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HWM

1500W-3000W

Handheld Laser Welding Machine

Maintenance Manual

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www.senfenglaser.com

PREFACE

Thanks for purchasing our products. SENFENG will wholeheartedly provide you with perfect service.

This high-tech product, integrating laser, mechanism and electricity, is completely developed and manufactured by SENFENG. It has compact structure, high precision, long life span, beautiful appearance and excellent cost performance. Please read this manual patiently before operating the handheld laser welding machine.

Please carefully understand the basic knowledge of the machine's principles, structure, performance, daily maintenance and safety, and master the correct operating procedures. Please develop the ability to handle failures in emergency situations to ensure the safety of people and machines.

If you have any questions, please contact our company in time. Do not operate the machine until the problem is resolved.

Contents

1 Safety

Failure to adhere to basic safety precautions during equipment operation, inspection, and maintenance can result in malfunctions. Before proceeding with any operation, it is crucial to read and understand the safety precautions outlined in this manual. Unauthorized operation should be strictly avoided to prevent potential harm or damage to workers and the equipment. The safety precautions in this manual are categorized for easy comprehension.

 Danger	Ignoring it may result in serious injury or death.
 Warning	Ignoring it may result in moderate injury or death.
 Caution	Ignoring it may result in minor injury or performance damage.
 Attention	Ignoring it may result in performance damage or a shortened lifespan of the machine tool.

The terms "safety," "safely," and "security" used in this manual do not imply the absence of any danger. Depending on the conditions, methods, and environment, any step can be considered "unsafe." Therefore, the methods and steps provided should be taken as general guidelines and may vary based on the specific circumstances.

1.1 Laser Product Safety Classification

Laser products can be classified into four categories based on safety and laser power according to the Accessible Emission Limit (AEL) table (refer to GB7247-2001):

1. Class 1: Laser products are inherently safe and will not exceed the maximum permissible exposure under any circumstances.

2. Class 2: Laser products emit visible light and are typically safe due to the natural aversion response of the eyes to light.

3. Class 3A: Laser products that are harmful when directly observed with optical instruments.

4. Class 3B: Laser products that can potentially cause eye damage when directly exposed.

5. Class 4: Laser products that are hazardous, whether through direct exposure or exposure to scattered or reflected laser beams.

1.2 Dangers during Equipment Operation

1. Mechanical hazards

   Mechanical moving parts may be in danger of collision or extrusion due to human negligence or component failure.

2. Thermal hazards

During laser welding, a significant amount of heat is generated. If there are flammable organic solvents or particles in the surrounding environment, there is a risk of fire.

3. Combustion hazards

Fiber laser beams carry intense heat energy and can ignite flammable materials like wood, paper, and clothing. It is crucial to have a fire extinguisher nearby the machine tool.

Avoid storing or leaving flammable substances in the laser control area, especially when working with materials that have a low ignition point.

4. Radiation hazards

1) Direct, reflected, or scattered laser beams can cause severe burns to the eyes and skin.
2) The red indicator light of the laser source should never be stared at as it can result in eye injuries.
3) Laser radiation can also pose a risk of fire and explosion.
4) Danger caused by ionizing radiation.

1.3 Safe Operation

1.3.1 Basic Rules

⚠ Warning	Before operating, please read and understand this manual. Ignoring these instructions may result in serious personal injury.

1. Prior to reading this manual, do not turn on any power sources or switches. Follow the steps described in this manual to operate the equipment and strictly avoid operating any unspecified items. Anything not mentioned in it should generally be considered "not allowed."
2. Identify potential hazards and take measures to avoid them.
3. During the operation, avoid making subjective judgments without proper assessment, as relying on incorrect conclusions to control the equipment can lead to hazardous accidents.
4. If you have any questions about this manual or the equipment operation steps, please consult your monitoring personnel or contact us for assistance.

Warning	This equipment is to be operated only by experienced personnel with safety knowledge and under the supervision of monitoring personnel. Unauthorized individuals must not operate the equipment. Disregarding this warning may cause severe personal injury.

This equipment should only be operated by personnel who have received comprehensive equipment safety training and have been authorized by monitoring personnel. Unauthorized individuals are strictly prohibited from operating the equipment.

1. Do not operate the equipment while under the influence of any medication, sedatives, or alcohol.
2. Repairs of optical components and electronic devices should be carried out by qualified electrical engineers.

Warning	This manual should be stored in a designated location near the machine for easy access and reference.

1. Please designate a responsible person to manage this manual to prevent loss or damage.
2. In case of loss or damage to this manual, please provide the equipment's model and serial number and contact our company for a paid replacement.

Warning

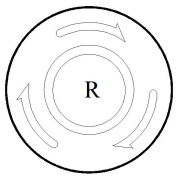
When there are any signs of personal injury or machine malfunction, promptly press the EMERGENCY STOP button.

Operators must be familiar with the function and location of the EMERGENCY STOP button to ensure prompt activation in case of an emergency.

Operators must be familiar with the location and operational procedures of the EMERGENCY STOP buttons on the laser welding machine.

To prevent hazards in case of an emergency, if it is necessary for workers other than the operators to press the EMERGENCY STOP button, your company should establish clear measures to address emergency situations in advance.

EMERGENCY STOP



Warning

To avoid serious personal injuries while operating machine tools, please wear appropriate clothing.

1. When operating equipment, it is important to minimize skin exposure by wearing appropriate clothing such as long pants and suitable garments, with high-temperature resistant protective clothing being the best choice.

2. Wear dedicated safety goggles to protect against potential harm from fiber lasers.

3. Tie up long hair to prevent obstruction of vision and mis-operation.

4. Wear safety shoes to protect your feet.

1.3.2 Equipment Control

1. Appointment of equipment monitoring personnel

The equipment monitoring personnel should have knowledge and experience in machinery, optics (especially laser beams), and electronic circuits (particularly high-voltage discharges).

The monitoring personnel have the following responsibilities.

1) Prepare and implement relevant plans and measures to prevent potential harm caused by mechanical movement and laser beams.

2) Set up and manage the equipment control area and control the operation buttons.

3) Maintain equipment inspections, repairs, and service records.

4) Conduct safety education regarding the equipment.

2. Appoint equipment operators.

The operators should possess basic knowledge of hazard handling, mechanics, lasers, and hazardous voltages. Additionally, they should undergo comprehensive training in equipment operations.

3. Safe education

Warning	Unauthorized personnel without proper safety training are strictly prohibited from entering the laser control area, as it may result in severe personal injuries.

Safety training should include:

1) Laser welding characteristics, principles of motion, hazards to individuals, preventive measures, and relevant regulations.

2) Laser beam characteristics, hazards to individuals, preventive measures, and relevant regulations.

3) Hazards associated with high-voltage circuits and preventive measures for handling power supplies.

4) Safety precautions during laser welding, prevention of hazardous operations by other workers.

5) Troubleshooting and hazard elimination during emergency situations and equipment failures.

4. Health monitoring

Workshop regulations should require regular medical examinations for equipment monitors and operators, in accordance with local laws and practical considerations.

5. Equipment failure recording

Maintenance staff must document equipment failures, perform repairs as specified, and inform equipment monitors who are responsible for maintaining the failure records.

6. Inspections before starting operation

To minimize the risk of machine failures and accidents, equipment monitors should conduct pre-operation inspections.

Warning

1.4 Security Settings

1.4.1 Control Area Settings

Warning

Equipment monitors should oversee the laser control area and strictly prohibit entry by any personnel other than the laser operators.

1. The equipment control area includes the following designated locations:

1) The motion paths where the operator uses the welding gun and the areas where the laser beam is present.

2) The installation of the laser source, the point of laser beam emission, and the areas through which the optical path passes.

3) The areas that may be exposed to laser beam radiation due to potential motion control failures.

2. When establishing the equipment control area, ensure the following conditions:

1) Mark the area with yellow lines to distinguish it as the equipment control area.

2) Prepare a signage board or panel to describe the status of the area.

3) Prepare a signage board or panel to indicate the names of the equipment monitors and operators.

4) In welding area, prepare a safety board with safety precautions.

5) Install safety protective barriers (doors, walls, screens, fences, etc.) to prevent unauthorized personnel from entering. If necessary, install an interlocking switch door.

3. Safety enclosures and interlocking switch doors should be prepared by the user:

1) Prepare a suitable fire extinguisher.

2) Install ventilation, dust collection and exhaust equipment as well as deodorant.

Warning	The atmospheric emission of smoke and dust system should comply with local laws and regulations. It is strictly prohibited to store ignition sources or leave flammable materials within the laser control area.

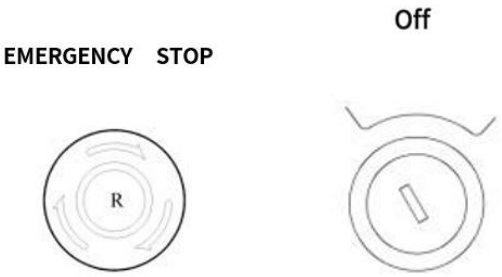
1.4.2 Safety Equipment

To ensure user safety, the equipment is equipped with safety devices. However, some of these devices have limited functions and may not provide continuous protection to operators. It is crucial to understand the limitations and initial positions of these devices and prioritize potential hazards that may not be blocked by the protective measures. Users are responsible for preparing peripheral enclosures and other protective setups.

Items	Quantity	Locations
EMERGENCY STOP button	2	Located on the welding machine control panel
Main circuit breaker	1	On the right side of the laser welding machine
Power on/off key switch	1	On the welding machine control panel
Alarm display		Touchscreen
Tri-color warning light	1	Located on the operation panel of the welding machine

Detailed description of the functions:

1. EMERGENCY STOP button



Pressing this button immediately puts the equipment into an emergency stop state.

2. Main circuit breaker

If the electrical circuit exceeds the allowed range, the main circuit breaker will automatically cut off the power supply to protect the electrical components in case of a fault.

3. Power on/off key switch

This switch is used to turn on/off the power supply of the laser welding machine. Insert the key and rotate it to the "On" position to enable the circuit and activate the power control button. Rotate it to the "Off" position, remove the key, and the power supply is turned off, rendering all operations related to the robot and laser welding machine invalid.

This key should be controlled by authorized personnel or equipment monitors.

Warning

4. Alarm display

Alarm information will be displayed on the CNC system screen if there are any malfunctions with the laser welding machine.

Warning	Maintenance personnel should identify and address mechanical malfunctions indicated by the alarm information before proceeding with the specified steps to restore operation.

5. Tri-color warning light

Red indicates an alarm state, indicating a malfunction in the laser welding machine. Yellow indicates normal operation, while green indicates a standby state.

1.5 Safety Precautions

Warning	Both the machine tool and laser source are equipped with lethal voltages. Special attention is required, and operation should be carried out by qualified electrical engineers.
	Do not touch any area marked with this warning sign, and avoid operating switches or keys with wet or dirty hands!

1.5.1 Overview

1. In case of a power failure, immediately cut off the main circuit breaker.
2. Apply moderate force when operating the control panel.
3. Keep all tools and materials clean and organized at all times. Please follow these guidelines:

1) Place them in areas where they are less likely to fall.
2) When vertically storing tools or components, ensure there are safety measures in place to prevent them from dropping.
3) When stacking any items, take safety measures to prevent them from toppling over.

1.5.2 Precautions during Installation

1. Cranes and forklifts must be operated by qualified personnel, and other individuals are strictly prohibited from operating them.
2. Under no circumstances, for any reason, should any part of the body be positioned beneath a crane.
3. Electrical wiring connections should be handled by qualified personnel, and to prevent electric shock, ensure that grounding work has been carried out. Before completing the grounding process, the main circuit breaker of the facility must be switched off and should not be switched on until the work is finished.

4. During electrical wiring connections, warning signs must be displayed to alert others that the wiring connection is in progress.
5. Contact our company for equipment repositioning and installation.
6. When multiple individuals are working simultaneously, a designated supervisor should be appointed to give instructions.
7. When laying cables on the ground, use a secure and sturdy shielding protection cover to fully enclose the cables and prevent damage.
8. When using lifting equipment, ensure that steel wire ropes and lifting devices are used at designated locations, and they must be capable of fully supporting the weight of the laser welding machine.
9. Equipment leveling should be performed according to the adjustment method provided. It is strictly prohibited to use any other methods, such as prying with a steel bar, for operation.
10. After equipment installation, perform the following checks before turning on the power:

1) Make sure all wire connections and water addition to the water cooler are complete.
2) Verify proper installation and secure fastening of all pipelines.
3) Ensure all screws and plugs are securely and reliably connected.
4) Wipe off any water and dust on the equipment.
5) Ensure there are no leaks of water or oil around the equipment.

1.5.3 Precautions before Operation



Warning To prevent electric leakage and shock, thoroughly inspect all cable and wire protective covers for any damage or signs of wear before powering on. If any issues are found, promptly contact a qualified electrician for repairs.

To prevent equipment failures, the operator should check the following before starting operations:

1. Ensure there are no obstacles in the work area or on the movable parts of the equipment.
2. Check the ground for water and oil to prevent slipping.
3. When turning on/off the power, strictly follow the steps outlined in this manual.
4. Check the functionality of all protective devices to ensure they are free from faults and damage.
5. After turning on the power, perform the following checks:

1) Ensure that the display does not show any error messages or alarms.
2) Verify that there are no abnormal sounds coming from the laser welder.
3) Verify that the cooling fans in the electrical cabinet are rotating properly.

6. Ensure that no flammable substances are left in the laser control area.

1.5.4 Precautions during Operation

1. It is strictly prohibited to tamper with, remove, or reposition any safety devices or interlock mechanisms.
2. During operation, adhere to the following guidelines:

1) Do not open the safety covers of the equipment.
2) Do not enter the movable parts of the equipment.
3) While the equipment is running, do not perform any tasks such as re-tightening, measuring workpieces, or cleaning around the equipment.
4) Personnel other than operators are prohibited from approaching the laser welding machine when it is running.

3. During the alignment process of the external optical path, adhere to the following guidelines:

1) Do not place any part of your body under the welding head.
2) Do not expose the human body to laser beam irradiation.
3) Avoid direct viewing or contact with laser indicator red light, laser beam, or its scattered light, as it may cause severe personal injury, including blindness and burns.
4) When performing laser welding, wear designated protective clothing and goggles to prevent serious personal injury.
5) Prior to operation, provide ventilation, dust collection, and exhaust devices for smoke and gases. Otherwise, lung function may be severely affected.

4. If the equipment unexpectedly stops during operation, identify the cause of the malfunction and know the steps to resume operation. Do not restart without understanding the issue and recovery process.

1) Do not touch the material directly with your hands after welding to prevent injuries caused by burrs or heat.
2) Do not wear gloves when operating any switches, keys or buttons.
3) Do not leave any tools or parts on the laser welder, on the workbench or in the surrounding areas to avoid malfunction, injury to workers or movement of the processing position.
4) During operation, please do not lean any part of your body against the laser welder to avoid contact with switches or keys, which may cause malfunction.
5) If the laser welder do not operate normally, an alarm message is displayed on the screen, or there are any signs of failure, please notify equipment monitoring personnel and maintenance personnel immediately.

1.5.5 Precautions during Maintenance

1. The main power supply to the equipment must be turned off before starting repairs.
2. Maintenance work must be performed by qualified personnel, especially electrical maintenance work, which must be performed by personnel with operating certificates.
3. Both the laser source and the control unit have lethal voltages. Contact with these parts will cause serious accidents. Before inspecting these units, make sure the

power is turned off and wait more than five minutes before opening the door (refer to the laser source manual for details).

4. In order to prevent unauthorized person from turning on the main power or accidentally touching the operation panel, a warning sign must be hung in an obvious position, indicating "Under maintenance, do not touch!".
5. Do not remove or modify any limit switch or proximity switch without authorization from our company.
6. Do not modify the control circuit to avoid malfunction of the laser welding machine, resulting in personal injury.
7. When replacing electronic components (including lights, fuses or mechanical parts), parts provided or designated by our company must be used.
8. When working at high altitudes, to ensure personnel safety, strong ladders and pedals must be used, and safety helmets should be worn.
9. If the welding machine guard is temporarily removed for repairs, return it to its original position after the repairs.
10. When cleaning laser welders and surrounding equipment, all machine movements must be stopped, the power must be turned off, and warning signs must be hung.
11. Do not use an air gun when cleaning the equipment to avoid causing welding debris and iron slag to splash, resulting in personal injury.
12. Gloves must be worn when cleaning welding debris and iron slag.
13. Comply with the regular inspection items described in this manual.

2 Maintenance

2.1 Overview

To ensure the normal use of the laser welders, routine maintenance must be carried out. Since the equipment is composed of high-precision components, special care must be taken during daily maintenance. Operating procedures must be strictly followed, and maintenance must be performed by dedicated personnel. Do not perform rough operations to avoid damaging components. Operation and maintenance personnel must undergo special training and be approved by the safety administrator before they can work.

Operators of laser welders, as well as personnel near lasers during operation, should wear suitable laser safety goggles. Adequate indoor lighting is necessary within the goggle-wearing area to ensure smooth operation.

To optimize equipment usage and maintenance, it is crucial to understand the fundamentals of daily maintenance and adhere to the correct maintenance protocols.

2.2 Maintenance Cycle

1. The inspection and maintenance cycles for the welding gun, laser source and water chiller should be conducted according to their respective user manuals.
2. For machine tools, an initial inspection should be performed after 24 hours of first-time use, followed by another inspection after 100 hours. Subsequently, a

maintenance check should be conducted every six months, and then every six months to one year thereafter, depending on the specific requirements of the customer.

2.3 Daily Maintenance

1. Before powering on the equipment each day, carefully inspect the laser source, water chiller, and check for any water and pipeline leaks.
2. Check the laser welding machine for any damages or interferences.
3. Inspect the buttons of the laser welding machine for any signs of damage.
4. Check the status button for laser readiness for any signs of damage (check indicator lights). Ensure that the emergency stop buttons for the laser welding machine are functioning properly.
5. Check whether the gas circuit is normal
6. After completing the work, promptly clean up welding waste, sweep the work area, and maintain a neat and clean workspace. Also, ensure the equipment is cleaned, with no stains or debris in any parts. Do not leave any clutter in any part of the equipment.
7. At the end of each day's work, follow the shutdown procedure to power off the equipment. Then, turn off the main power supply for the laser welding machine.

2.4 Runtime Maintenance

Before operation, check the laser welding machine according to the daily inspection requirements. If there are any unusual sounds, stop the machine

immediately for inspection. After operation, follow the shutdown procedure, clean the work surface and its surroundings, and avoid placing unrelated items on the workbench or control panel.

1. The slag at the mouth of the welding gun must be cleaned every day and the contamination on the protective lens surface must be checked.
2. Check the cooling water level inside the laser source every week. If it is insufficient, add water in time.
3. Check the contamination on the surface of the focusing lens half a month. Clean optical lenses promptly to ensure their service life.
4. Check the filter in the air circuit once a month and remove accumulated water and debris in it in a timely manner.
5. Regularly check whether the external cables are scratched and whether the line interfaces in the distribution cabinet are loose.

3 Long-term Maintenance

3.1 Repair and Maintenance of Water and Gas System

The water system of a laser welding machine has two parts:

1) Part 1: Cooling water from the chiller unit enters the laser source, cools the laser components through an internal heat exchanger, and then returns to the chiller unit.

2) Part 2: Cooling water is used to cool the welding head of the optical system.

1. Check for any damage or blockage in the water circulation system caused by animal bites, item compression, collisions, or other factors.
2. Inspect the aging condition of the water circulation pipes and check for any water leakage at connections.
3. The gas circuit system of the handheld laser welding machine provides protective gas for welding, including high-purity argon and high-purity nitrogen.
4. Check the gas handling components (pressure regulator, solenoid valve, etc.) for any damage or gas leaks.
5. Inspect the gas pipelines for any damage or blockage caused by animal bites, item compression, collisions, or other factors.

3.2 Water Chiller Maintenance

1. Performance introduction

---Flow rate: minimum 3.5L/min, maximum 13L/min.

---Refrigerating capacity: 14483Btu/h.

---The pressure difference between inlet and outlet water: at least 3kgf/cm2 or more.

---Temperature control capability: within ±10°.

---Cooling water: high-quality purified water, distilled water or deionized water. Replace cooling water regularly (every 30 days)

---Valves and pipes: All are stainless steel or high-pressure hoses. Galvanized materials cannot be used. Use stainless steel clamps for pipe joints.

---External water pipe of laser source: pressure-resistant rubber pipe with an inner

diameter of 6mm and an outer diameter of 8mm or more. Plastic (PVC) pipe, stainless steel pipe, and copper pipe are also available. If the length of the chiller pipe exceeds 10 meters, the diameter of the pipe must be increased to ensure the pressure difference required by the laser source. The specifications of tubes may very according to different lasers.

---Cooling water pipe of external laser path: PU pipe with pressure resistance of not less than 6kgf/cm2. Pay attention to the seals at the pipe joints.

---Filter: The filter hole diameter is 100um, preferably transparent plastic. The filter element added between the chiller and the laser source must use the standard filter element required by the manufacturer.

2. Inspection and replacement of cooling water:

1) Loosen the hose clamp, disconnect the water hose, and move the chiller to a suitable location.

2) Open the drain valve of the chiller (located at its bottom) to drain the water from the tank.

3) Check for any debris and floating microorganisms in the water tank, and clean its inner walls thoroughly.

4) Close the drain valve and fill the tank with purified water. Pay attention to the water level gauge and fill the water up to 85%-95% of the total capacity of the tank.

5) Place the chiller back in its original position, connect the water hose, and check for any water leaks.

3. Machine inspection:

Regular maintenance is essential for the chiller unit to ensure proper operation. In case of malfunctions, seek professional repair services and avoid unauthorized disassembly.

1) Regularly clean the heat dissipation fins by brushing them carefully and then use compressed air to blow them clean.
2) Regularly clean the condenser to remove dust.
3) Regularly check the water level in the tank of the chiller unit. If the level is too low, add purified water or deionized water promptly.
4) Regularly inspect the electrical wiring terminals and remove dust.
5) Regularly check water system connections for leaks and inspect pipelines for signs of aging. Replace components if any leaks are found.
6) Regularly check the water quality in the water tank of the chiller. If its quality is poor, and the transparency decreases, drain the water in time and replace it with new cooling water.
7) Regularly clean and replace the filter as needed. Use the manufacturer-approved standard filter for replacements.

3.3 Repair and Maintenance of Electrical Connections

1. Check if the main power circuit breaker, individual power breakers, and emergency stop breakers are responsive.
2. Verify the correct wiring of the laser machine's power supply. The workshop's 380VAC power should be connected to the corresponding ports (input) of the main power circuit breaker QF0.
3. Check that the main power circuit breaker and individual power breakers (such as for the host machine, laser source, air compressor, etc.) meet the specified capacity indicated.
4. Ensure that the wire diameter of the power cord, ground wire, and neutral wire is not smaller than the required wire diameter specified for the machine.
5. Verify that the ground wire of the power cord is properly connected.
6. Inspect all high-voltage wire terminals, especially the input and output points of the power transformer, for reliability and firmness. Ensure that all plugs and sockets are securely connected.
7. Check the stability of the power supply voltage and maintain a clean, tidy, and well-ventilated electrical cabinet for the laser welding system. Inspect the integrity and safety of all circuit components.

3.4 Inspection and Cleaning of Optical System

1. Precautions

1) Do not touch the surface of optical lenses (protective lenses, focusing lenses, etc.) directly with your hands, as this may cause scratches on them. Oil stains or dust on the lens surface will seriously affect its use and should be cleaned in time.
2) It is strictly forbidden to use water, detergent, etc. to clean optical lenses. Because that will cause damage to the surface of the lens coated with a special film.
3) Do not place the lens in a dark and humid place, as that will cause the lens surface to age.
4) The surface of the lens must be clean. If there is dust, dirt, or water vapor, it will easily absorb laser light and cause damage to the lens coating, thereby affecting the quality of the laser beam, or even no laser beam will be generated.
5) If the lens is damaged, please replace it in time.
6) When installing or replacing the protective lens or focusing lens, do not use too much pressure, otherwise it will cause the lens to deform, thus affecting the quality of the beam.

2. Installation and replacement of optical lenses

1) Before installation, make sure to wear clean clothes and clean your hands with soap or dish soap. It is strictly forbidden to touch the upper and lower surfaces of the lens with any part of your hands. Take the lens from the side and do not touch its coating surface directly.
2) When assembling the lens, do not blow on the lens with your mouth. The lens should be placed stably on a clean table with a few pieces of special lens paper underneath. Be as careful as possible when removing the lens to prevent collisions and falls, and do not apply any force to its coated surface. The lens holder should be clean. Use a

clean air gun to clean the dust and dirt in the holder. Then, gently place the lens into the holder.

3) After the lens is installed on the holder, do not use too much force to fix the lens to avoid its deformation and affecting the quality of the beam.

4) Precautions when replacing optical lenses:

- Be very careful when taking the lenses out of the box to prevent collisions.
- Do not apply any pressure to the lenses while the wrapper is still closed.
- When removing the reflector and focusing lens from the box, wear clean gloves and handle them from the side of the lens.
- When removing the wrapping paper from the lens, please avoid dust contamination.
- After taking out the lens, use a spray gun to clean the dust on the lens surface, and then place it on the special optical lens paper.
- Clean the dust and dirt on the lens support frame and fixing frame to avoid other foreign objects falling on the lens during assembly.
- When installing the lens on the holder, do not use excessive force to avoid deformation.
- After the lens assembly is completed, use a clean air gun to remove dust and foreign matter on the lens again.

3. Steps to clean lenses

1) Steps to clean the lens with lens paper:

a) Use a blower to blow off the dust on the lens surface.

b) Use lens paper dipped in alcohol to clean the surface of the lens. Place the lens paper flat on the surface of the lens, add 2 to 3 drops of high-purity alcohol or high-purity acetone, and slowly pull out the paper horizontally toward the operator. Repeat the above steps several times until the lens surface is clean

c) If the lens surface is very dirty, fold the paper in half 2 to 3 times and repeat the above steps until the lens surface is clean.

Note: Do not drag dry paper directly on the lens surface.

2) Steps to clean lenses with cotton swabs:

a) Use a spray gun to blow off the dust on the lens

b) Use a clean cotton swab to remove dirt. Use a new cotton swab dipped in high-purity alcohol or acetone to move in a circular motion from the center of the lens to wipe it. After that, replace with another clean cotton swab and repeat the above operations until the lens is clean.

c) Wipe the lens with a clean cloth to remove any traces on its surface. Be careful not to scratch its surface.

d) Take the cleaned lens to a well-lit place and observe it. If the reflection of the lens is good, it means it has been cleaned. If it is not good, continue to clean the lens. Place the cleaned lens on the lens holder as described above.

Note: It is forbidden to operate with used cotton swabs.

4. Storage of optical lenses

1) Proper storage can keep the quality of the lenses intact.

2) The storage environment temperature is 10~30°C. Do not put the lens into a freezer or similar environment, otherwise condensation and frost will easily damage the

lens when taken out. The temperature of the storage environment should not be greater than 30°C, otherwise it will affect the coating on the lens surface.

3) Store the lens in the box and place it in a non-vibrating environment, otherwise it will easily deform and affect its performance.

3.5 Repair and Maintenance of Laser Source and Its Optical Paths

Regular laser source maintenance

1. Maintain the laser source according to its user manual.
2. Check the power cord and ensure proper grounding of the laser source’s casing. Before powering on, use a multimeter in continuity mode to test the effective grounding of the casing to earth (PE yellow-green wire).
3. Ensure the laser source control lines and voltages meet the product's requirements to prevent irreversible damage. Before powering on, check if the voltage signals comply with specifications.
4. **Protect the optical fiber and output head from bending or excessive force. They are fragile components that require careful handling.**
5. **Pay attention to the dust protection of the lens on the optic output head of the laser source. If there is dust, please clean it following the lens cleaning procedures. (a. Use anhydrous ethanol with a purity of 99.9% or higher; b. Use lint-free cotton swabs, do not use regular cotton swabs as they may leave lint and cause secondary contamination of the lens).**
6. Power on/off sequence

1) Power-on sequence

Turn on the main power supply - turn on the emergency stop switch - turn on the electric lock.

2) Power-off sequence

Turn off the electric lock - turn off the emergency stop switch - turn off the main power supply

7. Other precautions:

Ensure proper functionality of the water, gas, and electrical circuits during laser source operation. If any issues arise, power off the equipment and investigate the cause.

8. If laser source malfunctions occur, document the time, symptoms, and system status. Investigate the cause and reach out to our staff if necessary.

9. During extended laser source usage, clean cooling water pipelines, maintain laser source cleanliness, and regularly replace chiller cooling water.

4 Maintenance during Long-term Storage

When the laser welding machine are not used for a long period, please cover the welding torch with a dust cap, drain the water from the water chiller and laser source, and regularly clean and inspect the equipment.

4.1 Winter Maintenance of Water Chiller

1. To protect the laser equipment and prevent avoidable damage, please adhere to the following guidelines when using the equipment.

1) Install air conditioning or heating facilities to maintain the ambient temperature at around 10°C.

2) Run the refrigerator 24 hours a day because water will not freeze when it is flowing. (Ensure the factory has uninterrupted power supply 24 hours a day)

3) Add ethylene glycol antifreeze to the water cooling system. The freezing point of the solution varies with the concentration of ethylene glycol in it.

Comparison table of concentration and freezing point of ethylene glycol antifreeze	
Ethylene glycol content (%)	Freezing point (°C)
26	-10
32	-15
37	-20
40	-25
45	-30
50	-35

2. Recommended: Use Clariant's Antifrogen N antifreeze in a 3:7 ratio (3 parts antifreeze, 7 parts water). This mixture can resist freezing down to -20°C.

3. If the ambient temperature around the laser source is between 10°C and 40°C, no antifreeze is necessary. In summer, drain the antifreeze from the water chiller and refill it with distilled water.
4. Before starting the equipment in a cold environment, check the water status.
5. When the equipment is not in use for a long time or during power outages, it is crucial to drain the water from the refrigeration system's water tank and the laser source. (For holiday shutdowns, ensure proper frost protection and drainage of the equipment.)
6. Drainage method

1) Turn off the equipment and open the drain valve at the back of the refrigeration system to empty the water tank.
2) Remove the filter element inside the refrigeration system and drain the water. Also, unscrew the drain screw below the water pump to empty it.
3) Disconnect the water pipe at the back of the water tank, making sure to mark its position. Connect a 0.2 MPa (2 kg) gas source to one end of the water pipe (ϕ12) to drain the water from the laser source. (Low-temperature area)
4) Connect a 0.2 MPa (2 kg) gas source to one end of the water pipe (ϕ8) to drain the water from the fiber optic head. (High-temperature area)

Note: Excessive gas pressure for drainage can damage the laser source. High concentration of antifreeze can increase water circulation resistance.

Special Reminder: If the customer fails to follow our antifreeze instructions strictly, any

resulting losses and repair costs will be the customer's responsibility. Please ensure timely and proper antifreeze measures.

5 Equipment Maintenance

5.1 Purpose

The goal of equipment maintenance is to ensure its optimal condition, meet production requirements, and maintain cleanliness, lubrication, and safety.

5.2 Range

It is suitable for maintenance of SENFENG laser welding equipment.

5.3 Requirements

5.3.1 First-level Maintenance

Operators must perform daily equipment inspections and maintain records according to the inspection form before their shifts. During operation, they should strictly adhere to the operating procedures and promptly address any issues. After their shifts, operators should clean and wipe the equipment, while documenting any abnormal conditions.

Operators should resolve minor adjustments, while complex issues or potential hazards should be reported for timely repair by contacting our company.

5.3.2 Second-level Maintenance

Thoroughly wipe down and inspect every unit of equipment. Thoroughly clean up the area around the equipment.

6 Equipment Maintenance Management System

6.1 Purpose

The purpose is to expedite the resolution of equipment failures by maintaining detailed records of the issues and analyzing their root causes.

6.2 Range

It is suitable for maintenance of SENFENG laser welding equipment.

6.3 Requirements

1. When a malfunction occurs, operators should immediately stop production, fill out the repair form, and report the issue to the maintenance department.
2. Maintenance personnel will promptly arrive at the site to repair the equipment and address the malfunction.
3. Maintenance personnel can contact our company for both online and on-site guidance and repair assistance.

Appendix 1 Contact Us

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