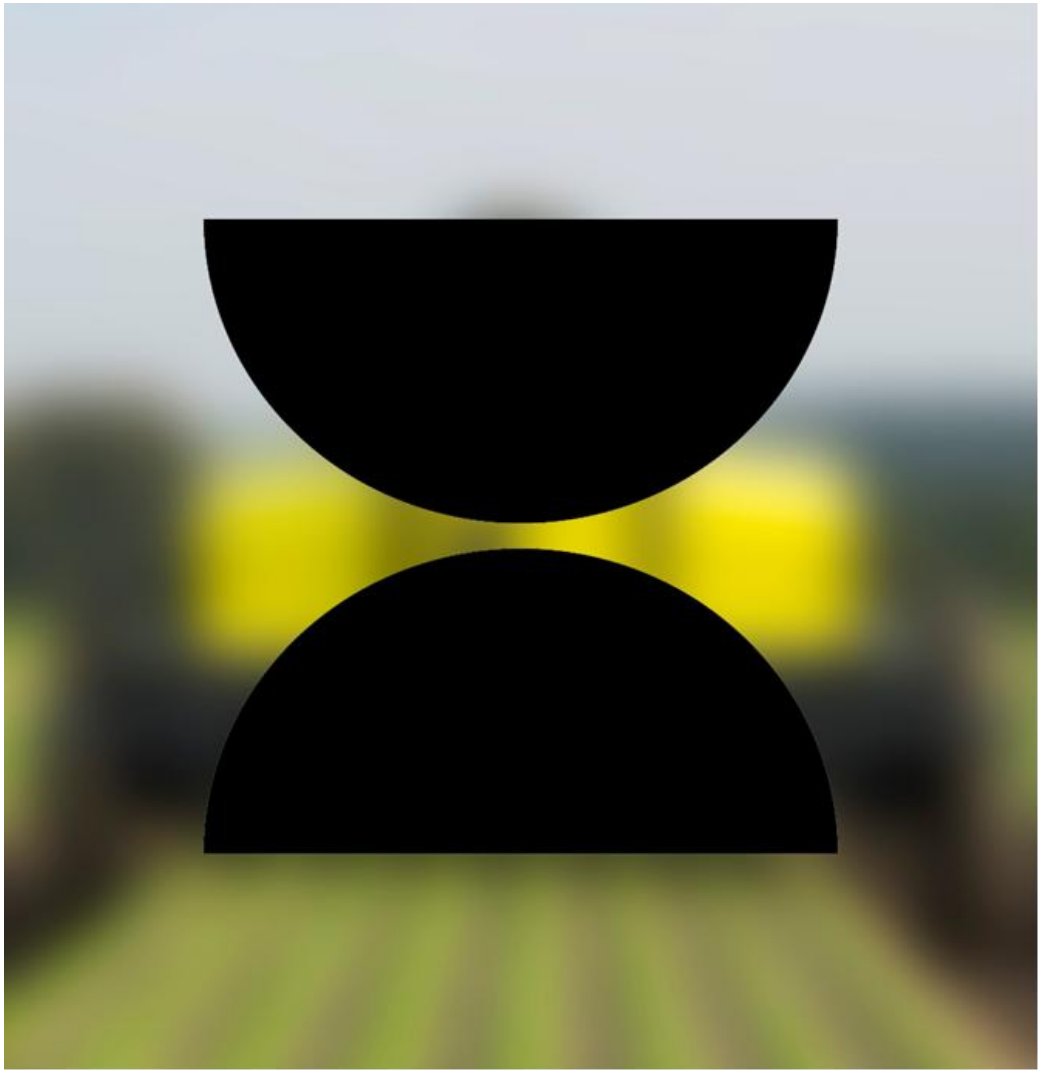


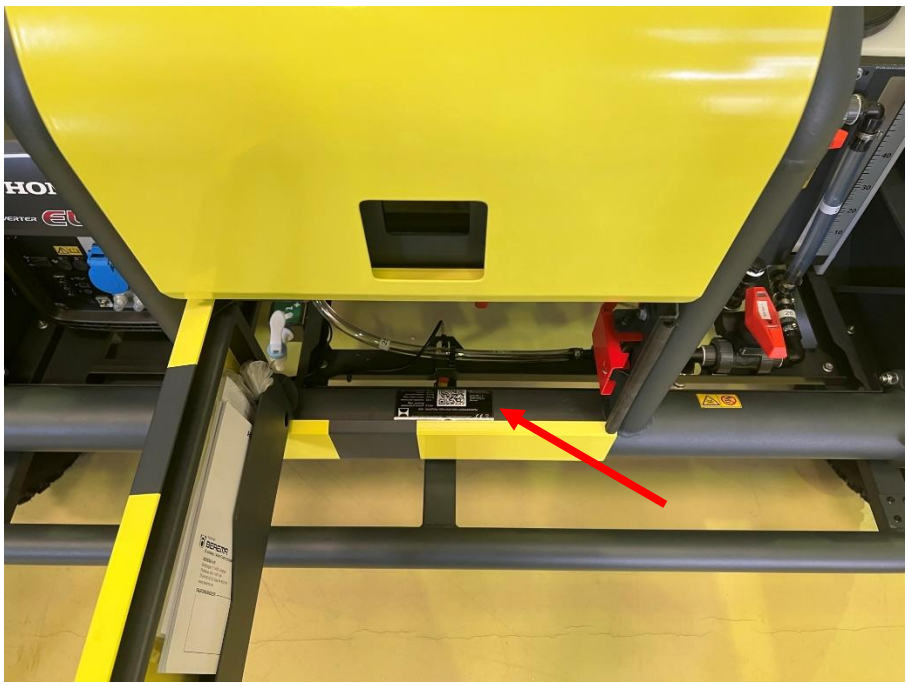
User Manual

Kilter AX-1

1 Introduction

1.1 Identification Data

1.1.1 Location of Machine Plate



1.1.2 Manufacturer's Address

Berghagan 3, 1405 Langhus, Norway

1.1.3 Model Covered by this User Manual

This user manual applies to model AX-1 from Kilter, hereafter referred to as the machine or robot.

1.1.4 Ordering Spare Parts

When ordering spare parts, visit www.kiltersystems.com for customer service contact information. Please have the part number of the item you wish to order ready in advance.

1.2 Foreword

This document serves as a guide to get started with the AX-1 spraying machine in a safe and secure manner. We kindly ask you to read the user manual carefully before using the machine, both for your safety and that of others, as well as to ensure proper environmental considerations.

Pay special attention to the content in *Chapter 3: Safety.*

1.3 About the User Manual

The user manual must always accompany the machine and be kept in the designated location, along with the included user manual for the Honda EU22i power generator. These manuals must be accessible to anyone using the machine and should be preserved throughout the machine's entire lifespan.

Questions regarding the user manual and its content should be directed to Kilter's service department via the website or by phone.

1.3.1 Publication Number

The user manual has the publication number xxx-xxx-xxx.

Contact the manufacturer to request a new copy if the manual is lost, or if damage or defects result in reduced readability.

1.3.2 Owner’s responsibility

- The owner must read the entire user manual and understand its content.
- Ensure that the machine is in good technical condition and adheres to the necessary maintenance schedule and inspections.
- Symbols and signs on the machine must be legible.
- The owner is responsible for ensuring that any operator of the machine has undergone training in its use and is familiar with the safety aspects described in this user manual. Ensure that operators understand the content and feel confident in using the machine.
- This guide must be accessible to anyone working with the machine.

1.3.3 Employer’s responsibility

The employer holds the same responsibilities as the owner, in addition to the following:

- Ensure that personnel working with the machine are authorized through regular training in accordance with applicable national regulations and legislation. Unauthorized personnel or individuals with insufficient training are not permitted to use the machine.
- Provide personal protective equipment (PPE) for all machine users. The PPE must be in good condition and comply with the requirements for the specific plant protection product being used.

1.3.4 User’s responsibility

- Strive for the correct use of the machine.
- It is the user's responsibility to regularly check that the output from the classifier appears correct. This must be done at a minimum each time the machine is started, or if there is significant variation in the crop, weeds, or soil.
- It is the user's responsibility to ensure that it is safe for the machine to operate within the planned driving pattern.
- It is the user's responsibility to ensure that it is safe for the machine to operate within the defined "field boundary."

- Familiarize yourself with the content in *Chapter 3: Safety.*

2 Presentation

Congratulations on Your New AX-1! We are proud to present a product that contributes to better management of natural resources and a significant reduction in the use of pesticides.

2.1 Purpose of the Machine

The AX-1 is an agricultural robot designed for targeted precision spraying of weeds in vegetable fields. The AX-1 is self-driving and applies droplets of herbicide without affecting the crops. This allows for spraying along the entire vegetable row, not just between rows. The machine enables treatment with herbicide even after the crops have sprouted. This saves you from manual weeding, reduces the use of herbicides, and promotes healthier crops. With this machine, you contribute to improving global food production by managing the resources we already have in a more efficient, considerate, and sustainable way—for the benefit of the environment, animals, and people.

2.2 Working Method of the Machine

The AX-1 combines the most precise spraying technology on the market with the capability to operate autonomously in the field. This sets it apart significantly from traditional field sprayers, which are both imprecise and time-consuming to use. Below is a brief introduction to how the machine operates, utilizing its two competitive advantages to perform spraying for you in an easier and more sustainable way.

2.2.1 Precision Spraying

The AX-1 typically features five spraying units. Each spraying unit is equipped with a camera for ground imaging, along with 42 individually controlled nozzle outlets.

As the machine operates, the cameras capture images that are sent to the control center for image processing. The control center uses its learned capabilities to identify weeds and crops. Once identification is complete, instructions are sent to the spraying units, specifying which nozzle outlets should open, how many should be activated, and the exact timing required to target the identified weeds. This process ensures that the spraying units release controlled single droplets of herbicide, which land exclusively on the weeds.

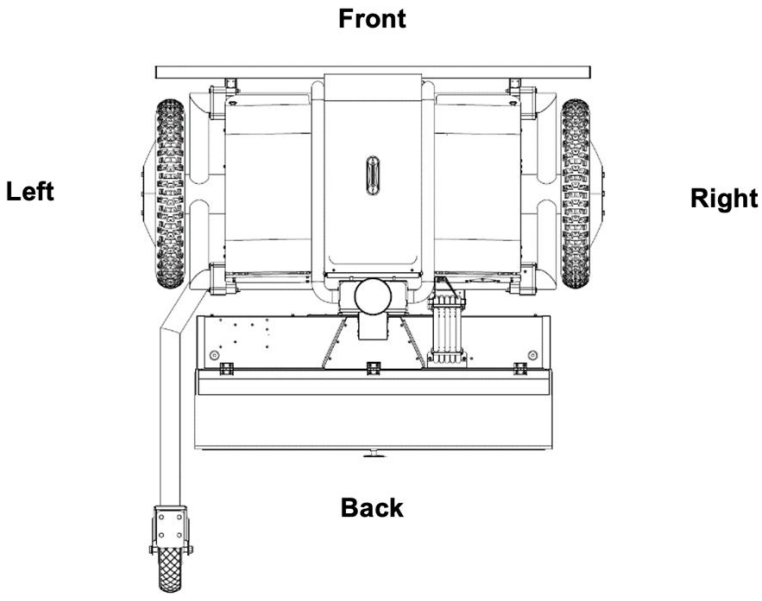
For more information about the nozzles, see *subsection 4.4 Spraying Unit.*

2.2.2 Autonomous Operation

The AX-1 is a self-driving machine with automated functions. This means it performs its tasks entirely on its own once the necessary preparations have been completed. The machine drives, turns, adjusts boom height, and navigates your field without operator intervention. It navigates using driving routes that are pre-programmed into the machine's software. These routes can correspond to the same paths created by the tractor when forming the beds. Utilizing satellite-based positioning and mobile network connectivity, the machine is capable of positioning itself along the driving route with an accuracy of 2 cm. The machine will continue spraying the field until the route is completed or it requires assistance with refilling herbicide or fuel. The operator will receive notifications via the mobile application, Kilter Remote, if the AX-1 needs assistance or changes its operational status. For more information about the Kilter Remote application, refer to *Chapter 6: Connecting and Controlling the Machine.*

2.3 Directional References

The various directions of the machine are defined based on the machine's driving direction. The reference directions for the robot are illustrated in Figure 2.



Figur 2 – Directional References. Machine Viewed from above

3 Safety

In this chapter, you will find the general safety instructions.

Warning: The user is responsible for reading the Safety chapter carefully before using the machine. Incorrect use of the machine may result in death, serious personal injury, and environmental consequences.

Working with agricultural machinery can be dangerous. Avoid accidents! Don't take any chances! Always stay alert! Think safety! Work in a safe manner!

Make sure you are familiar with all operating functions and safety instructions before using the machine. Knowledge of the safety regulations forms the basis for the safe and error-free use of the machine.

Failure to follow the safety instructions, neglect of maintenance, use of the machine for purposes other than its intended use, overloading of the machine, or unauthorized modifications to the machine will void the manufacturer's liability for any resulting consequences.

Incorrect use of the machine can lead to dangerous situations. Therefore, always work in a controlled and safe manner.

3.1 General Regulations

In addition to the regulations in this chapter, the following safety regulations must be observed:

- Regulations for accident prevention
- General, recognized safety standards
- Workplace safety regulations applicable in each country
- Information provided in this user manual
- Rules regarding the use, maintenance, and repair of machinery

Failure to comply with these rules may result in harm to the user, other individuals, and the machine.

3.2 Symbol overview

3.2.1 Safety Symbols in the User Manual

Danger: Ignoring this information results in an immediate risk to life!

Warning: Ignoring this information involves a risk to life, serious personal injury, or significant environmental pollution!

Caution: Ignoring this information involves minor or moderate personal injury or environmental pollution!

Important: This information requires extra attention!

3.2.2 Safety Symbols on the Machine

Important: Ensure that you and other users of the machine are well acquainted with the meaning and placement of the symbols on the product.

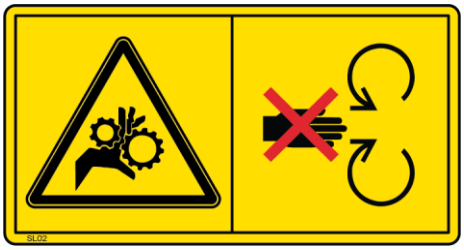
Important: Pay special attention to the hazard represented by the symbol when you are in its vicinity.

Important: The labels with the symbols must always be clearly legible and kept clean.

Important: The machine owner is responsible for ensuring that all safety labels are in good condition. If labels need to be replaced due to wear or because they are missing, contact your supplier to request replacements. Be sure to provide the label number.

SL01 Warning:

Les manualen før bruk.



SL02 Warning :

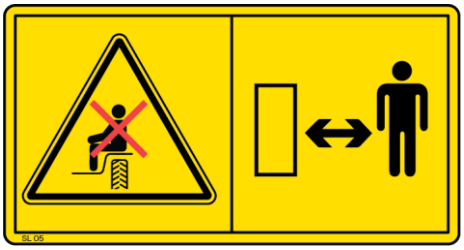
Risk of hand crushing. Keep a safe distance from rotating

SL03 Warning:

Risk of harmful substances. Use protective equipment.

SL04 Warning:

Read the manual before performing service.



SL05 Warning:

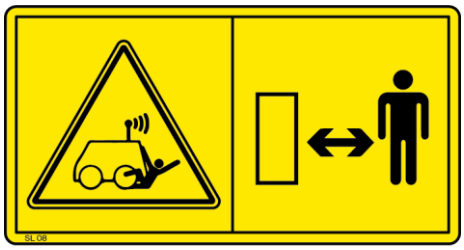
Do not sit here; keep a safe distance.

SL06 Warning:

Risk of toxic substances. Do not drink the water.

SL07 Warning:

Risk of hot surface. Do not touch.



SL08 Warning:

Autonomous vehicle. Keep a safe distance during operation.

SL09 Caution:

Components sensitive to static electricity. Always use a grounding wrist strap in this area.

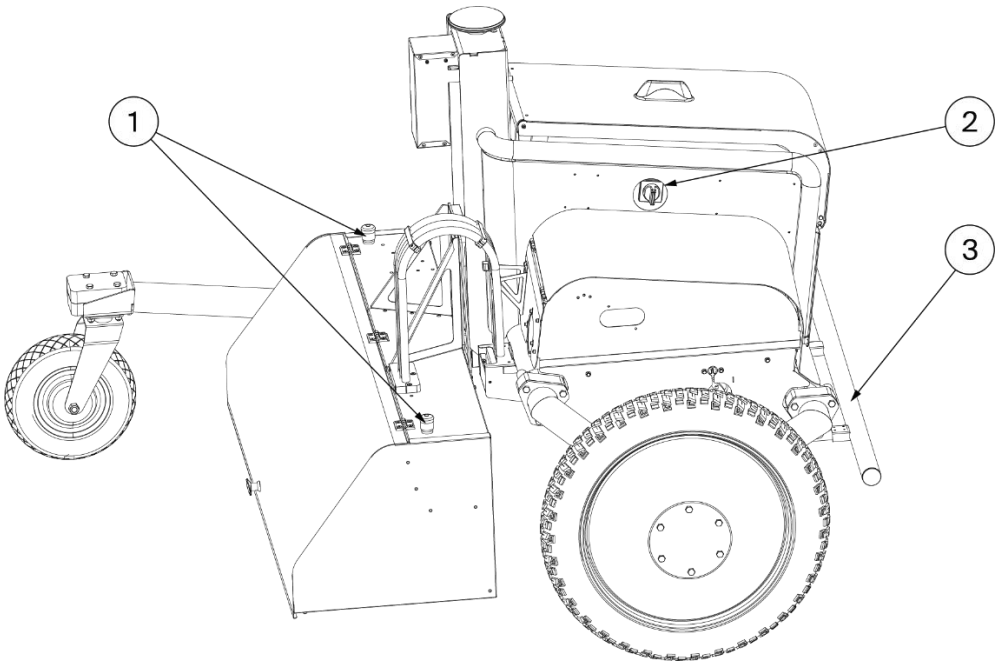
SL10 Medical Aid:

Container with eyewash solution.

SL11 Medical Aid:

Tap with water for rinsing hands.

3.3 Safety Features on the Machine



1. Emergency stop button
2. Main power switch
3. Bumper and emergency stop

3.3.1 Emergency Stop Buttons

At each end of the boom, there is an emergency stop button. Pressing any of these buttons will immediately halt the machine's spraying and autonomous operation. To restart the machine after an emergency stop, rotate the emergency stop button a quarter turn counterclockwise to reset it. Then, confirm the robot’s restart in the app before resuming normal operations.

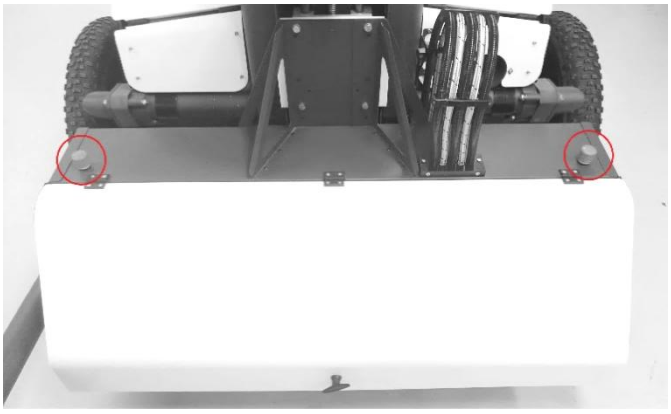


Figure 1 – Emergency Stop Buttons

3.3.2 Main Power Switch

The main power switch is a manual rotary switch used to turn the machine on and off. If the switch is in the "OFF" position, the main power to the machine is cut. When in the "ON" position, the circuits are powered. During normal operation, it is recommended to turn off the machine in the app before switching it off manually. In emergencies, this switch can be used directly without turning off the machine in the app first.

3.3.3 Bumper/Emergency Stop

The machine is equipped with a bumper that stops the robot if it encounters an obstacle. The bumper is a transverse bar with a magnet that disconnects from an inductive sensor when pressed. The drive wheels will immediately stop, and the machine halts, just as with an emergency stop button.

Figure 4 – Shock Absorber/Emergency Stop

3.3.4 Eye Washer

Located underneath the left side cover is an eye washer for immediate first aid. It contains sterile water and is used if anyone's eyes come into contact with pesticides. To use, detach it from the straps holding it in place, open the lid on top of the bottle, and place the nozzle over the affected eye. Tilt your head back and flush the eye with the sterile water. Repeat as needed. Contact the Poison Control Center at +47 22 59 13 00 for advice. Ensure that a full eye washer is always available at this location.

Figure 5 – The Eye Wash Station is Located Under the Left Cover

3.3.5 Clean Water Tap

On the machine's right-side compartment, there is a tap connected to the clean water tank (Figure 6). Use this tap to rinse hands or skin that has come into contact with pesticides. For further information, refer to Chapter 8.3.1 Filling the Clean Water and Rinse Water Tanks.

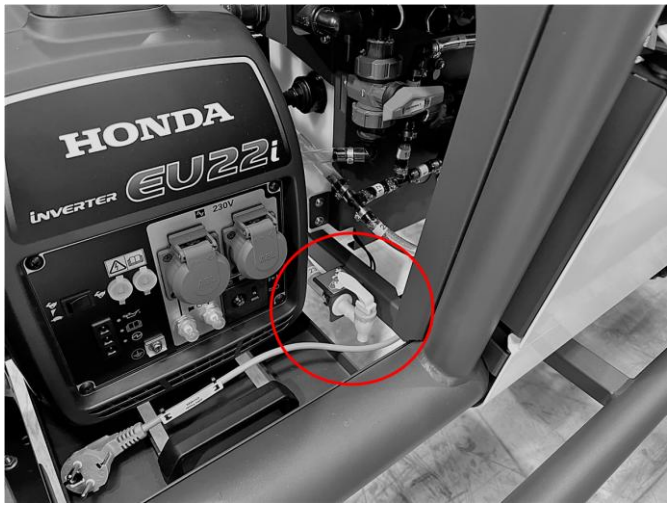


Figure 6 – The Water Tap is Located Between the Generator and the Tank

3.4 Intended Use of the Machine

The machine is intended solely for spraying weeds in fields with approved vegetable crops suitable for the machine. Contact your Kilter representative for an updated list of compatible vegetable crops for your robot.

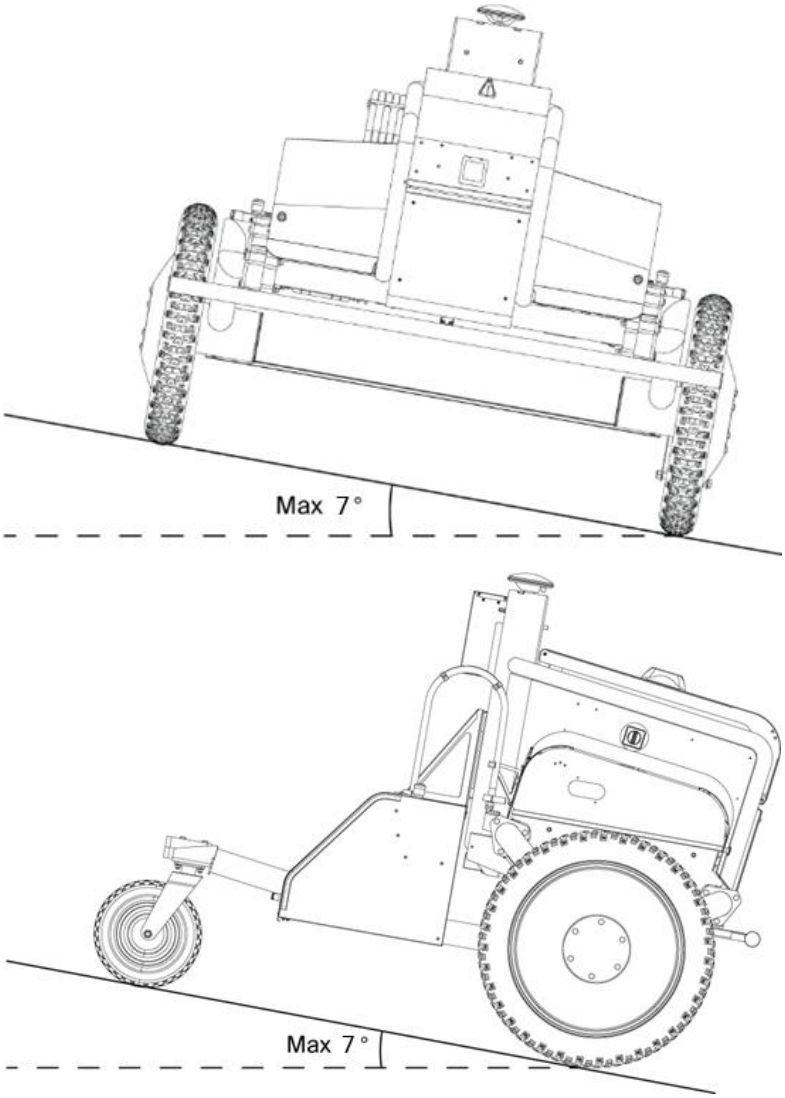
The machine is only to be operated on private property. Driving on public roads is prohibited. If transport on public roads is necessary, the machine must be transported on an approved trailer or rig.

Ensure thorough knowledge of the machine's functionality and associated risks before use. Machine operators must have the training required by national authorities and be properly instructed in the safe use of the product.

The machine must only operate within the conditions specified in Subchapter 5.2, *Requirements for a Suitable Work Area.*

Danger: *Violation of safety recommendations for stability may lead to severe injury as the machine can tip over onto people or animals.*

The robot must not operate on terrain with more than a 7-degree slope, both along and across its direction of travel.



Figur 2 – The machine's maximum allowable inclination

3.5 General Safety Advice for Accident Prevention

- Read the safety chapter carefully and adhere to the provided safety recommendations.
- Be aware of the hazards represented by the machine's warning symbols and other markings. Follow them for your own and others' safety and to prevent environmental spills.
- Maintain a safe distance from the robot during both autonomous and manual operation.
- Never lie under the robot, even if it is lifted for service or maintenance.
- Never use the machine on areas exceeding the recommended maximum incline.
- Practice manually driving the robot in a safe area with no risk of collisions with people, animals, or objects.
- In addition to the information in this manual, follow national safety regulations and accident prevention guidelines.
- Inspect the area around the machine before starting it (e.g., for children or animals). Ensure sufficient visibility and keep the area monitored during operation.
- It is prohibited to use the machine for transporting people, goods, or anything other than spraying plant protection products.
- No person should be in the robot's working area, including areas where the machine turns.
- Ensure no livestock can access the machine's working area.

3.6 Measures to Prevent Contact with Chemicals and Environmental Spills

- Always use safety equipment when handling spray agents and in situations described in *Situations Requiring Protective Equipment*.
- When mixing plant protection products, always follow the recommended mixing ratio stated on the product label.
- Ensure a container is placed under the drain point to collect surplus residues when draining leftover plant protection products or rinse water from the tank. Ensure the container does not overflow.
- Always verify that the machine has the correct spray pressure.
- Each nozzle block has two hoses—one for inlet and one for outlet. Ensure they are correctly connected to their respective connection points on the boom.
- Verify that the selected crop type in the spray control menu matches the type of vegetable being cultivated in the field.
- Store plant protection products in a locked location and in accordance with the manufacturer's safety data sheet.
- The machine automatically adjusts the amount of spray per area based on weed coverage. Compared to conventional spraying, this significantly reduces the use of plant protection products.

3.6.1 Filling the Tank

- Always wear complete protective equipment when handling spray agents. See *Safety and Protective Equipment*.
- Avoid spills when filling spray agents. Always use appropriate equipment for filling and follow the procedures described in *Internal Cleaning of the Spray System*.
- Follow the spray agent manufacturer's recommendations regarding:
    - Protective equipment
    - Handling warnings
    - Dosage, usage, and cleaning

Note: The use of unauthorized plant protection products is prohibited! Use only products approved for this machine.

- The spray agent tank capacity is 52 liters. Do not exceed this volume.

3.6.2 Spraying

- Ensure that no one is near the machine's working area during spraying.
- Recommended protective equipment must be worn if entering a treated area before the reentry interval has elapsed. The interval is specified in the spray agent's safety data sheet

Warning: Never loosen hoses, pipes, or other components in the machine's spray system while the machine is running. This could result in uncontrolled leakage of spray agents.

3.6.3 Adjustments

- Before making adjustments to the machine, the spray tank must be emptied, and the spray system, including the boom and nozzle blocks, must be rinsed with water. The machine should also be cleaned externally.
- If the machine is lifted for maintenance or adjustments, it must be securely supported, and the lifting rig must be stable to prevent tipping.

3.6.4 Draining and Cleaning the Tank

- Always wear necessary protective equipment when draining the spray tank.
- Residual spray agents must be labeled with their contents and delivered to a hazardous waste facility. Never dispose of spray agents in nature, drains, or other improper locations.
- Use an appropriate container for draining the tank and follow the procedure described in Chapter *9.2.1 Draining the Spray Tank*.
- Always follow the instructions on the pesticide label/data sheet.

3.6.5 Cleaning Spray Agents

When switching spray agents, follow this procedure:

1. Empty the tank completely, including any residual volume.
2. Clean the tank with an appropriate cleaning agent. Follow the instructions on the product label. Insufficient cleaning before refilling with a new agent may harm sensitive crops. Refer to the recommendations on the spray agent's label.
3. Drain the tank of cleaning water and refill it with the new spray agent.

3.6.6 Service

- Maintenance, service, and cleaning (excluding internal tank and spray system cleaning) must only be performed when the machine's main power switch is turned off.
- Screws and nuts must be checked regularly and tightened as needed.
- Bolts for both drive wheels and support wheels must be checked as needed, especially after periods of inactivity.

Warning: Never loosen hoses, pipes, or other components in the spray system while the machine is running. This may cause uncontrolled leakage of spray agents.

3.7 Safety and Protective Equipment

- The person responsible for operations must provide necessary personal safety and protective equipment for handling plant protection products.
- Follow the precautions on the spray agent's label, which may include:
    - Chemical-resistant gloves (material specified on the label)
    - Chemical-resistant suit
    - Waterproof footwear
    - Face protection
    - Respiratory protection
    - Safety goggles
    - Skin protection products, etc.
- The safety equipment is designed to protect the user from injuries caused by contact with spray agents on skin and/or eyes.
- Safety equipment should be used when physically handling the machine beyond turning it on or off. The operator or machine owner is responsible for ensuring that necessary protective equipment is always available. Equipment must not be damaged or defective in any way.

3.7.1 Defective Safety Equipment

Defective safety equipment is equipment that no longer meets protection requirements, such as gloves with holes or cracked safety goggles that can no longer protect against contact with spray agents.

3.7.2 Situations Requiring Protective Equipment

I Protective equipment is mandatory in the following situations:

- Filling the spray tank
- Handling spray agents
- Handling the spray system and nozzles
- Cleaning the nozzles
- Any situation where the operator anticipates possible contact with spray agents on the skin or eyes.

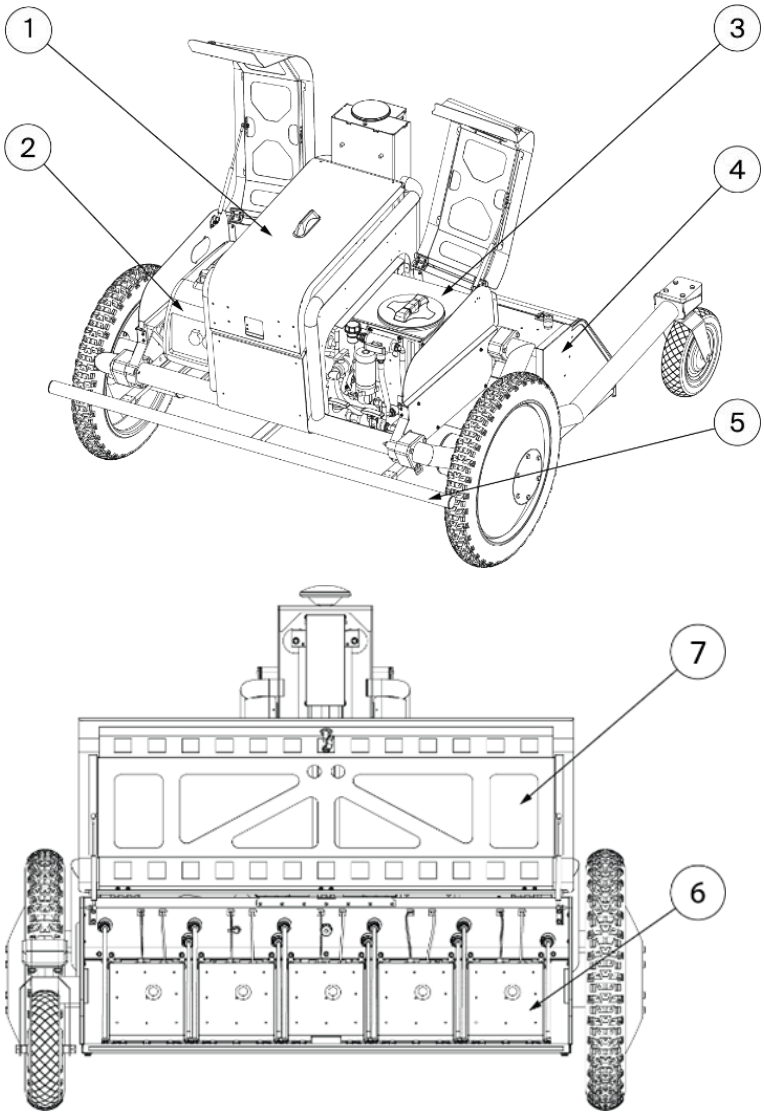
3.7.3 Of Spray Liquid Comes into Contact with Eyes or Skin

- If spray liquid contacts the eyes, rinse immediately. An eyewash bottle is located in the machine's left side cover (see *Eyewash*).
- If spray liquid contacts the skin, rinse immediately. A tap for clean water is located to the right of the generator (see *Clean Water Tap*).
- If symptoms such as vision loss, irritation, or rashes occur, contact a doctor or the Poison Information Center at **+47 22 59 13 00**. Specify the spray agent involved.
- In acute situations, call **113**.

4 Main Compontents

The main components of the AX-1 are particularly important to understand in order to grasp the machine's structure. Chapter 4 provides an overview and description of their locations and primary functions.

4.1 Overview of Main Compontents



Figur 3 – Maskinens hovedkomponenter sett forfra (øverste bilde) og bakfra (nederste bilde).

1. Control Center
2. Generator
3. Tank Module
4. Boom
5. Bumper/Collision Sensor
6. Spray Units
7. Boom Cover

4.2 Tank Module

The tank module is the primary unit for managing fluid flow and storing spray liquids. It contains three separate tanks, along with valves, a pump, hoses, and filters. This module is compact compared to conventional spraying systems and is well-protected under the machine's side covers, yet easily accessible for operation. Details are further specified in *Subchapter 4.2.6 Valve Positions.*

4.2.1 Tank Overview

The tank module consists of three separate fluid chambers:

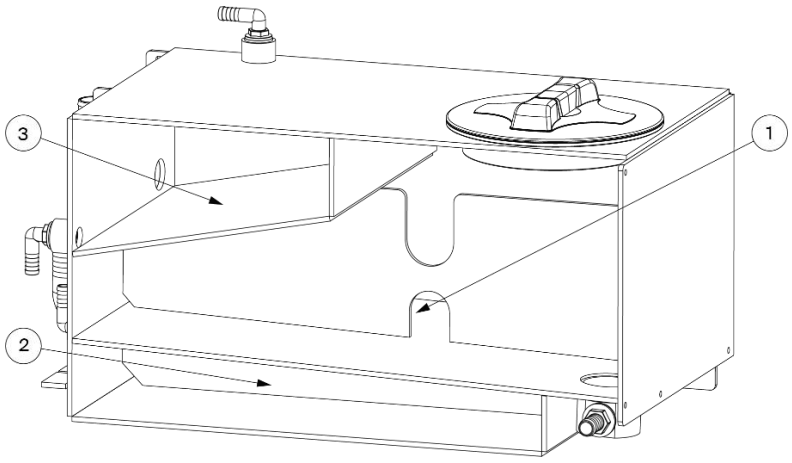


Figure 4 – Tanks

1. Spray Tank
2. Rinse Water Tank
3. Clean Water Tank

4.2.2 Spray Tank

CAUTION: The liquid volume in the tank must never exceed the nominal capacity.

The spray tank has a total volume of 55 L and a usable volume of 52 L. The tank is equipped with two return flows: a low-level flow for normal operation and one connected to a wash nozzle for internal tank cleaning. From the tank basin, there is only one outlet, which serves both for system circulation and tank drainage. The tank is sloped toward the basin to ensure a steady supply of spray mixture even at low remaining volumes during spraying.

4.2.3 Rinse Water Tank

This water tank is used for internal rinsing of the spray system and for diluting the spray mixture. It is located at the base of the tank module and has a total volume of 17 L.

4.2.4 Clean Water Tank

The clean water tank is to be filled with clean water that can be used to rinse off spray residues in case of spills. The tank has a total volume of 15 L and is equipped with a tap (22) on the right side near the generator.

4.2.5 Valves

The machine's spray agent management system is controlled by eight manual valves located on the tank unit's control panel.

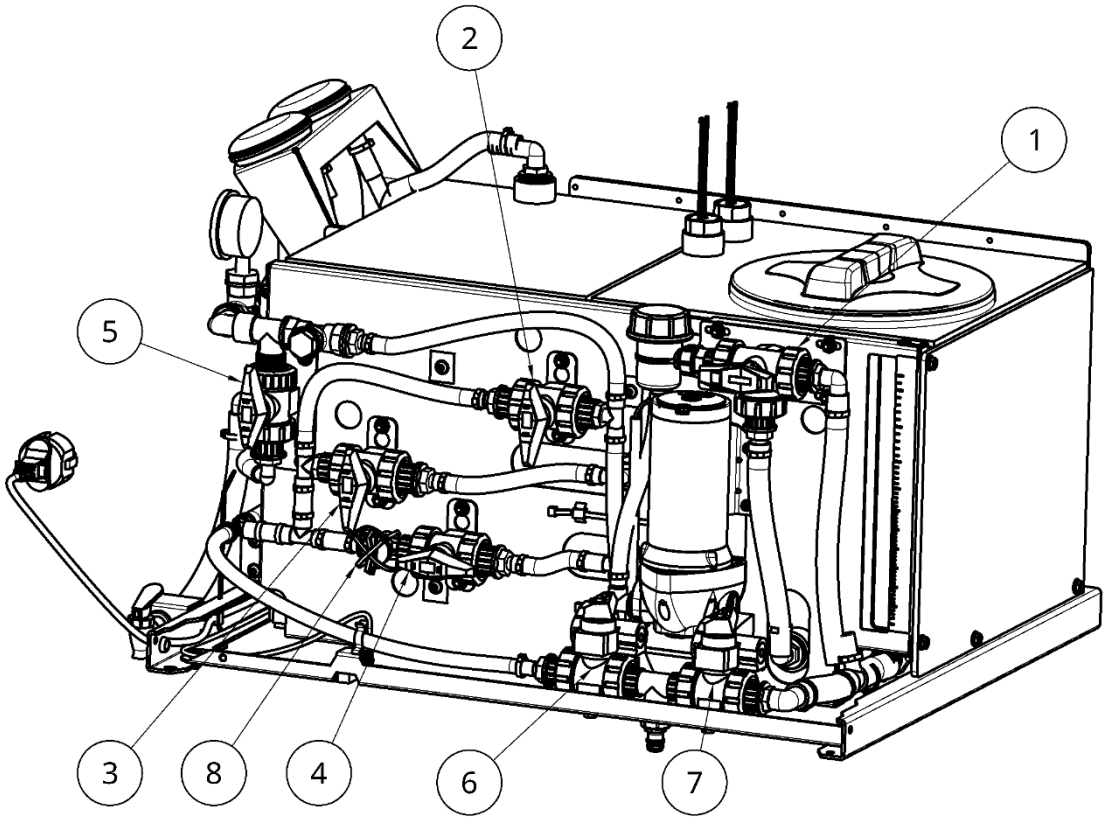


Figure 5 – Valves

1. Tank selector valve
2. Bypass valve - boom
3. Wash nozzle valve
4. Tank return valve
5. Disengagement valve - boom
6. Drain valve - system
7. Drain valve - tank
8. Fixed restrictor valve

Function of each valve:

1. Select between the spray tank and the rinse water tank for the pump's inlet.
2. Open/close the bypass between the high-pressure side and the tank's return hoses.
3. Open/close the return hose supplying the tank's wash nozzle.
4. Open/close the tank's standard return hose.
5. Open/close the liquid supply to the boom.
6. Drain spray liquid from the system.
7. Drain spray liquid from the tank.
8. Fixed restriction on the tank's standard return hose.

4.2.6 Valve Positions

The liquid flow in the machine's spray system is controlled by operating the machine's manual valves. Different configurations of valve positions enable six different modes for performing normal operations and system rinsing. The diagram below shows the positions of each valve to achieve various functionalities during use.

Normal operation

The pump circulates spray liquid from the main tank, out to the nozzle blocks, and back again. Use this setting during spraying.

Rinse system with clean water

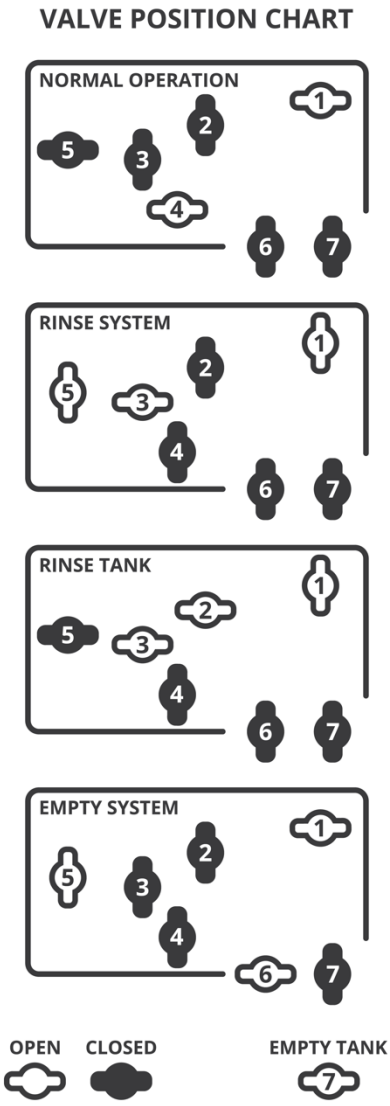
The pump pumps water from the water tank to the nozzle blocks. Return flow goes to the wash nozzle in the main tank. Use this setting to rinse the system (hoses, nozzles, and tank) while also washing the tank.

Rinse tank with clean water

The pump pumps water from the water tank to the wash nozzle. Valve 5 remains closed, while Valve 2 is open to disconnect the loop to the boom. Use this setting for maximum washing efficiency from the wash nozzle in the main tank.

Drain system

The pump pumps spray liquid out through the boom and nozzle blocks before draining it at the drain point. Valve 6 remains open, while return valves 3 and 4 to the spray tank are closed. Use this setting to drain the system after rinsing.



Drain tank

Manual draining of the spray tank for liquid using natural gravity. Draining occurs at the drain point when Valve 7 is opened. Use this setting for manual draining of spray liquid in the spray tank or to drain remaining liquid that the pump was unable to remove.

Dilute spray agent in the tank

The pump pumps water from the rinse and dilution tank into the spray tank's return flow. Valve 5 and 3 remain closed, while Valve 2 and 4 are open. Use this setting when the concentration of spray agent in the spray tank needs to be diluted.

Rinse system while mixed spray agent is in the tank

The pump pumps water from the rinse and dilution tank to the nozzle blocks. The wastewater is discharged at the drain point. The valve positions are the same as in Drain System, except Valve 1 is in the vertical position. Use this setting to clean the nozzle blocks without emptying the spray tank.

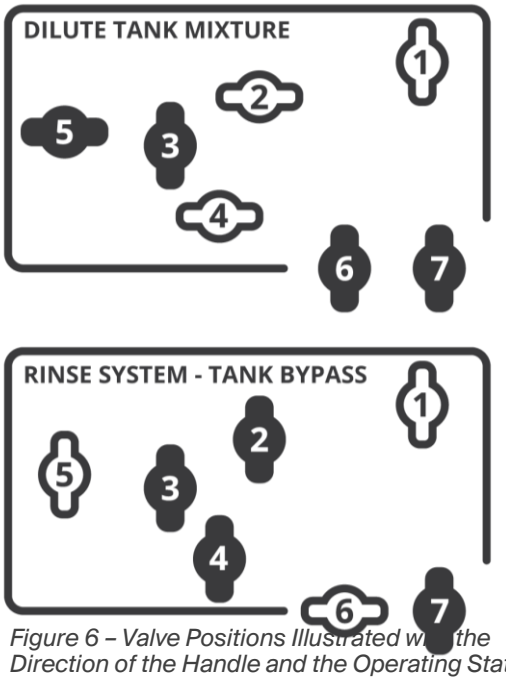
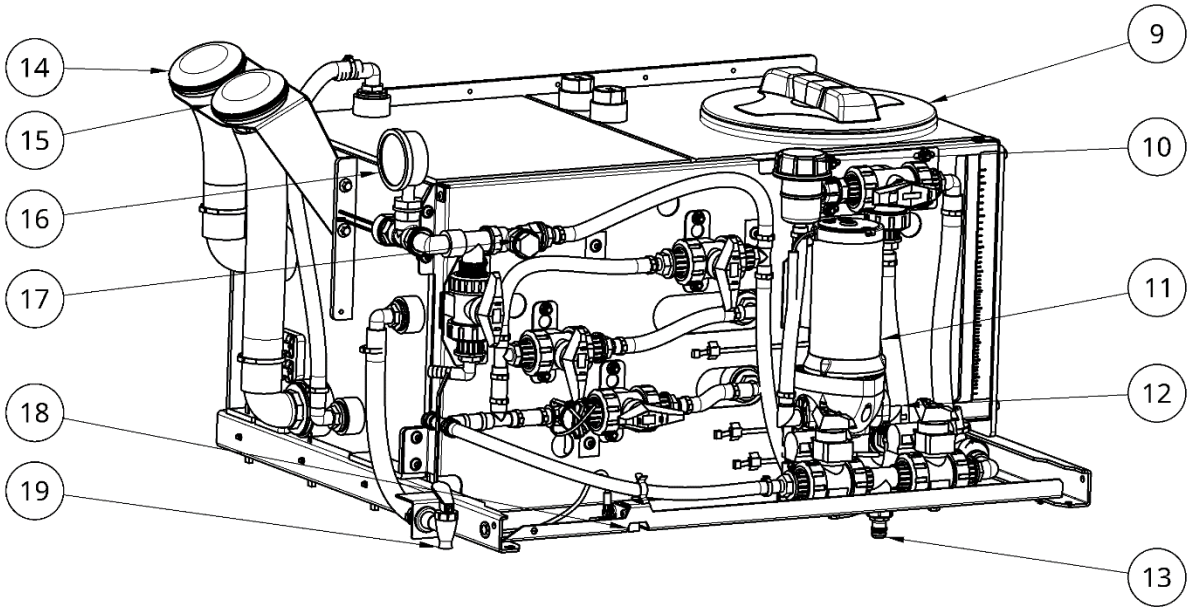


Figure 6 – Valve Positions Illustrated with the Direction of the Handle and the Operating State of the Valve

4.2.7 Other Components in the Tank Module



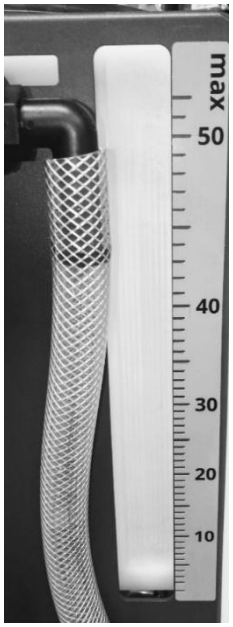
Figur 7 – Øvrige komponenter i væskesystemet

9. Tank lid
10. Suction filter
11. Pump
12. Connection point for measuring equipment
13. Drain point
14. Water filling for clean water tank (handwashing)
15. Water filling for rinse and dilution tank
16. Pressure gauge for spray pressure
17. Connection point for measuring equipment
18. Bumper sensor
19. Water tap for clean water (handwashing)

4.2.8 Tank gauge

IMPORTANT: The scale provides an indication of how much spray liquid is left in the tank. The machine must be on a horizontal surface to display the correct amount.

The spray tank has a liquid level indicator for manual reading of the liquid level. The scale has a resolution of 1 liter per mark



Figur 8 – Indicator for liquid level

4.3 Boom

The boom is located at the rear of the machine and typically accommodates up to five spray units. It can be height-adjusted using an electric lift via the Kilter Remote app. The working height is primarily 15 cm above the ground, but the boom can be raised up to 50 cm. The machine has automatic height adjustment, ensuring that the distance from the boom to the ground remains at 15 cm, even on uneven terrain. This is achieved using height sensors in the spray units that continuously measure the distance to the ground. Good control of the distance between the boom and the ground is an important factor for successful precision spraying. The height of the boom can also be set manually by operating the lift via Kilter Remote.

There is one valve on the boom. This should normally not be operated. The knob must always be pointed downward during operation.

4.4 Spray Unit

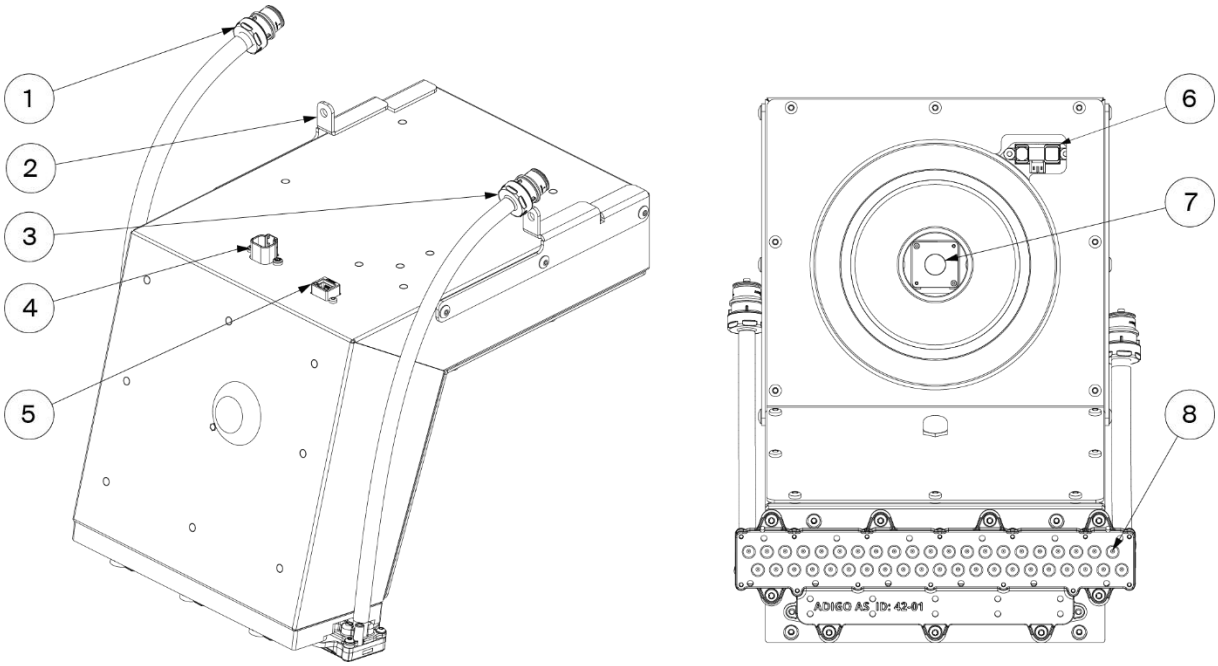


Figure 9 – Spraying Unit Viewed in Perspective and from Below

1. Quick connector for nozzle outlet
2. Mounting bracket
3. Quick connector for nozzle inlet
4. Power connection
5. Communication connection
6. Height sensor
7. Camera
8. Nozzle block

The spray unit is built around a steel cabinet that houses a camera and a nozzle block. The camera is surrounded by a light reflector, with a height sensor located next to the reflector. On each side of the nozzle block are hoses for the inlet and outlet of spray liquid, equipped with quick connectors that attach to corresponding parts on the spray boom. The inlet is on the right side, and the outlet is on the left. The top of the unit features mounting brackets for attachment to the boom, along with connection points for power and communication with the control center.

IMPORTANT: The spray units should normally remain mounted on the boom. If removed, they must be handled with great care.

4.4.1 Nozzles

Each spray unit has a nozzle block consisting of two rows with a total of 42 nozzle outlets. Each nozzle outlet operates independently. During operation, droplets of spray liquid are discharged when the machine passes areas identified as weeds. The nozzle blocks are controlled by electronics located inside each spray unit and the machine's control center (see *Overview of Main Components*).
Droplets of spray liquid may remain on the nozzle modules even after the system has been rinsed following spraying. These droplets may drip, and the operator must avoid spills. Do not

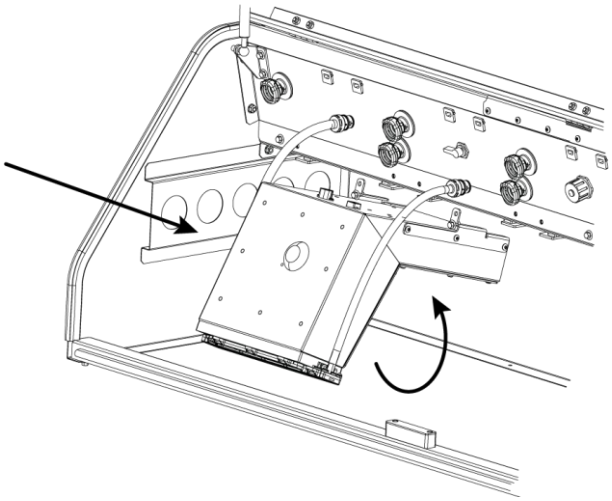
touch the nozzle blocks without approved protective equipment (see *Safety and Protective Equipment*). Never bend your head under a nozzle block, either before or after use.
A defective nozzle block must be replaced. This must be carried out by an authorized technician. For information on service and maintenance, see *Spray Unit.*

4.4.2 Connecting and Disconnecting the Spraying Unit

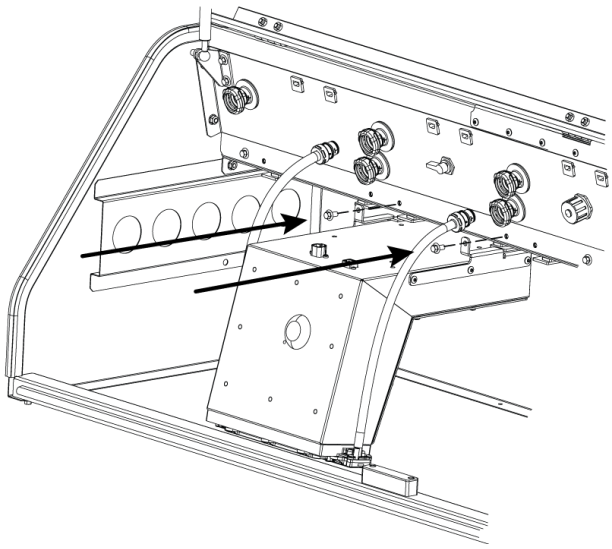
Important: Be cautious during the attachment and detachment of the spray unit. Limited space increases the risk of damaging the nozzle block due to collisions with the cross-profile of the boom. Follow the instructions below carefully.

CAUTION: Ensure that hoses are connected to the correct ports. Incorrect connections will significantly reduce the nozzles' precision and may cause spray liquid to hit undesired areas.

1. The spray unit is inserted at an angle from above into the boom and then rotated until the top surface is horizontal.

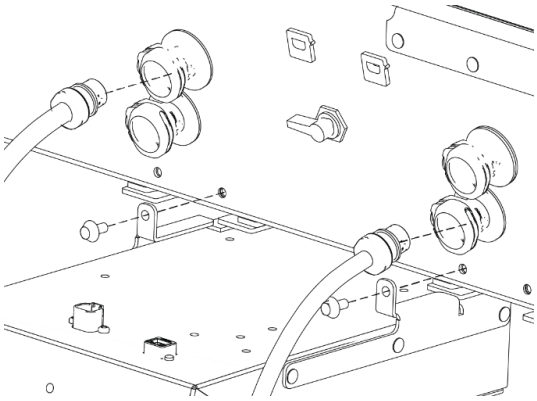


2. Slide the brackets on each side of the spray unit into the grooves on the underside of the boom.

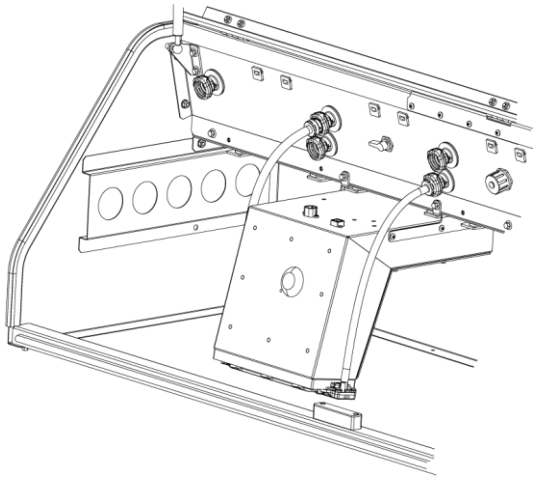


3. The screw hole in the brackets is aligned with the threads on the panel. Tighten the screws to 3 Nm (2 x M6 screws).

4. The inlet hose on the right side must be connected to the lower connection point. The outlet hose on the left side must be connected to the upper connection point.



5. The network cable and power cable are plugged into the top of the spray unit before the spray unit is fully mounted on the boom.



4.4.3 Spray Configurations

The boom can typically accommodate up to 5 spray units. The number of units and their positions can easily be adjusted as needed without requiring changes to the spraying settings.

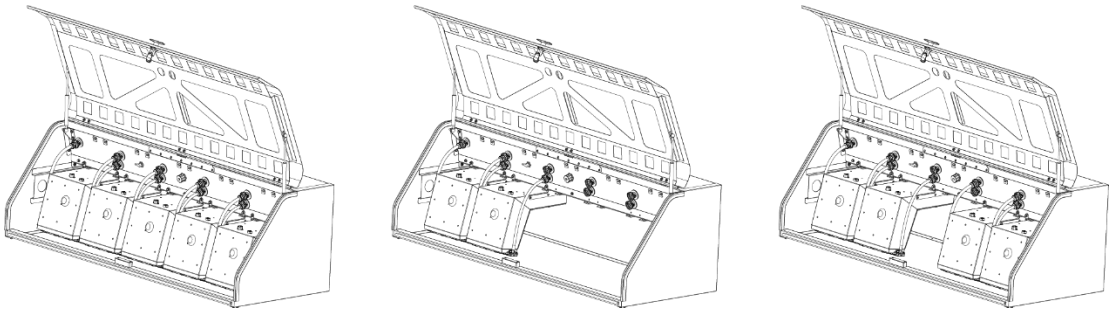


Figure 10 – Spray Configurations

4.5 Circulation Circuit for Spray Liquid

In the AX-1, the spray liquid circulates in a loop from the tank, out to the spray units mounted on the boom, and back to the tank. This forms the main circuit for the circulation of spray liquid. Operation of this circuit is done manually using the valves on the tank module. How these valves should be set to achieve different functions is described in Subchapter 4.2.6 Valve Positions.

4.6 Generator

The machine is powered by a Honda EU22i gasoline generator. The generator supplies power to the batteries located in the control unit. The generator's load is automatically adjusted according to the power demand of the spray units. This demand is regulated by the amount of weeds being sprayed at any given time. If the weed density in the field is high, causing the machine to work under heavy load, the generator should be set to high-load mode to provide sufficient power to the machine. For more information, see Subchapter 8.1.1 Starting with Generator Power.

Figure 11 – Generator

4.7 Drive Wheels

Important: Elmotorene skal ikke frakobles maskinen eller utføres service på av andre enn autoriserte serviceteknikere.

De The two front wheels are powered by individual electric motors, providing sufficient propulsion for the machine. Individual control of each wheel allows the machine to maneuver and rotate around its own central axis. The size of the wheels ensures good ground clearance and low pressure on the surface for gentle operation in the field.

The electric motors are maintenance-free and should only be handled by service technicians.

4.8 Wheel Service

Contact your Kilter customer representative for further information regarding wheel service.

4.9 National and Regional Regulations for Inspection

The machine is subject to national regulations for periodic inspection of the robot's spraying functionality.

4.10 Machine Control Center

Important: This unit must not be operated by the user, except for the external main power switch

The machine has a control center located at the top of the robot. This unit can be considered the machine's "brain," containing electronics and control systems to operate the robot's functions. On top of the cover is a mobile antenna (1) and a GPS (2) for precise positioning during autonomous operation. At the front of the cover is a camera (3) for observing the surroundings in front of the machine. This information is used to position the robot when driving in rows and performing turns.

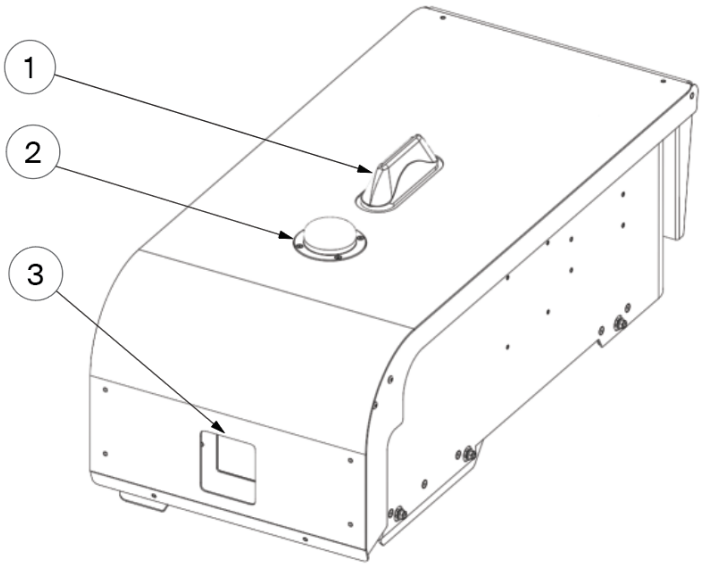


Figure 12 – The Control Center

5 Before Using the Machine

5.1 Before Using the Machine for the First Time

5.1.1 Product Inspection

Upon receiving the machine, a visual inspection should be performed to identify any damage or defects that may have occurred during transport. If any discrepancies are found, the dealer must be notified within three days.

5.1.2 Required Facilities for Installation

The machine requires access to a charging station and an internet connection to perform necessary software updates before it can be put into operation. Therefore, find a suitable location with these facilities and a level horizontal surface where it can be parked.Lading

The machine has integrated batteries that can be charged by connecting the plug at the front of the generator to a 220V AC outlet with a minimum of 10A. The machine must always be connected to the charger when performing system updates.

Charging the battery before use reduces the need for power from the generator, thereby decreasing fuel consumption.

Important: Ensure that the machine is connected to a power source before performing a software update

5.2 Requirements for a Suitable Work Area

- Må Must be an agricultural field used for food production.
- The field must not have a slope greater than 7°.
- The field condition must not be too wet or muddy.
- No people or animals should be present on the field.

5.3 Machine Configuration – Wheel Width

The AX-1 can be configured with different wheel widths to match the track spacing on your field. Upon delivery, the wheel width of your AX-1 will be configured according to the agreement made prior to delivery. If you need to configure the machine with different wheel widths, additional spacers can be purchased. Contact Kilter to purchase spacers for your AX-1.

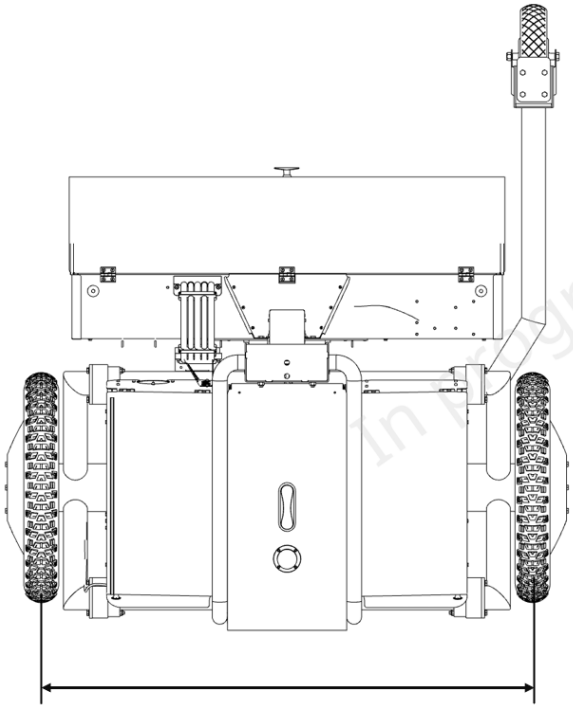


Figure 13 – Wheel Width

5.4 Software Updates

Aside from keeping the robot powered on and connected to the mains, you as a user do not need to take any action to receive software updates for your machine. The Kilter Remote app will notify you when new updates are available and when the machine can be turned off after an update.

5.5 Operating Postitions

CAUTION: Protective equipment described in subsection 3.12 must always be used at operator positions 1 and 2.

Familiarize Yourself with the Machine. The machine has three positions for manual operation (see figure). At each position, the following functions can be performed:

Position 1

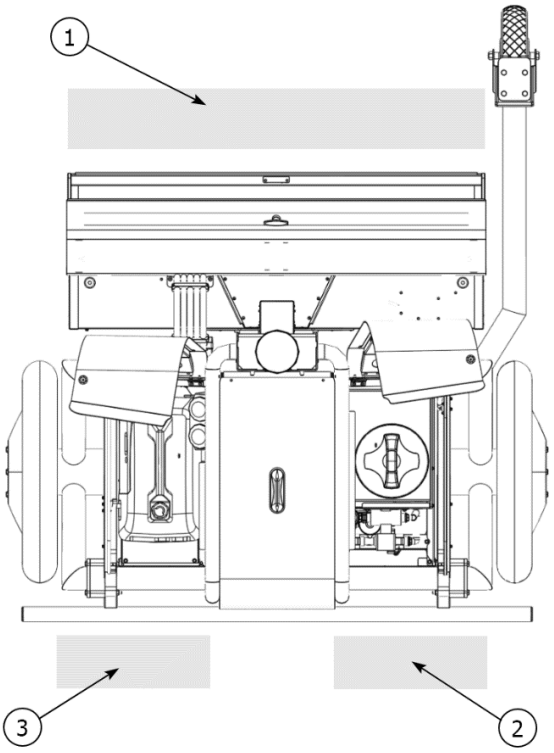
- Visual inspection of nozzle modules.
- External cleaning of nozzle blocks.
- Cleaning the high-pressure filter (section filter).
- Connecting and disconnecting spraying units.
- Activating the emergency stop.

Position 2

- Filling the spray tank with water.
- Cleaning the strainer.
- Cleaning the suction filter.
- Replacing the air filter for the control center.
- Operating valves.

Position 3

- Operating valve 5.
- Reading the pressure gauge.
- Refueling the generator with gasoline.
- Filling the clean water tank and rinse/dilution tank with water.
- Starting the generator.
- Tap for rinsing off pesticide spills.
- Operating the main power switch.



6 Connecting and Controlling the Machine

6.1 «Kilter Remote»

Control of the machine is remote and operated through the Kilter Remote application on mobile devices and tablets. These devices serve as the machine's control unit. This is where the machine is operated, monitored, driving routes are managed, and spraying settings are configured. Without this application, it is not possible to use the machine, as it does not have an integrated control panel or other means of operation.

The AX-1 has an integrated local Wi-Fi that becomes available for connection when the machine's main power switch is turned on. Note: In some cases, it may take up to 2 minutes after the main power switch is activated before it is possible to connect to the robot.

To use the application, a mobile device or tablet with Kilter Remote installed is required. The app can be downloaded from the App Store for Apple users or Google Play for Android users (see QR codes below). Wi-Fi must be enabled on your control device during the connection process.

GET IT ON Google Play

Download on the App Store

6.1.1 Registering a User in Kilter Remote

Upon purchasing the AX-1, a user account will automatically be created and sent to you via email. If additional user accounts are needed, please contact your customer representative. Use your account credentials to log in.

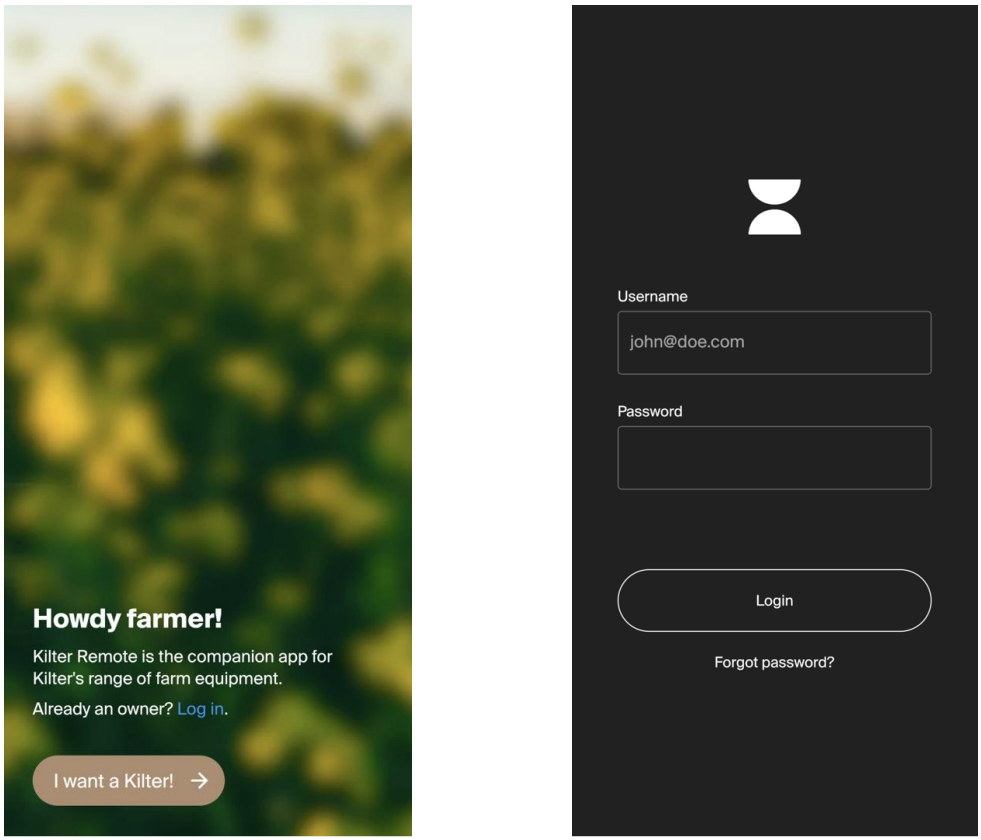


Figure 14 – Login Menus

After logging in, you will see an overview of available machines linked to your account. Select your AX-1 to connect via the machine's internal Wi-Fi. Choose "Connect." It will take approximately 1 minute after the AX-1 is powered on before it is possible to connect using a tablet or mobile device. This device will function as the control unit for the machine.

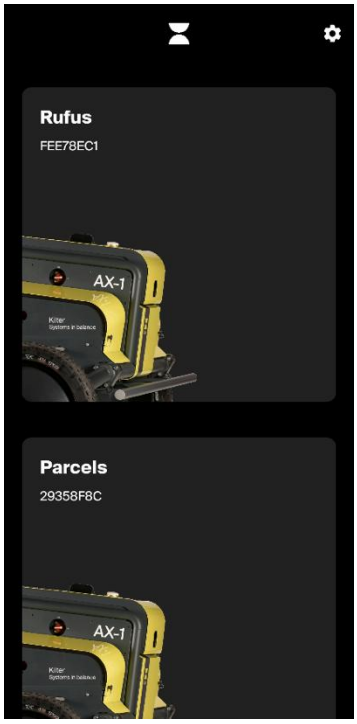


Figure 15 – Kilter Remote Showing Two Machines Available for Use

7 Machine routes

The AX-1 uses predefined machine routes to navigate fields. A machine route consists of a series of crop rows in a field. These rows form the path that the AX-1 follows during spraying.

Machine routes can be created in several ways, which can be grouped into two methods:

1. Creating a new machine route manually using Kilter Remote.
2. Creating a new machine route using GPS data from a tractor or tracking device.

For more information on generating machine routes, refer to the help tool in Kilter Remote or contact Kilter Support.

7.1 Principle of Navigation in Crop Rows

AX-1 The AX-1 follows crop rows by navigating through predefined GPS points. Each row is defined by two or more GPS points, referred to as waypoints. Upon reaching a waypoint, the AX-1 begins driving toward the next waypoint in the row.

The AX-1 travels in a straight line between two waypoints.

8 Use

8.1 Starting the Machine

The machine can be started in two ways, depending on whether the generator will be used. If you choose to operate the machine without the generator, the operating time is very limited before the machine runs out of power. Therefore, weed spraying should only be performed with the generator running.

8.1.1 Start with Generator Operation

Important: The generator must be filled with gasoline to start**.**

Important: Do not operate the generator with the choke on, as this may cause permanent damage and irregular operation**.**

Startup Procedure:

1. Ensure the power cable to the control unit is connected to the generator. Without this connection, the batteries will not charge.
2. Turn the generator switch counterclockwise so that it points diagonally upwards.
3. Turn on the choke on the generator.
4. Pull firmly on the generator’s starter cord until it starts.
5. Turn off the choke.
6. Turn the red main switch for the system clockwise so that it is in the "On" position, pointing to the right.
7. After approximately 1 minute, the AX-1 can be connected to your mobile or tablet using **Kilter Remote**. Once the machine is connected to your control device, it is ready for use.

8.1.2 Starting with Battery Operation

The AX-1 can operate solely using its batteries. The generator does not need to be started for this type of operation.

Startup Procedure:

1. Turn the main switch clockwise so that it is in the "On" position, pointing to the right.
2. Open Kilter Remote and select the machine that was powered on. This will be possible after approximately 1 minute.
3. Once the machine is connected to your control device, it is ready for use

8.2 Turn Off the Machine

Caution: The machine must be parked in a suitable location before it is turned off. *See subsection 13.1 Parking*.

Procedure for Turning Off the Machine:

1. Turn off the robot using the Kilter Remote app.
2. Wait approximately 5 seconds.
3. Turn the main power switch.
4. Turn off the generator.

8.3 Filling the tanks

Important: The machine has a total of three tanks that must be filled with water before spraying can begin.

8.3.1 Filling the Clean Water Tank and the Rinse Water Tank

Warning: Only water must be filled into these tanks.

The clean water tank and the rinse/dilution tank must be full of water at startup. Water is filled on the machine's right side. Two filling ports with screw caps are located under the side cover next to the generator. The left port is for the clean water tank. The right port is for the rinse and dilution tank. To minimize unnecessary water spillage, it is recommended to use a water hose for filling. (The generator can withstand some water splashes.)

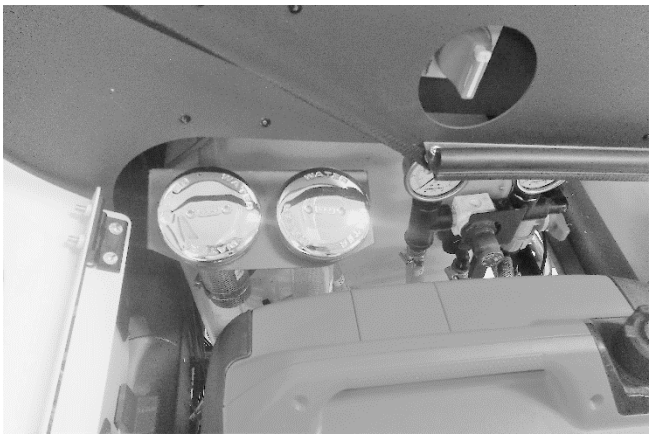


Figure 16 – Clean Water Tank and Rinse Water Tank

8.3.2 Mixing Pesticide in the Spray Tank

CAUTION: Always ensure the tank strainer is placed in the tank's filling opening during filling and operation. Make sure it rests evenly and flat on the flange.

The spray tank is operated from the machine's left side, under the side cover. The tank lid is removed by turning it half a turn counterclockwise. The strainer must always be in place in the tank opening to filter out larger particles. The tank is filled with water through this opening.

Start by planning how much diluted pesticide is needed in the tank. Follow the label's instructions for the mixing ratio between water and pesticide. Based on this, calculate the required amount of water.

The pesticide is mixed directly in the tank. First, pour in the water, and then add the correct amount of pesticide according to the water volume and mixing ratio.

Start the pump and let the spray liquid circulate for at least 3 minutes to ensure the water and pesticide mix thoroughly. This must be done before spraying can begin.

8.4 Spraying Parameters

The AX-1 autonomously manages the optimal distribution of pesticides across the field during autonomous operation, making it the most precise spraying robot in the world. To achieve excellent spraying results, there are parameters that must be set by the operator beforehand. The rest is handled by the machine. Below is a list of the different spraying parameters:

Machine-Controlled Parameters

- Selective spraying
- Boom height
- Driving speed
- Consumption/volume of spray liquid per area
- Spraying pressure

Operator-Controlled Parameters

- Mixing and dosing of pesticides
- Spraying settings for the current field

8.4.1 Selective Spraying

The AX-1 autonomously controls where spray liquid is applied during operation. For a detailed description of the technology, see *subsection 4.4 Spraying Unit.*

8.4.2 Boom Height

The distance from the spraying units to the ground is critical for spraying precision. Therefore, the AX-1 has automatic boom height adjustment to maintain a consistent distance from the ground during operation. Automatic boom height adjustment is activated automatically during autonomous operation.

8.4.3 Driving Speed

During spraying, the AX-1 maintains a variable speed between 0.1 m/s and 0.5 m/s. A high density of weeds reduces the speed, while a low density of weeds allows the robot to move faster with the same level of spraying precision.

8.4.4 Spray Liquid Consumption Per Area

The AX-1's spray liquid consumption depends on the weed coverage in the field. Weed coverage can vary from 0% to 100% during operation. A 100% weed coverage means the machine detects weeds, or a spray zone from nearby weeds, across the entire width of the bed. In this case, all 210 nozzle outlets will fire a single droplet.

If 100% weed coverage persists, all nozzle outlets will continue firing a new droplet every 6 mm in the driving direction. Since the distance between each nozzle outlet is 6 mm, the maximum consumption per nozzle outlet is as follows:

$\text{Consumption}_{\text{At nozzle outlet}}$ = Spray liquid/area

= 1 drop / 6*6 mm^2

= 1 drop /36 mm^2

At an operating pressure of 0,9 bar:

$\text{Consumption}_{\text{At nozzle outlet}}$ = 0,000001 l / 36 mm^2

= 0,000001 l / 0,000036 m^2

= 0,0278 l / m^2

= 27,8 l / daa

This figure represents the spray liquid used per nozzle outlet per sprayed hectare. With a 6 mm wide treatment area for one nozzle outlet, the AX-1 must cover 1000 m^2 / 0.0006 m = 166,666 m to use 27.8 l of spray liquid. Since the machine has 210 nozzle outlets, the actual length is 166,666 m / 210 = 794 m to use 27.8 l at 100% weed coverage. The spray liquid consumption per hectare remains the same in both cases.

Normally, the weed coverage will not be 100% on one hectare but significantly lower. In those cases, the spray liquid consumption per hectare will be considerably lower than 27.8 l/ha. To reduce the machine's consumption, it is therefore strategically important to spray at an early growth stage when weed coverage is low.

8.4.5 Mixing and Dosing of Pesticides

27.8 liters per decare (l/daa) is the maximum consumption of spray liquid and is the reference value used when preparing the pesticide mixture to achieve the correct dosage.

Example 1
Pesticide: Centium 36
Dosage for Carrots: 12.5 ml in 20–40 liters of water per decare.
Tank Capacity of AX-1: 52 liters
Consumption of AX-1: 27.8 l/daa
Area: 5 daa

- **Total liquid volume:** = 27.8 l/daa * 5 daa = 137.5 l
- **Number of tanks required:** = 137.5 / 52 = 2.64
- **Tank capacity (area covered by one tank):** = 52 / 27.8 = 1.87 daa
- **Total amount of pesticide:** = 12.5 ml * 5 daa = 62.5 ml
- **Pesticide volume per tank:** = 62.5 ml / 2.64 = 23.7 ml

For more information on mixing and dosing pesticides,
visit https://farm.kiltersystems.com/.

8.4.6 Pressure

The spraying pressure on the robot is automatically adjusted by the pump using software-controlled pressure readings. The machine ensures that the pressure stays within the correct pressure range. The operator can always check the spraying pressure in the Kilter Remote app.

The machine is also equipped with a pressure gauge, which should display approximately the same pressure as shown in Kilter Remote.

Before the machine can begin autonomous operation, the spraying pressure must be within the correct pressure range. It may take a few seconds after the pump is activated for the correct spraying pressure to be reached. Once achieved, autonomous operation can begin.

If the pressure becomes too low or too high for any reason during autonomous operation, the machine will stop, and the operator will receive a notification in the app.

Low pressure may occur, for instance, if the tank is running out of pesticide. Clogged filters can also be a potential cause of incorrect pressure.

8.4.7 Spraying Settings for the Current Field

In Kilter Remote, spraying parameters are selected and adjusted by the operator for each field before treatment with the AX-1. For more information, refer to Kilter Remote.

8.5 GPS-signal

The AX-1 must have GPS coverage before it can begin spraying. Signal status can be viewed in Kilter Remote.

8.6 Start Autonomous Spraying

To start autonomous spraying, open Kilter Remote and follow the start procedure in the app.

8.7 Checklist before Spraying

- ✓ Driving routes are created and uploaded to the robot.
- ✓ Gasoline and water are filled in the tanks.
- ✓ Pesticide is mixed in the spray tank.
- ✓ Valves are set to the position for "normal operation."
- ✓ Generator is started, and choke is turned off.
- ✓ Main power switch is on.
- ✓ Mobile device or tablet is connected to AX-1 via Kilter Remote.
- ✓ RTK GPS signal is functioning properly.
- ✓ Spraying pressure is within the correct specified range.
- ✓ Spraying settings for the current field are selected.
- ✓ Correct driving route is selected.
- ✓ Correct starting point is selected.
- ✓ "Nozzle cleaning" is completed, and all spraying units are confirmed to be operational.
- ✓ Ensure that image recognition is functioning properly for the crop on the field.

8.8 Spraying Strategy

Guidelines are under development.

9 General Maintenance

Warning: Risk of pinching, cutting, shearing, severing, entrapment, entanglement, pulling in, catching, and impacts at unprotected danger points!

- If covers or other protective equipment are removed during maintenance, repairs, or cleaning, they must be reinstalled afterward.
- Damaged protective equipment must be replaced.

Warning: Follow the safety instructions during all maintenance, repairs, and servicing activities.

Warning: Follow the safety instructions during all maintenance, repairs, and servicing activities.

Before Each Startup: Inspect hoses, pipes, valves, and connection parts for leaks, wear, and defects. If faults are detected, they must be repaired and/or reported immediately

9.1 General Safety for Maintenance and Repairs

Regular and properly executed maintenance helps extend the machine's service life and improves operational reliability. The product warranty is valid only if the maintenance schedule is followed.

All spare parts must be original parts supplied by Kilter AS.

Before performing service and repairs:

- The machine must be emptied of spray agents, and the circulation system must be cleaned.
- The machine must be externally cleaned to eliminate the risk of contact with spray residue.
- The machine’s main power switch must be turned off during all maintenance and repair work.

9.2 Internal Cleaning of the Spray System

CAUTION: Always use the necessary safety equipment when draining spray agents

9.2.1 Draining the Spray Tank

Warning: When draining spray agents from the tank and disposing of residues from cleaning, no discharge into the environment is permitted. Spray residues must be collected, labeled with their contents, and delivered to a hazardous waste disposal facility.

Important: Ensure there is a collection container placed under the drain point.

Etter After spraying, there may be residue of the spray mixture in the tank. This must be drained into an appropriate container before cleaning can begin. Follow these steps to drain the spray mixture from the tank:

1. Place a collection container under the drain point.
2. Set the valves to the "Drain System" position and start the pump.
3. Allow the pump to run until the tank is empty of spray mixture.
4. Open Valve 7 to release the last remnants.
5. Prepare to rinse the tank, hoses, and nozzle blocks by setting the valves to the "Rinse System" position.

The washing procedure is available in Kilter Remote. Follow the step-by-step guide, as it provides access to necessary machine controls and up-to-date procedures. Refer to the label under the left cover of the machine for illustrations of commonly used valve positions.

CAUTION: Ensure the spray tank is empty before cleaning the system.

The washing process follows the principle of stepwise dilution of residual spray agent. The liquid system must be rinsed and flushed with a washing nozzle three times using water. After each step, the rinse water is drained.

9.2.2 Cleaning the Spray System When Spray Agent is in the Tank

CAUTION: Ensure that Valves 2, 3, and 4 are closed to prevent unintended dilution of the spray agent.

1. Plasser Place a collection container under the drain point.
2. Set the valves to “Rinse System,” except for Valve 3, which remains closed, and Valve 6, which is opened.
3. Run the pump until all the water in the rinse tank is used. Perform two rounds of Nozzle Rinsing (accessible in Kilter Remote) while the water flushes the system.
4. Set the valves to the “Normal Operation” position..

9.2.3 Residual Volume After Draining

After completing the cleaning procedure for the spray system after use, a small residual volume (< 0.1 L) of spray agent may remain in the tank. This can be drained manually by opening Valve 7.

9.2.4 Changing Spray Agents

When changing spray agents, use a soap specifically designed for cleaning spray equipment.

9.2.5 Nozzles

Important: The nozzle blocks must always be cleaned with clean water after use. Failure to clean can result in leaks and blockages in the nozzle outlets.

The nozzle modules are precision instruments. To maintain their precision, it is essential to rinse them with water after use while running the cleaning procedure for nozzle modules (available in Kilter Remote). This can be achieved by performing: *Cleaning the Spray System and Tank After Use* or *Cleaning the Spray System When Spray Agent is in the Tank.*

9.3 Cleaning the Machine

Warning: Always use the recommended protective equipment when washing the machine, as spray residue may be present on the machine.

Important: Use low-pressure water when rinsing the outside of the tank to minimize water contact with the underside of the control panel and the generator.

Important: Do not use soap to clean the nozzle blocks. Soap can compromise the sealing capability of the nozzles, leading to leaks. Only clean with water.

Important: Do not use paper or lint-producing cloths to clean the nozzle blocks. Debris and lint can cause leaks and reduce the droplet quality from the nozzle outlets.

Important: The machine must always be turned off during cleaning. If the machine is on, the fans may draw in water, potentially damaging the electronics of the control panel.

Important: The generator must always be turned off, and its power cord disconnected during machine cleaning.

Important: Do not spray the wind sensor with high-pressure water.

9.3.1 External Cleaning

Important: Important: Do not clean the machine at close range (less than one meter) with a high-pressure washer or other high-pressure water sprayers. High-pressure water can penetrate and damage the electronics.

The machine can be cleaned externally using a water hose, soap, and a sponge or lint-free cloth.

9.3.2 Internal Cleaning

Warning: Never clean the inside of the control panel.

Important: Use low-pressure water when rinsing the tank's exterior to minimize water contact with the underside of the control panel and the generator.

Important: Do not use soap to clean the nozzle blocks. Soap can damage the nozzles' sealing capability, causing leaks. Use only clean water.

Important: Do not use paper or lint-producing cloths to clean the nozzle blocks. Debris and lint can lead to leaks and reduce the droplet quality from the nozzle outlets.

Tankmodulen The tank module under the left side cover can be cleaned using a low-pressure water hose, sponge, or lint-free cloth. Soap may be used but ensure no soap residues enter the tanks.

The generator under the right side cover should not be cleaned using a water hose. Use a sponge or a damp, lint-free cloth instead. Soap may be used, but ensure no soap residues enter the fuel tank.

The spraying units and the rest of the inside of the boom can be cleaned with a low-pressure water hose. A sponge or lint-free cloth can also be used, but ensure no lint or debris enters the nozzle holes in the nozzle block. Do not use soap, as it can compromise the functionality of the nozzles if it enters the nozzle holes.

9.4 Spray Unit

Important: Do not use a high-pressure washer for external cleaning of the spray units. This can damage the nozzles and electronics. When using a water hose, avoid directing the stream straight into the nozzle outlet.

Spray fluid may accumulate on the nozzles after use. This should be cleaned with a gentle rinse using low pressure from a water hose.

If there are issues with the spray units, contact Kilter AS for support. Do not attempt to repair this unit on your own without approval from Kilter, as this will void the warranty.

9.4.1 Filter for Spray Unit

Each spray unit is equipped with a fine-mesh inlet filter to capture small particles. The filter is of type **250 mesh** and requires regular cleaning to maintain proper flow. Residual spray agents caused by inadequate cleaning of the spray system can lead to clogged filters. It is therefore crucial to inspect the filters' condition before use.

Cleaning Procedure:

If there is liquid in the tank, disconnect both hoses of the spray unit from the boom. Unscrew the filter cup. Remove the filter screen from the filter cup. Submerge it in soapy water and allow the soap to dissolve any residual spray agents. Rinse both the filter and the filter cup thoroughly with clean water.

In some cases, compressed air can be used to blow the filters clean instead of using soapy water. Regardless of the method, ensure the filter is rinsed in clean water as the final step.

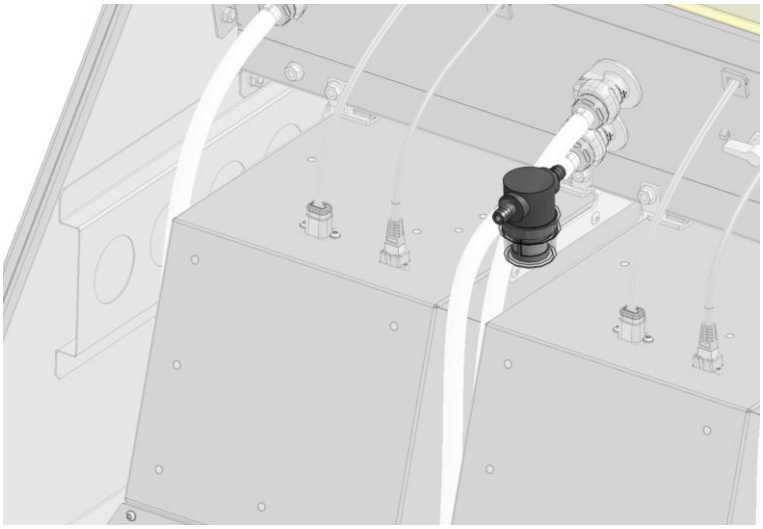


Figure 17 – Filter for Spray Unit

9.5 Suction Filter

Sugefilteret The suction filter is located at the front of the tank, beneath the left side cover, positioned in the fluid line before the pump (refer to Figure 12 for illustration)

The filter must be emptied and rinsed with clean water regularly, as needed. Ensure the filter is free from visible particles before reinserting it into the filter housing. Inspect the filter screen visually before each use. If the filter has been clogged and a deformations has

occured it should be swapped with a new filter, this is also a good indication that inspection and cleaning of the filter needs to be performed more often.

The filter is equipped with a magnet to capture metallic particles. Clean the magnet by wiping it off, blowing it clean with compressed air, or using tape to remove debris. Check and clean the filter, particularly before and after long-term storage of the machine..

Warning: Individuals with pacemakers should avoid handling magnets.

Warning: Wear safety goggles and gloves when handling large magnets. Avoid pinching fingers between magnets or letting them collide with other magnets or metallic objects, as collisions can cause magnets to crack.

Important: Strong magnetic fields can permanently damage items such as credit cards, hard drives, watches, and other electronic devices .

Ensure the filter screen is centered in the filter housing before tightening the lid. Misalignment can damage the filter when the lid is secured.

Important: If the filter is defective and its filtration capability is compromised, it must be replaced with a new filter before the machine is put into operation.

9.6 Maintenance Schedule

The machine requires maintenance at specified intervals. Some repairs and maintenance tasks can only be performed by service personnel authorized by Kilter. These tasks are marked as "Service Center" in the table below.

Before Each Start-Up

After Each Workday

Monthly Maintenance

Annual Maintenance (Minimum)

Functional Testing of Your Spraying Robot (Every Three Years)

9.7 Control Center

Errors related to the control center must be repaired by authorized service personnel. This is particularly important for situations involving opening the control center's cover. The interior of the control center contains exposed high-voltage points and other sensitive components.

Danger: Contact with high-voltage points can pose an immediate risk to life.

Danger: Contact with high-voltage points can pose an immediate risk to life.

It is strongly discouraged to connect your own PC to the control center's connection points for troubleshooting or software updates, as this may cause critical software errors.

Service and maintenance tasks that the user can perform include washing/cleaning the exterior of the control center and cleaning/replacing the air filter.

9.7.1 Air Filter

The control center has an air filter located at the air intake on the front of the robot. This must be cleaned as needed or every two weeks during the operating season.

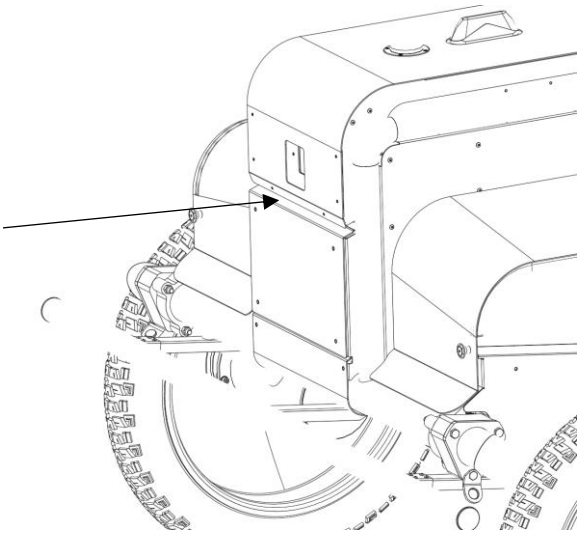
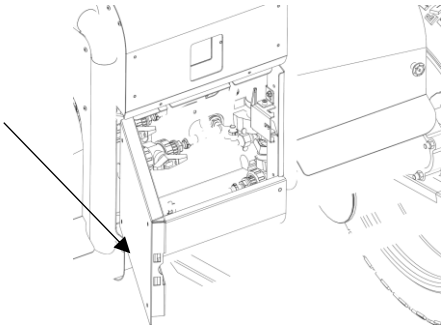


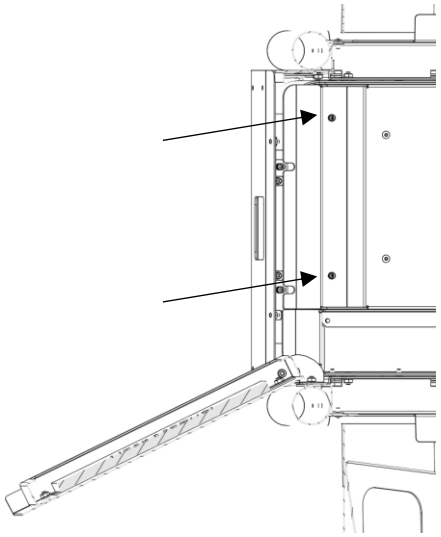
Figure 18 - Air Intake Between the Control Center and Front Door

Procedure for Cleaning the Air Filter

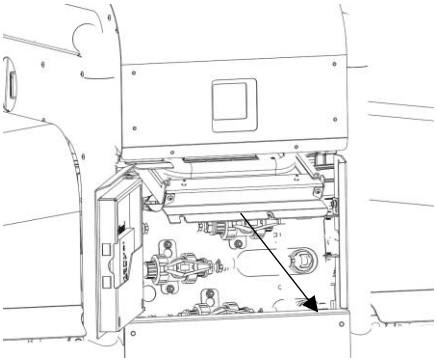
Step 1: Open the front door by operating the red lever located under the left side cover.



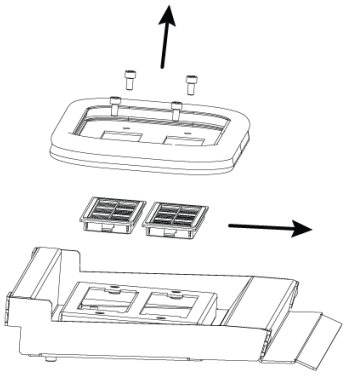
Step 2: Loosen the two screws at the bottom of the filter tray, underneath the control center.



Step 3: Tilt the filter tray downward and pull it out.



Step 4: Unscrew the gasket plate from the filter tray.



Step 5: Remove the two air filters. The filters can either be washed with lukewarm water or vacuumed. Ensure the filters are dry before reinserting them into the machine. Alternatively, the filters can be replaced with two new Xiaomi filters (SDLW04RR).

Step 6: Repeat steps 1–4 in reverse order to reinstall the filters and reinsert the filter tray into the machine..

The control center also has an internal filter at the rear air outlet, which prevents debris and dust from passively entering when the machine is not in use. Since this filter is located inside the control center, it should only be cleaned or replaced by service personnel. This filter does not require cleaning as frequently as the filters at the air intake.

9.8 Generator

CAUTION: Familiarize yourself with and adhere to the specific warnings in the generator's user manual regarding service and maintenance.

Note: Several of the generator's service and maintenance tasks require the generator to be removed from the machine. It may be practical to perform multiple service tasks simultaneously when the generator is removed.

9.8.1 Refueling the Generator

Refueling can be done with the generator mounted in the robot. Ensure the generator is turned off during the process.

Use 4-stroke alkylate gasoline/environmentally friendly gasoline or gasoline with ≥95 octane.

Open the generator’s fuel cap. Place the cap in a clean location to prevent dirt from contaminating the fuel tank during reassembly.

Pour gasoline into the generator’s tank. If the fuel canister includes a hose or funnel, use it to prevent spills. Stop refueling before the tank is completely full to allow the cap to be securely closed without overflow.

Screw the fuel cap back on securely.

Once refueling is complete, the generator can be restarted.

9.8.2 Oil Change

CAUTION: Used oil drained from the generator must be disposed of as hazardous waste at a recycling station.

Perform oil changes regularly as outlined in the generator's user manual.

Oil Change Procedure:

- Step 1: The generator must be removed from the machine to perform an oil change. Unscrew the four screws securing the generator baseplate to the machine.
- Step 2: Tilt the generator slightly upward at the front, then lift the generator and baseplate diagonally out of the machine. Use the generator's carrying handle for safe lifting.
- Step 3: Refer to the generator's user manual for the specific steps to change the oil.
- Step 4: Place the generator and baseplate back into the machine's right compartment. Tilt the rear end slightly downward to facilitate proper placement.

9.8.3 Cleaning the Generator's Air Filter

The air filter should be cleaned regularly as specified in the generator's user manual.

- Step 1: The generator must be removed from the machine for cleaning the air filter. Unscrew the four screws securing the generator baseplate to the machine.
- Step 2: Tilt the front of the generator slightly upward, then lift the generator and baseplate diagonally out of the machine using the carrying handle.
- Step 3: Refer to the generator's user manual for detailed cleaning instructions.
- Step 4: Place the generator and baseplate back into the machine's right compartment. Tilt the rear end slightly downward to ease the reinstallation process

9.8.4 Maintenance of the Generator's Spark Plug

- Regularly inspect and replace the spark plug as recommended in the generator's user manual.
- The spark plug can be inspected or replaced without removing the generator from the machine.
- Follow the procedures outlined in the generator's user manual.

9.8.5 Other Generator Maintenance and Service

For additional maintenance and service tasks such as checking/adjusting valve clearance, cleaning the combustion chamber, cleaning the fuel tank and filter or inspecting the fuel hose, please refer to the generator's manufacturer and user manual (picture below for reference).

9.9 Pump

Perform the internal rinse procedure described in Subchapter 9.3 after each spraying session to maintain the pump. If leaks occur or replacement parts are needed, contact your Kilter customer representative for further assistance.

9.10 Tank Strainer

Remove the tank strainer from the tank opening, empty it, and rinse it with clean water regularly or as needed. Ensure the strainer is free of visible particles before reinserting it into the tank opening.

9.11 Winter Storage

Procedures are under development.

9.12 National and Regional Inspection Regulations

9.13 Tires

9.14 Spare Parts List

10 Optional Equipment

10.1 External fuel tank

An external fuel tank can be connected to the fuel inlet on the generator. It consists of:

1. Mounting bracket
2. 5L fuel tank
3. Cap for external tank
4. Retention strap
5. Vent valve
6. Fuel hose
7. Fuel cap for the generator

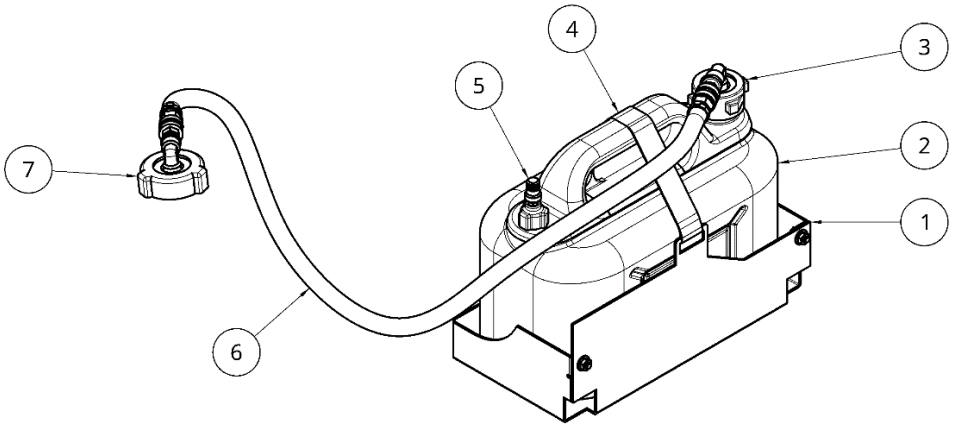


Figure 19 – Components of the External Fuel Tank

Important: The generator must contain fuel for the external tank to function properly.

Important: Ensure that the fuel hose does not get caught on anything when opening or closing the door with the fuel tank.

Danger: The vent valve must always have an air pocket, or fuel may leak from the tank. Never fill the tank beyond the 5-liter mark (see figure below). The fuel tank must always remain in a vertical position.

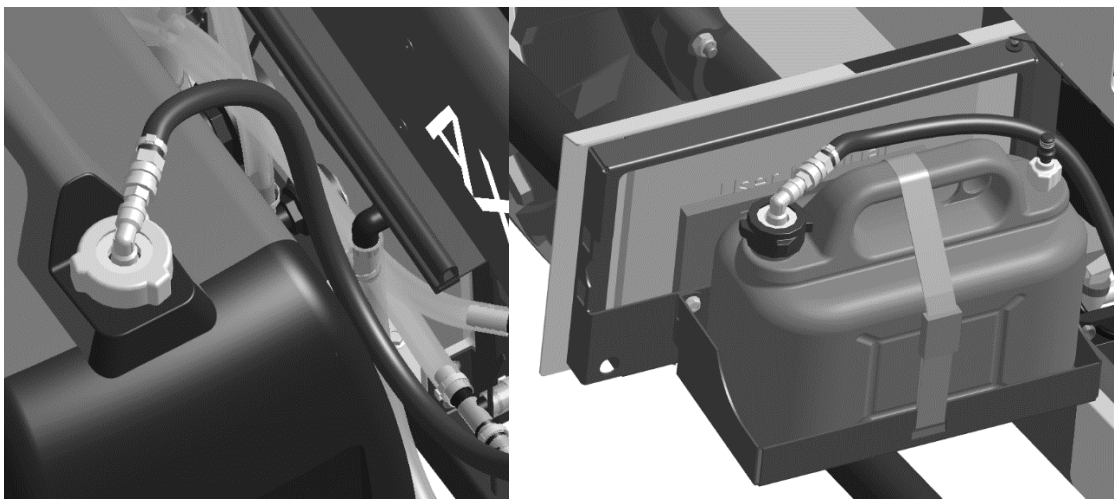
Warning: The generator's vent valve is located in the original cap. To avoid pressure buildup in the generator's tank, it must not be left with the alternative cap for extended periods without being connected to the external fuel tank.

CAUTION: The arrow on the generator (see figure below) indicates the recommended orientation for the generator cap and hose. If the hose is not oriented correctly, it may come into contact with the generator cover and sustain mechanical damage due to vibrations. To adjust the orientation, loosen the generator cap, rotate the hose connector, and tighten the cap again.

When the generator's fuel tank runs out of fuel, a vacuum is created that draws fuel from the external tank into the generator's tank. The volume displaced from the external tank is replaced with air through the vent valve. The vent valve also serves to release pressure buildup caused by temperature fluctuations.

Figure 20 – Warning Labels for the External Fuel Tank

During refueling, the external fuel tank can be replaced with a full one as long as there is fuel in the generator. Loosen the strap securing the external tank and disconnect the fuel hose. Replace the empty tank, secure the new one with the strap, and reconnect the fuel hose.



Figur 21 – External Fuel Tank on AX-1

11 Troubleshooting

11.1 Error Messages and Solutions

- Støtdemper Shock Absorber Error: Ensure nothing is obstructing the machine.
- Emergency Stop Activated: To restart the machine after an emergency stop, rotate the emergency stop button a quarter turn counterclockwise to reset it.
- Boom Sensor: The boom is likely in too low a position. Raise the boom manually via the app on the tablet. The boom can then operate autonomously again.
- Too Large an Angle to the Next Point During Autonomous Driving, Cannot Find the Next Point: Manually drive the machine to a point where it can be activated.
- Low Voltage: The robot may experience low voltage even if the generator is on. This indicates the machine has been working too hard. Let the machine rest with the generator running for a few minutes. Then attempt to resume work with the machine running at a slower speed.
- GPS Missing RTK: The GPS requires access to Real-Time Kinematic (RTK) positioning for the machine to operate autonomously. Allow the machine to remain stationary until the GPS regains the RTK signal. The machine will automatically resume work once the signal is restored. Alternatively, the machine can be operated manually via the Kilter Remote application until RTK is restored.

12 Clearing Blockages in the Fluid System

Blockages in the fluid system can occur for various reasons, such as debris or dried spray agent obstructing the flow, or improperly connected hoses. Below is a general procedure for troubleshooting and removing blockages:

- **Step 1**: Check that all spray units are properly connected as described in Section 4.4 Spray Unit.
- **Step 2:** Verify that all valves are in the correct position as described in Section 4.2.6 Valve Positions.
- **Step 3:** Check the spray pressure in the Kilter Remote application and the pressure gauge (see Figure 12 – Other Components of the Fluid System) to determine if the pressure readings indicate the location of the blockage.
- **Step 4:** Clean the suction filter of the fluid system as described in Section 9.5 Suction Filter.
- **Step 5:** Clean the filters of the spray units as described in Section 9.4.1 Filter for Spray Unit.
- **Step 6:** Perform a nozzle cleaning procedure in the Kilter Remote application.
- **Step 7:** If blockages persist in the spray system, contact your Kilter representative for further assistance.

12.1 Spray Liquid Does Not Circulate

This issue could result from one or more of the following causes:

- The tank is empty. Refill the tank with spray liquid.
- The pump is not drawing. Check in the Kilter Remote application that the pump is turned on.
- Clean the suction filter of the fluid system as described in *Suction Filter*.
- Verify that all spray units are properly connected as described in *Spray Unit*.
- Clean the filters of the spray units as described in *Filter for Spray Unit*.

- Verify that all valves are in the correct position as described in *Valve Positions*.
- Check the spray pressure in the Kilter Remote application and the pressure gauge to identify potential blockages.
- If the spray liquid still does not circulate, contact your Kilter representative for further assistance.

12.2 Pressure is not high enough

This issue could result from one or more of the following causes:

- There may be a leak in the spray system. If there is a leak, stop the pump immediately.
- The tank is empty. Refill the tank with spray liquid.
- The pump is not drawing. Check in the Kilter Remote application that the pump is turned on.
- Clean the suction filter of the fluid system as described in Section 9.5 Suction Filter.
- Verify that all spray units are properly connected as described in Section 4.4 Spray Unit.
- Verify that all valves are in the correct position as described in Section 4.2.6 Valve Positions.
- If the pressure remains low, contact your Kilter representative for further assistance.

12.3 Other Troubleshooting in the Field

- Nettbrett/mobil får ikke kontakt med roboten
    - Check if Wi-Fi is enabled on the tablet/mobile device.
    - Verify that the AX-1 is turned on and has power.
    - It may take up to 2 minutes after powering on the machine to establish a connection.
    - Ensure you have the correct username and password for logging into the Kilter Remote application.

- Generator Stops or Won't Start
    - Check the fuel level. Refer to the generator's user manual.
    - Ensure the choke is turned off after starting.

- Nozzles Are Spraying Excessively
    - Verify that the spray pressure is correct.
    - Check that all spray modules have hoses and cables connected to the correct ports.
    - Confirm in the Kilter Remote application that all spray modules have the correct status (green, not red) and proper numbering.

13 Technical data

13.1 General machine data

Machine Data

Length	2,2 m
Widtg	1,78 m – 2,15 m
Height	1,5 m
Spray Width	1,3 m
Net Weight	265 kg
Total Weight with Full Load	365 kg
Maximum Driving Speed	0,6 m/s

Tanks

Spray Tank	52L
Rinse and Dilution Tank	17 L
Clean Water Tank	15 L

Other Data

Minimum Charging Circuit	10 A
Wheel Motor Power Output	

Nozzles

Maximum Number of Spray Units	5 (6) units
Number of Nozzle Outlets per Unit	42 outlets
Nozzle Opening	1,0 mm

Generator

Modell	EU22i
Continuous Power Output	1800 W
Maximum Power Output	2200 W
Tank Size	3,6 L
Runtime at Max Continuous Load	3,2 timer
Fuel	Bensin

13.2 Operating Parameters

Operating Pressure Nozzles	0,95 Bar
Maximum System Pressure	4 Bar
Maximum Spraying Speed in Autonomous Driving	0,5 m/s

Working Height of Boom	150 – 600 mm
Consumption at 100% Weed Coverage	27,8 l /daa
Tank Capacity, Coverage per Tank at 100% Weed	1,87 daa
Approved Plant Crops	See website

13.2.1 Noise Level

The machine generates a noise level of **LWA = 80.5 dB(A)** during operation.

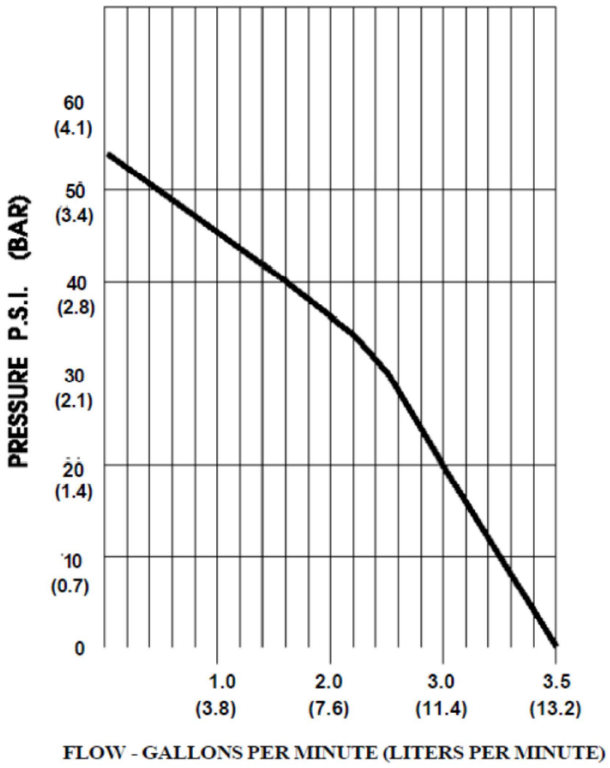
13.3 Specific Component Data

13.3.1 Pump

Type Shurflo 2066-773-515 24V.

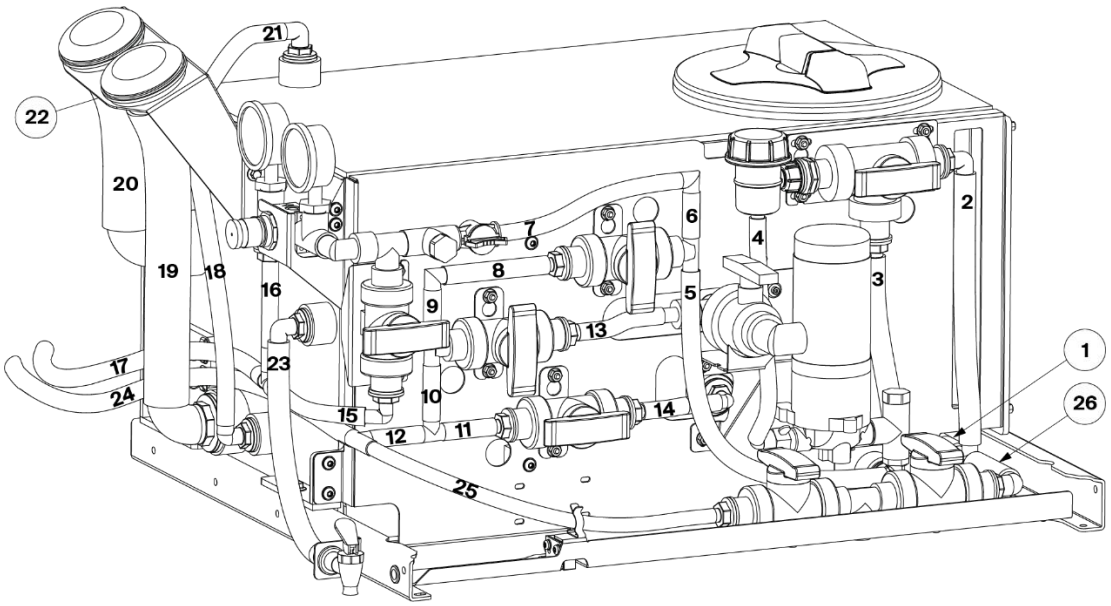
Tabell 1 Pumpeparametere

Pressure [Bar]	Flow Rate [L]	Current [A]	Voltage [V]
Open	13,2	2,8	24
0,7	12,9	4,0	24
1,4	12,1	4,8	24
2,1	8,7	5,5	24
2,8	6,0	5,8	24
3,44	2,3	6,5	24



13.3.2 Hoses

The figure below provides an overview of the hoses used in the tank unit. The hoses have a maximum operating pressure of 4 bar at 21°C.



Hose Numbers	Suction Side Hoses	Pressurized Hoses	Non-Pressurized Hoses	Maximum Pressure allowed at 21°C

1 – 4	x				4 bar
5-7		x			4 bar
8-17		x			4 bar
18-22			x		4 bar
24 - 25		x			4 bar
26		x			4 bar

13.3.3 Filters and Tank Strainer

Filter / Strainer	Location	Mesh Size	Model	Manufacturer
Tank Strainer	Spray Tank Filling		300315	ARAG
Suction Filter	Pump Inlet	200 mesh	309954	ARAG
Inline Filter	Spray Unit Inlet	250 mesh	LP-6B-PNC-E250 Caged	Pneuline supply
Air Filter Out to Control	Backside of Buteo		G4/EU4 8 mm	Sandler AG
Air Filter Into Control	Under Buteo		SDLW04RR	Xiaomi

14 Storage and Handling

14.1 Parking

- Maskinen The machine should be parked on a flat surface, as it may roll on its own if left on an incline. The machine has no active brakes when powered off.
- If parking on a flat surface is not possible, the wheels and/or the entire machine must be secured to prevent rolling.
    - The robot should never be parked on an incline greater than the recommended operating incline of 7°.
    - If the machine must be parked on an incline, it is recommended that the robot's right or left side faces downhill, as this provides more stability than having the front or rear facing downhill.
    - If the machine must be parked on an incline, ensure that it cannot pose a risk to life or health if, despite the above precautions, it begins to roll.
- The machine must be parked in a location where children and unauthorized persons cannot easily access it and come into contact with residual plant protection chemicals.
- plantevernmidler.

14.2 Transportation

14.2.1 Towing

- The machine must not be towed, as this may damage the machine's components.
- The robot's wheels should only roll when driven by the robot’s own motors.
- If the robot is towed or pushed, the motors will act as generators and produce a voltage that can damage the control panel.
- During all forms of transport, except self-transport, the wheels must not have ground contact.

14.2.2 Lifting the machine

Danger: Humans and animals must never be underneath the robot when it is in a lifted position. Being under the robot may result in injury or, in the worst case, death.

- If the machine, or parts of it, need to be lifted slightly off the ground (e.g., with a jack), the contact point with the machine must be underneath the motor compartment (*insert image here*).
- The robot can also be lifted using lifting straps. The straps must be attached to the four designated points on the frame (*insert image here*).

14.3 Storage

«By "storage," long-term parking is meant. See the "Parking" section for recommendations on parking.

14.3.1 Winter Storage

For winter storage, all hoses and components in the spraying system should be emptied.

15 Index

16 Warranty

Declaration of Conformity

Machine Description
Product: Autonomous Precision Spraying Robot
Function: Precision spraying of weeds using plant protection products
Model: AX-1

Kilter AS, represented by Managing Director Anders Brevik, hereby declares that the machine described in this document complies with the relevant requirements of the following directives and standards:

European Parliament and Council Directives

- 2006/42/EC: Machinery Directive
- 2014/30/EU: Low Voltage Directive

Harmonized Standards:

- EN ISO 12100:2012
- ISO 4254-1:2013
- ISO 4254-6:2009
- ISO 16119-1:2013
- ISO 16119-2:2013

Noise level measurement has been performed by the following notified body:
RISE SMP Swedish Machinery Testing AB, Division of Testing, Box 4053, SE-904 03 UMEÅ, Sweden

Authorized Representative for Technical Documentation Compilation

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Anders Brevik CEO

Langhus 19.04.2023

Notes: