ORC-1000

OWNER'S MANUAL

Version 3.0

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TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

LIST OF FIGURES

1. INTRODUCTION

This manual is a comprehensive tool that serves as a reference for the **ORC-1000** laser. Sections of this manual identify and describe the major assemblies, summarize their operation, and list requirements for periodic maintenance.

1.1 Warranty Limitation

This manual provides the guidance needed for routine maintenance and alignment of the **ORC-1000** laser system (laser head and power supply).

The owner/operator is not authorized to remove any of the fixed modules from the **ORC-1000** laser system, except as described elsewhere in this manual for the completion of routine maintenance tasks. Removal of any of these modules will be considered unauthorized modification or misuse of the laser and will void Clark-MXR, Inc.'s warranty. Clark-MXR, Inc. will not be responsible for problems arising from repairs made by unauthorized personnel.

1.2 Copyright Notice

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1.3 Overview and Specifications

The model **ORC-1000** consists of a free standing laser head and a separate power and cooling station connected by appropriate cabling and cooling lines.

Specifications:

Laser head

Mechanical

- length: 33 in./84 cm.
- width 13 in./33 cm.
- height 9 in./23 cm.
- beam height 6 in./15 cm.
- weight 50 lbs/23 kg

Optical

- output power (green)
- cw > 3 watts
- Q-switch (5kHz) > 25 watts
- Q-switch (1kHz) > 9 watts
- Beam profile: Multi transverse mode (top hat)

Power supply

- length 30 in./76 cm.
- width 23 in./58 cm.
- height 31 in./79 cm.
- weight 550 lbs/250 kg

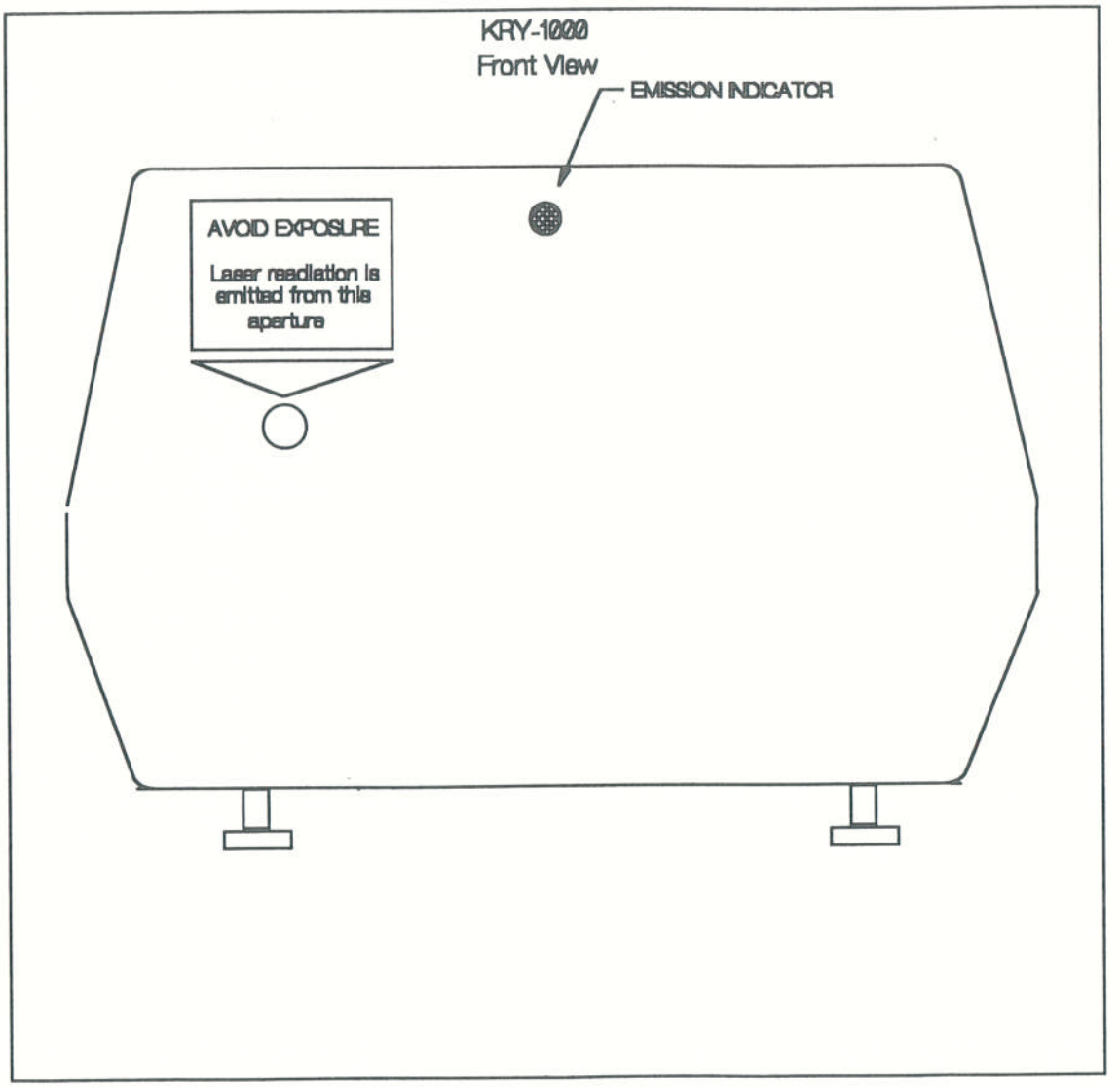


Figure 1-1. Front of laser head.

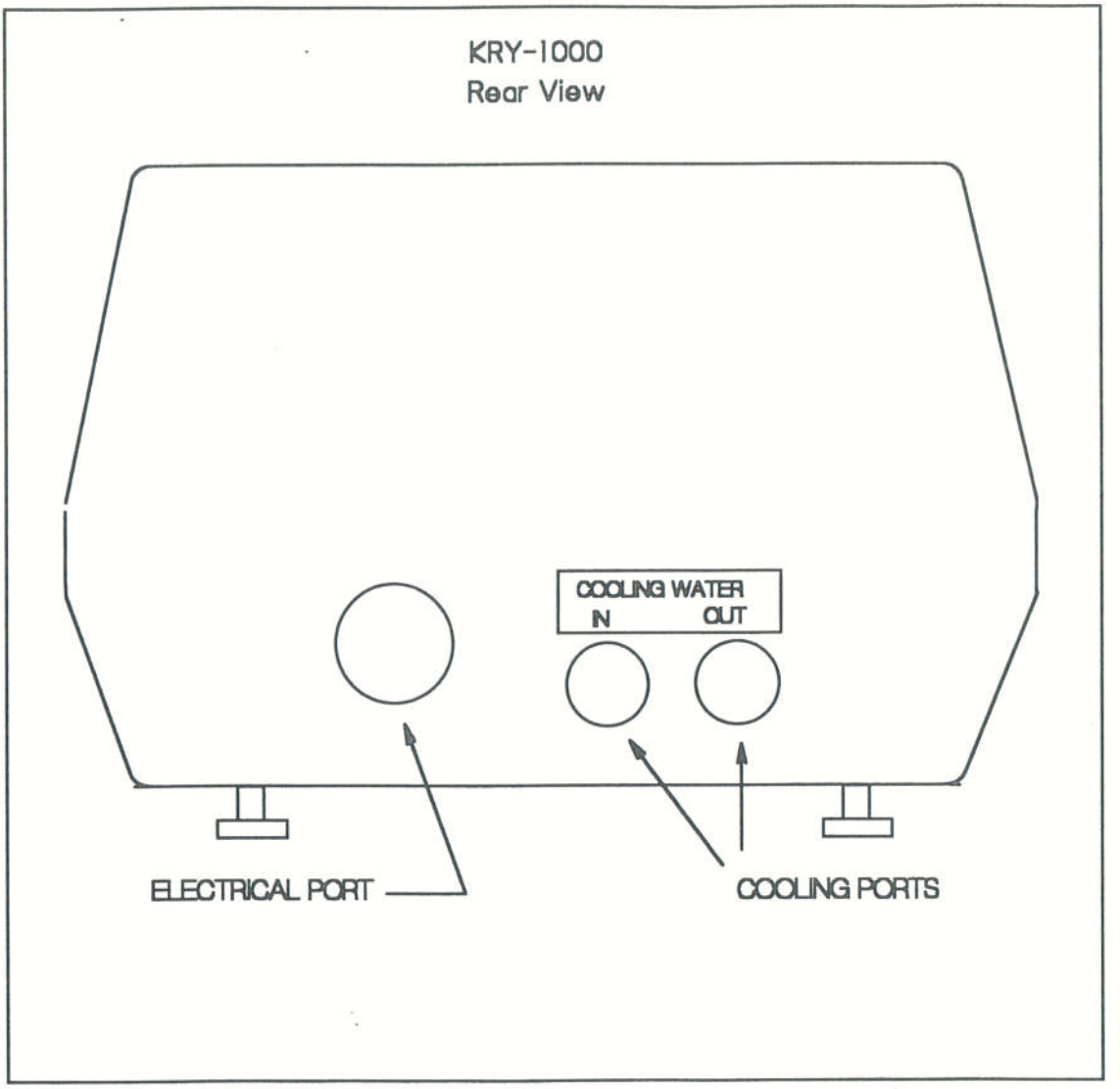


Figure 1-2. Back of laser head.

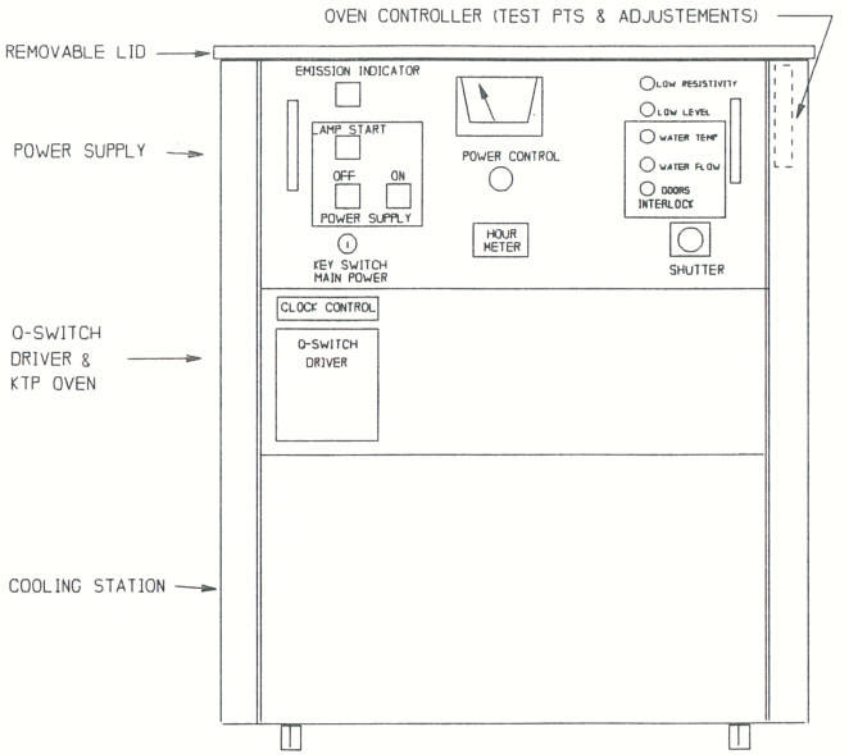


Figure 1-3. Front of power and cooling station.

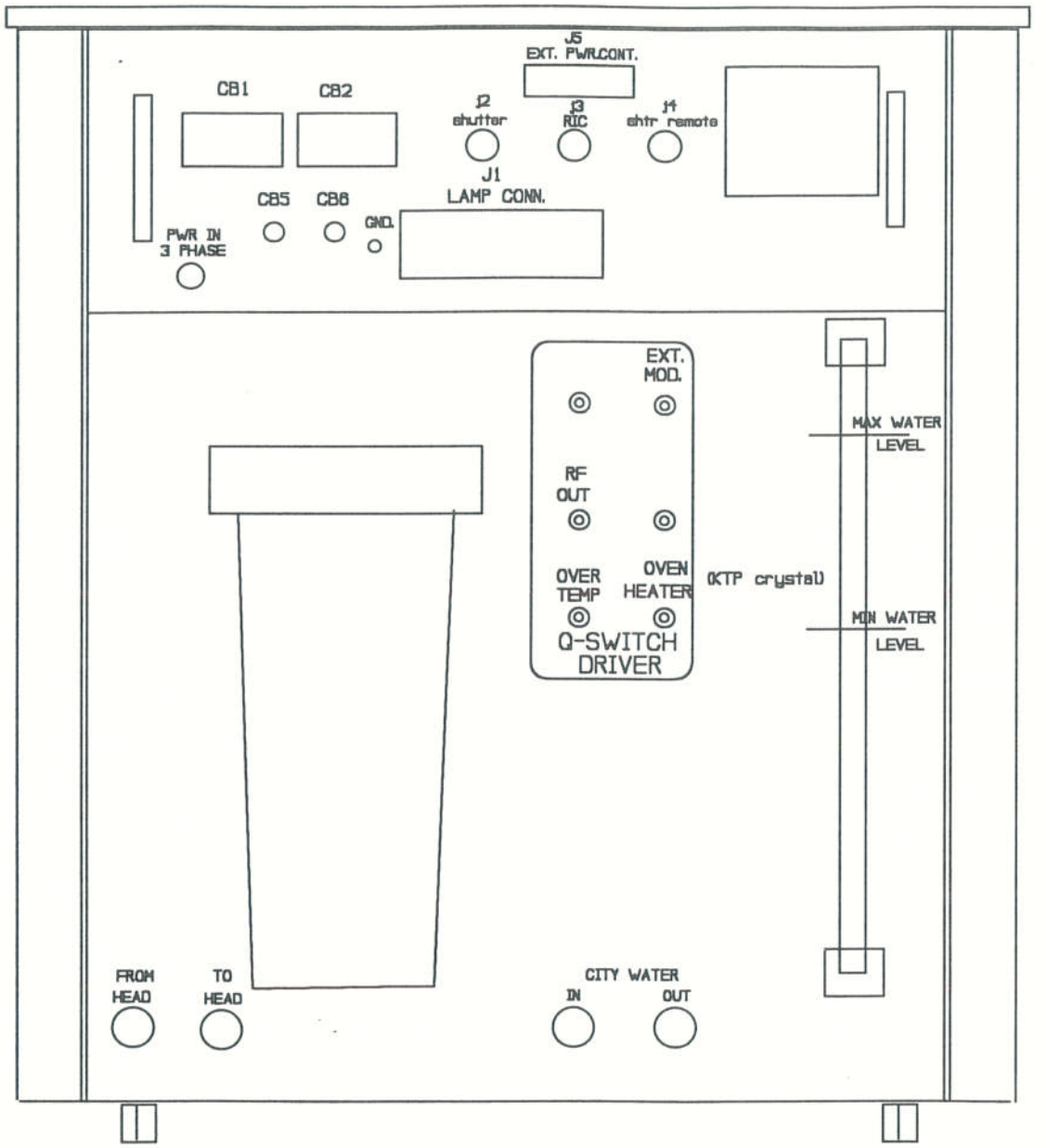


Figure 1-4. Back of power and cooling station.

2. SAFETY

This safety section should be thoroughly reviewed prior to operating the **ORC-1000** laser system described herein. Follow all safety precautions described throughout the manual to ensure that all personnel who come in contact with, operate, or maintain the laser are protected from accidental or unnecessary exposure to laser radiation.

WARNING: The* ORC-1000 *is a Class IV laser. Laser light from the model ORC-1000 presents a severe eye and skin hazard and a potential for burns and fire.

2.1 Protection of operators and users

The laser user is encouraged to obtain a copy of ANSI Z136.1, American National Standard for the Safe Use of lasers, published by the American National Standards Institute, 1430 Broadway, New York, NY 10018. This publication is a guide to the safety standards required of laser users.

The safety features listed below are incorporated into the model **ORC-1000** in compliance with Title 21, Code of Federal Regulations, Subchapter J. (21 CFR 1040.10). Any alterations to the **ORC-1000** laser system which modifies any of these features invalidates the Class IV certification of the **ORC-1000**.

Remote interlock connector - An interlock socket and plug is provided on the rear of the power supply . This is intended to be connected to a switch on the laser room doors so that the laser will be disabled if the doors are opened accidentally, thereby preventing exposure to laser radiation by anyone entering the laser operating area. The laser is disabled by shutting down the power supply . Lasing cannot be automatically resumed. The power supply must be manually restarted after an interlock caused shutdown. The laser should not be operated without the remote interlock function enabled.

Key switch - A key is required to energize the **ORC-1000** laser power supply. The key for the ON/OFF switch can only be removed when the switch is in the OFF position. (This prevents removing the key without first turning off the system, and additionally controls the use of the laser to prevent use by unauthorized personnel.)

Protective Housing - The **ORC-1000** laser head is enclosed in a protective housing which encloses the laser beam until it exits through the output aperture. The top cover is designed to be removed occasionally for service which may occasionally require operation of the laser with the cover removed. The laser head is equipped with a redundant electrical top cover interlock. The interlock can be "defeated" by pulling up the actuating rod. The "defeated" status is indicated when the actuating rod is in the up position. The **ORC-1000** should not be operated with the protective covers removed except for service or maintenance by knowledgeable and qualified personnel.

Emission Indicator - Two visible emission indicators are used on the **ORC-1000** laser system: (1) An amber indicator on the power supply and, (2) An amber indicator on the laser head. Both indicators are energized whenever the key switch is turned on.
This indicates the laser is being readied for emission of laser radiation. The indicators remain on as long as the laser power supply is energized. The emission indicators light prior to actual emission to warn nearby personnel of impending laser radiation.

Location of Controls - Controls for operation of the **ORC-1000** laser are located on the power supply control panel. This ensures that exposure to laser radiation is avoided during operation.

Warning Labels - Warning labels and the compliance certification are attached to the **ORC-1000** laser head as indicated in Figure 2-1. The function of the labels is to provide the user with information on the wavelength and power emitted and to warn the user against exposure to laser radiation.

Operating Instructions - The instructions for safely operating and maintaining the **ORC-1000** laser system are provided in this manual.

Safety Shutter - A rotary solenoid actuated safety shutter is mounted in the **ORC-1000** optical head. It is controlled by a switch on the power supply.

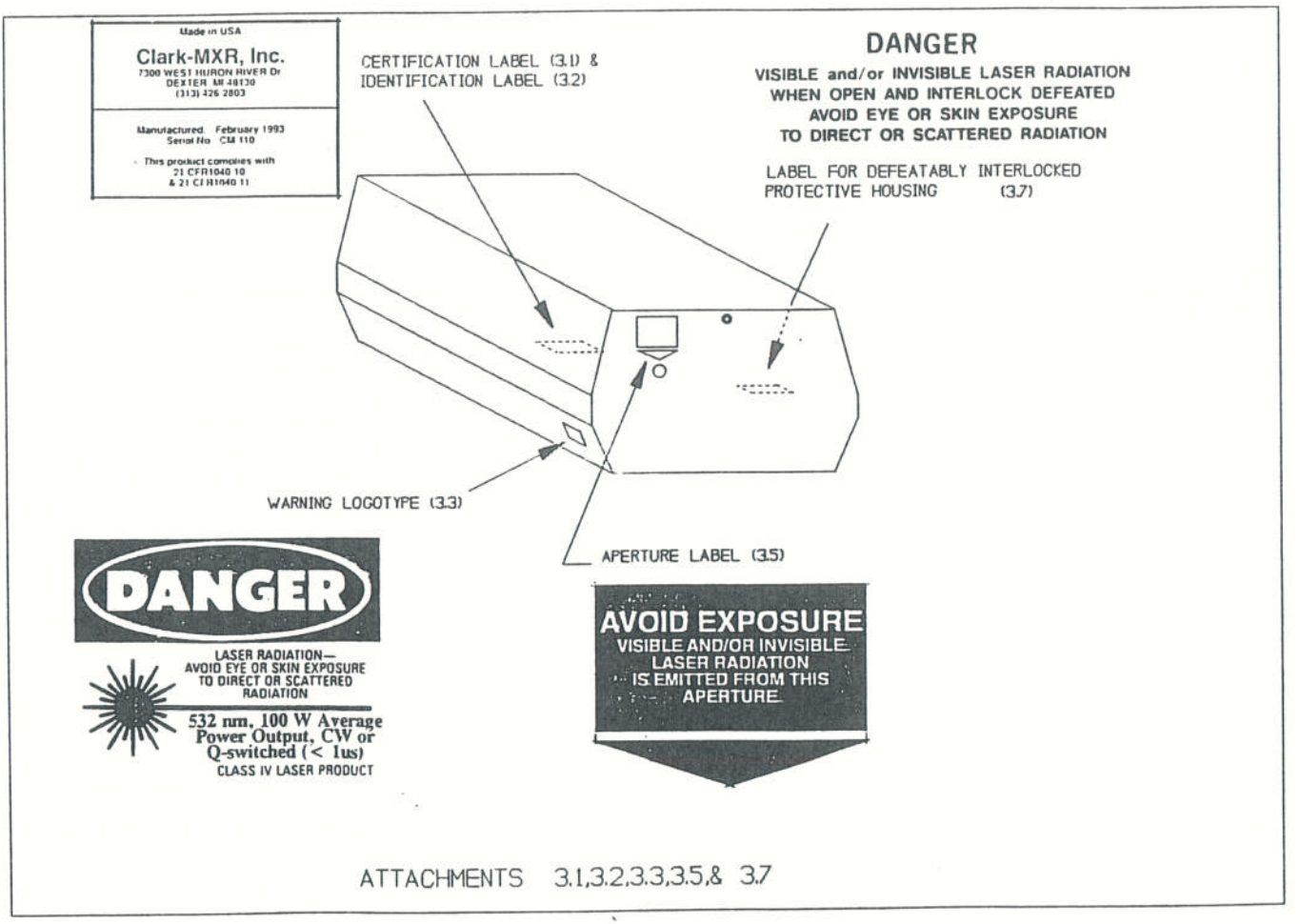


Figure 2-1. Placement of labels.

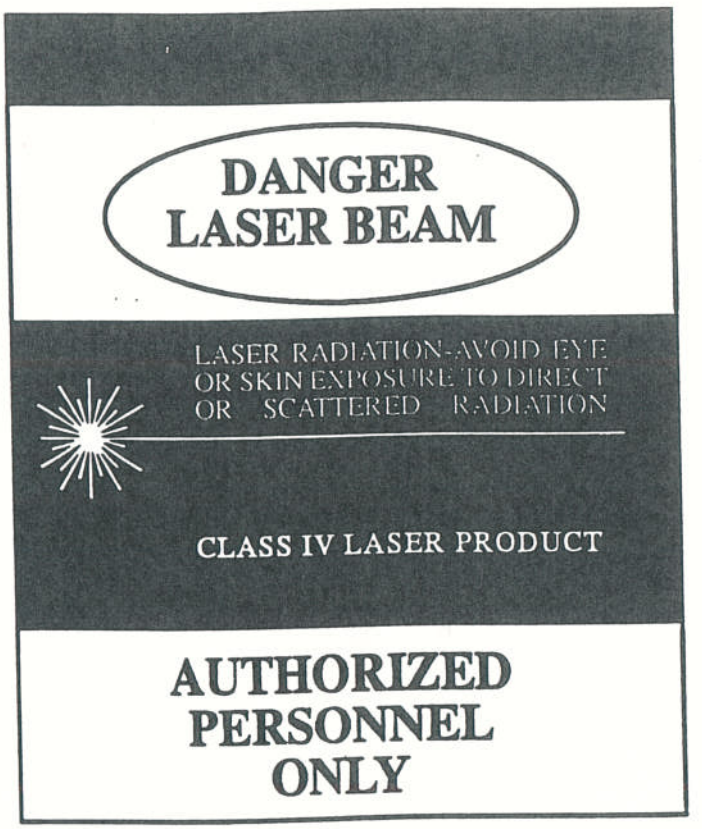


Figure 2-2. Warning signs for room.

2.2 Electrical hazards

Applying AC power to the system after removing laser head cover panels will expose you to high voltages. At such times, practice common sense when placing hands inside the enclosure, and do not allow foreign object to fall inside.

Disconnect main power lines prior to working on any electrical equipment whenever it is not required to have the power on.

Allow at least five (5) minutes for the power supply output capacitors to discharge and then measure the output before touching any electrical equipment.

Do not short or ground the power supply output. Positive protection against possible hazards requires proper connection of the ground terminal on the power cable, and an adequate external ground. Check these connections at the time of installation, and periodically thereafter.

Never work on electrical equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment, and who is competent to administer first aid.

When possible, keep one hand away from electrical equipment to reduce the danger of current flowing throughout the body if a live circuit is accidentally touched.

Always use approved, insulated tools when working on equipment.

Special measurement techniques are required for this system. Ground references must be selected by a technician who has a complete understanding of the system operation and associated electronics.

2.3 Optical radiation hazards

The principal optical hazards are eye injury, burns, and ignition of flammable materials.

EYE INJURY Visible light and near infrared laser energy pass through the transparent components of the eye (the cornea, lens, aqueous and vitreous humor) and are focused on the retina at the back of the eye.

This light can therefore cause an accidental retinal burn, the degree of damage depending on the power of the beam, the amount of focusing carried out by the lens, and the duration of the exposure. ***Minimum precautions against eye injury include wearing safety eye wear designed for protection at 532nm and of sufficient optical density at 532nm to protect the wearer from the high peak power associated with the Q-switched laser output.***

With the top cover removed you will have access to laser beams that would otherwise be contained within the protective housing. These beams may be of multiple wavelengths (.532 and 1.064 micron) . ***At such times, always wear optical safety glasses designed for protection at 532nm and 1064nm. The optical density at these wavelengths should be sufficient to protect the wearer from the high peak power associated with a Q-switched laser.***

WARNING: When servicing the system do not wear jewelry (such as rings, chains, etc.) , that might pass into the laser beam line. Uncontrolled reflections might result!

BURNS Accidental irradiation of skin/tissue will result in a laser burn. In addition, be careful handling beam blocks and power meters that have been exposed to the laser output. They may be very hot.

IGNITION OF FLAMMABLE MATERIALS The **ORC-1000** laser is intense enough to ignite flammable materials placed in the beam path. This includes "beam blocks", clothing, etc. Care and precision in pointing the laser is of paramount importance. Always align the system at the lowest output power.

2.4 Laser room

The area where the laser is used should be clearly labeled at all entrances with warning signs when the laser is actually in use. The sign should indicate the laser being used. Figure 2-2 shows an example of a sign suitable for use with the **ORC-1000** laser.

The power supply is provided with an interlock socket which should be connected to a door switch. This will automatically switch off the laser in the event of the door's being opened. Personnel present in the room should be limited to those essential to the laser operation or experiment. Appropriate protective eye wear should be available for all personnel in the room.

IMPORTANT NOTE: The power supply is switched on with a key switch. It is recommended that the keys be assigned to one or two key holders, who should make the keys available for authorized users only.

In addition to the possible hazard of accidental laser burns of the eye and the skin, there is an associated electrical hazard such as is found with any piece of electrical equipment. Accordingly, care must be taken when connecting or disconnecting the system.

3. POWER/WATER REQUIREMENTS

3.1 Facility Connections

3.1.1 Electrical

The AC power required for the North American version is 215 + - 5 % VAC, three phase, 60 Hz. (30 A/line @ 220V)

The AC power required for the European version is 380 + - 10% VAC, three phase, 50 Hz (20 A/line @ 380V)

Imbalance of incoming AC line phases will result in a noisy laser output modulated at the phase imbalance frequency.

3.1.2 Water

Nominal supply water requirements are as follows: 4-6 GPM at 30-50 psi. intermittent flow controlled by a built in thermostat. The power station contains a closed circuit heat exchanger filled with 8 gal. of distilled water for the actual laser head cooling.

The following characteristics of the tap water supply can have a significant effect on the system operation:

- UN dissolved solids: Although moderately high levels of dissolved solids (hard water) can be tolerated, pre-filtering is required to ensure optimum performance.

- Inlet static pressure: A water pressure regulator should be installed if the inlet static pressure is grater then 60 psi. (the minimum should be 30 psi.)

- Inlet water temperature: The heat exchanger inside the laser power supply will not be able to adequately cool the laser and resonator assembly if the inlet water temperature exceeds 75 degrees Fahrenheit (24 C).

4. SYSTEM DESCRIPTION

4.1 Laser beam paths

The laser system can be divided into several subsystems. A brief description of these subsystems is given below, followed by the various modes of operation of the entire laser system.

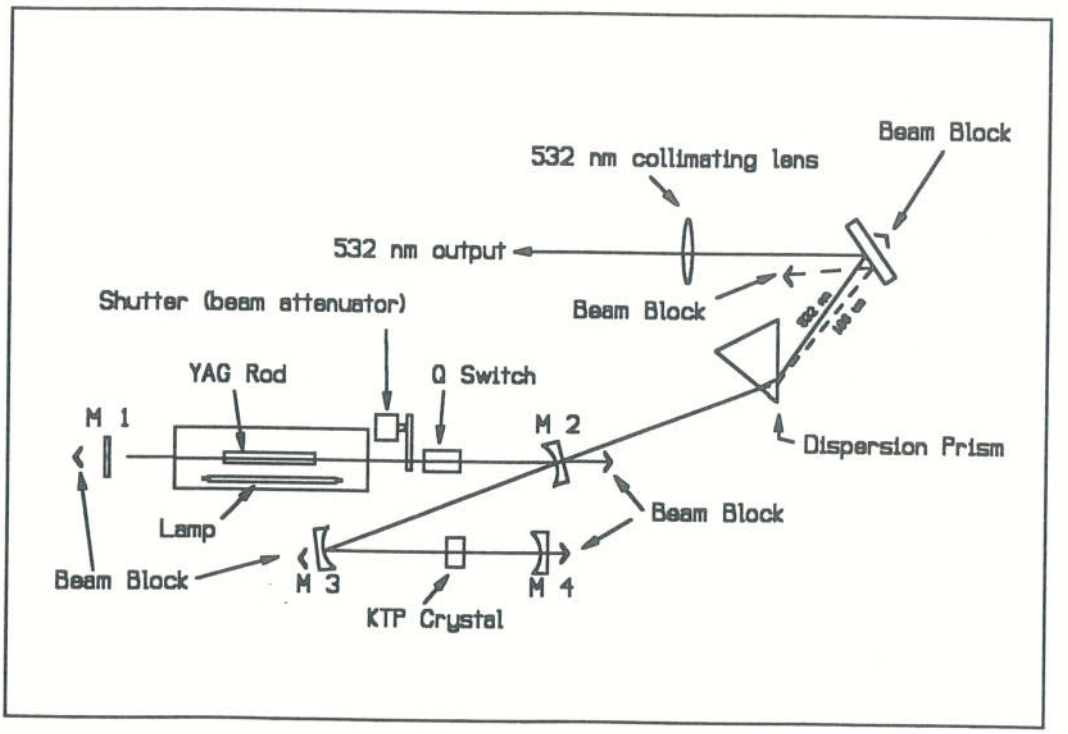


Figure 4-1. Schematic View of **ORC-1000** beam path.

When the power supply is energized, the system will be in the KTP (green) mode of operation. In the lamp housing, the light from the lamp is focused from the lamp into the YAG rod. Much of the light from the Krypton arc lamp is concentrated at a few wavelengths bands in the near infrared. Some of the spectral bands emitted from the lamp match the absorption bands of the YAG rod. This match between the emission bands of the Krypton arc lamp and absorption bands of the YAG rod makes this lamp a relatively efficient pump source for YAG. The light absorbed by the YAG rod will excite the Neodymium ions in the rod and cause the rod to act as a light amplifier for the 1064 nm infrared wavelength. This means that the light a 1064 nm that enters the excited YAG rod at one end, will exit stronger at the other end. As shown in figure 4-1 above, some of the amplified light emerges from one end of the rod and strikes mirror M1, which is a high reflecting mirror at 1064 nm that reflects nearly all of the light back into the YAG rod. (The small portion of light, about 0.2%, that does manage to pass through the mirror is absorbed by the beam block behind the mirror.) The 1064 nm light that emerges from the end of the YAG rod, (see figure 4-1), travels through the Q switch, (which initially is open and allows light to pass), and on to the 532 nm output coupler (mirror M2). Nearly all the 1064 nm light is reflected off the output coupler and reaches mirror M3, which is another high reflecting mirror at 1064 nm. After that, the 1064 nm light passes through the KTP crystal and strikes mirror M4, where it is again reflected and retraces the same path back to the YAG rod. (The small portion of the 1064 nm light that passes through mirrors M3 and M4 is absorbed by the appropriate beam block.) The returning light is further amplified by the YAG rod, until eventually the gain of the YAG becomes saturated. This entire arrangement is called a laser resonator because the 1064 nm light resonates back and forth over the path between the mirrors and through the YAG rod.

As 1064 nm light passes through the KTP crystal, a process called Second Harmonic Generation (SHG) causes the conversion of a small portion of this 1064 nm light to a visible green wavelength at 532 nm. (Note that the KTP crystal only converts some of the light to visible green but does not amplify it.) The green light that emerges from the KTP crystal also reflects off mirror M4 and passes back through the KTP crystal. The 1064 nm light that propagates through the KTP with the 532 nm light now generates more 532 nm light that adds to the 532 nm light generated on the first pass. All this 532 nm light reflects off mirror M4

and reaches the 532 nm output coupler M2 . This output coupler mirror is highly transmissive for 532 nm light and highly reflective for 1064 nm light. As a result, 532 nm light passes through the mirror and goes on to the next optical components while 1064 nm light is reflected back into the resonator.

4.2 Q-switch

The Q-switch is an optical switch that can be closed to block the laser light. If this happens, the 1064 nm light is prevented from oscillating in the resonator and consequently no green light is generated, but the lamp is still on. Gain builds up in the YAG rod and energy is stored in the YAG rod. When the Q-switch is subsequently opened, all the energy stored in the YAG rod is dumped in the laser resonator, causing a large pulse of 1064 nm light in the laser. The KTP crystal conversion of infrared to visible green is non-linear. Consequently the peak KTP power is increased considerably by Q-switching the laser. This Q-switching process (opening and closing) is repeated at a typically kHz or multi kHz rate, and the average 532 nm light produced increases considerably.

The Q switch is controlled by an RF driver. No RF means the Q-switch is off and the YAG laser runs in its normal, continuous wave (CW) mode. This produces very little green conversion and results in a low level of 532 nm light. With the RF on and gated, the Q-switch turns on and off at a high repetition rate, the peak laser power is high, and the average 532nm green output power is high.

4.3 Intracavity shutter

The shutter is a solenoid operated beam block that rotates into the intracavity beam path and stops the lasing process. The shutter is actuated by a switch located on the front of the power supply.

4.4 KTP Oven

To avoid fluctuations in the doubling efficiency process, the KTP crystal is mounted in a temperature stabilized oven. The oven is actuated whenever the water pump is on. A time delay prohibits opening the laser shutter until the temperature is stabilized.

5. INSTALLATION

5.1 Unpacking the system

The **ORC-1000** laser head and power supply are packaged separately in specially designed shipping containers. Remove the units from the shipping containers very carefully to prevent damage.

The power supply is bolted with four "lag" bolts to the bottom of its shipping crate. Remove the power supply side panel to access the bolts.

5.2 Inspection

Inspect the shipping containers and equipment for damage (dents, broken parts, suspicious rattles). If the equipment is damaged, notify the carrier promptly and document any damage noted. Any damage should also be reported immediately to Clark-MXR, Inc.

5.3 Installation procedure

Prior to beginning the installation, ensure the installation area is stable, flat, and clear, and it provides sufficient working space.

5.3.1 Laser head

Use the four clamps provided with the **ORC-1000** to secure the laser head to the table. The **ORC-1000** laser head is completely assembled and aligned at the factory, and should require very little, if any, adjustment following installation. A slight "tweaking" of mirror M4(see figure 4-1) may be necessary to establish rated output. Prior to connecting the laser head to the power supply, check the lamp connections, hose connections, and fasteners, and tighten as necessary.

CAUTION! Do not connect the power station to the main incoming power line until the following procedures are completed.

5.3.2 Umbilical cord and power supply

Mate the umbilical connections to the back of the power supply (Fig. 1_4). These include the two high voltage lamp cables, safety shutter cable, RF output and overheat protection cables for the Q-switch, the oven heater/control cable, and two ground wire cables. Secure the umbilical cord to the back side of the power station using the two cable clamps provided.

Connect the supplied hoses from the power supply to the laser head. *Note that the hoses are permanently attached to the laser head, the connectors are for strain relief only!* Observe the labeling on the power supply and laser head as the input and output are not interchangeable. The hose on the power supply end is secured with hose clamps.

Connect 1/2 inch I.D. high-operating pressure hose from the building water supply to the fitting labeled "city water in" on the rear of the power supply.

Connect a 1/2 inch I.D. high-operating pressure hose to the fitting labeled "city water out" on the rear of the power supply and the other end to a suitable drain.

Fill the primary water tank in the laser cooling system with distilled or de ionized water through the fill port. The water required to fill the tank is approximately seven gallons. The fill port is accessible by removing the right side panel (as viewed from the rear of the power supply)

The **ORC-1000** laser is shipped from the factory without a plug attached to the line cord. The user must attach a plug or make whatever connection is required for his or her facilities.

Verify the incoming power voltage. ***Do not connect the power supply to the ac power at this time.***

6. OPERATING INSTRUCTIONS

6.1 Laser system controls/indicators and functions

POWER SUPPLY FRONT PANEL (Figure 6-1)

KEY SWITCH: Controls main power on and off, and water pump start. Control power is enabled when the key is turned to ON (Main power contactor is not engaged at this time.) To start the pump, turn to PUMP START and hold until water flow is started . When released, the key will return to the ON position . The main power contactor is now on, and the pump should be running. (If not, see: Troubleshooting-Section 8)

The key switch is designed so that the key can be removed only in the OFF position.

EMISSION INDICATOR: This indicator lights when the key-switch is turned ON to indicate that laser emission is eminent.

POWER SUPPLY ON: A green push-button switch used to turn the lamp power supply on. The indicator in the switch lights when the switch is depressed.

POWER SUPPLY OFF: A red push-button switch used to turn the lamp power supply off. The indicator in the switch lights when the switch is depressed.

LAMP START: A white push-button switch to start the krypton arc lamp. The indicator turns off when the lamp is started. The lamp will not start if the shutter control is turned on.

POWER CONTROL: Used to adjust lamp current.

SHUTTER OPEN/CLOSED: Used to actuate the safety shutter.

DC AMPERE METER: Indicates krypton arc lamp current.

HOUR METER: Non-resettable, indicates power supply usage. 50/60Hz switch is provided.

LOW WATER LEVEL: Illuminates when there is insufficient de ionized water in the cooling system.

WATER TEMPERATURE INTERLOCK: Illuminates when the de ionized water is above 105 degrees Fahrenheit (40 C) to indicate insufficient cooling to the laser head. The interlock then engages to shut down the laser system. The interlock can be bypassed by turning the key switch to the PUMP START position.

WATER FLOW INTERLOCK: Indicates insufficient flow of de ionized cooling water, and shut down the laser when engaged . The interlock can be bypassed by turning the key switch to the PUMP START position.

DOOR INTERLOCK: Illuminates when the 1) RIC (J3) circuit or 2) the high-voltage interlock switch (behind the high-voltage connector block, Jl, at the rear of the power supply) or 3) the protective housing interlock have been interrupted, and shuts down the lamp power supply. The cooling system will continue to operate during a DOOR INTERLOCK condition.

LOW WATER RESISTIVITY: Indicates low electrical resistivity of deionized water.

Q-SWITCH DRIVER - BACK PANEL of POWER STATION (Figure 6-2)

RF OUT: Power connection for the Q-switch load ***must be connected at all times when energized to prevent severe damage to the Q-switch driver.***

OVERTEMP: Connect to the Q-switch to provide thermal protection against overheating of the Q-switch.

EXT. MOD: Input for external modulation frequency input. (5 volts into 50 ohms)

SHUTTER: Not used for this model.

GATE: Not used for this model.

Q-SWITCH CONTROLS - FRONT PANEL (Figure 6-3)

ON/OFF: Push button switch used to power the Q-switch driver.

EXTERNAL: Allow the use of an external clock to drive the Q-switch. External clock should be able to provide TTL level signals.

INTERNAL: Internal clock rate for Q-switch drive. Three repetition rates are available: 50 Hz, 500 Hz, and 5000 Hz. (These rates are a nominal value and might vary significantly.)

CAUTION: During initial alignment the Q-switch must be operating at 5000 Hz.

POWER SUPPLY REAR PANEL

CB1: Circuit breaker for main input power. Also provides overload protection.

CB2: Overload protection circuit breaker for the cooling pump.

CB5: Overload protection circuit breaker for control voltage. Push to reset.

CB6: Overload protection circuit breaker for the power supply control. Push to reset.

J2 SHUTTER: Provides power connection point for the safety shutter.

J3 RIC: Provides for electrical interlock shut down of the power supply when the circuit is open. May be used optionally in lieu of the J4 to meet RIC requirements of 21 CFR 1040.10.

J4 SHUTTER REMOTE: Allows connection of a remote interlock switch to actuate the safety shutter. Used to meet the RIC of 21 CFR 1040.10.

PWR IN: Or Main input power required is 220/380 VAC ± 10%, 50/60 Hz.

Jl LAMP CONN: Two-pin connector for the high voltage laser lamp cables. The connector is interlocked so that the power supply will be shut down when the connector is open.

J5 EXT PWR CONN: Optional feature for external digital or analog computer current control.

OVEN HEATER: (Located within "Q-switch" section on back of power station.) Five pin connector used to connect the internal oven controller to the KTP oven in the laser head.

WATER FITTINGS

FROM HEAD: Hose connection for cooling water returning from the laser head.

TO HEAD: Hose connection for cooling water flowing to the laser head.

CAUTION: Do not interchange supply and return hoses connecting the power supply and laser head.

CITY WATER IN: Hose connection for incoming city water used for secondary cooling (Cooling for the deionized laser cooling water).

CITY WATER OUT: Hose connection for city water discharge.

MINIMUM WATER LEVEL: Indicates the minimum level of deionized water required for proper cooling of the laser head.

MAXIMUM WATER LEVEL Indicates the maximum level of deionized water permitted in the cooling system. DO NOT FILL ABOVE THE INDICATED LEVEL.

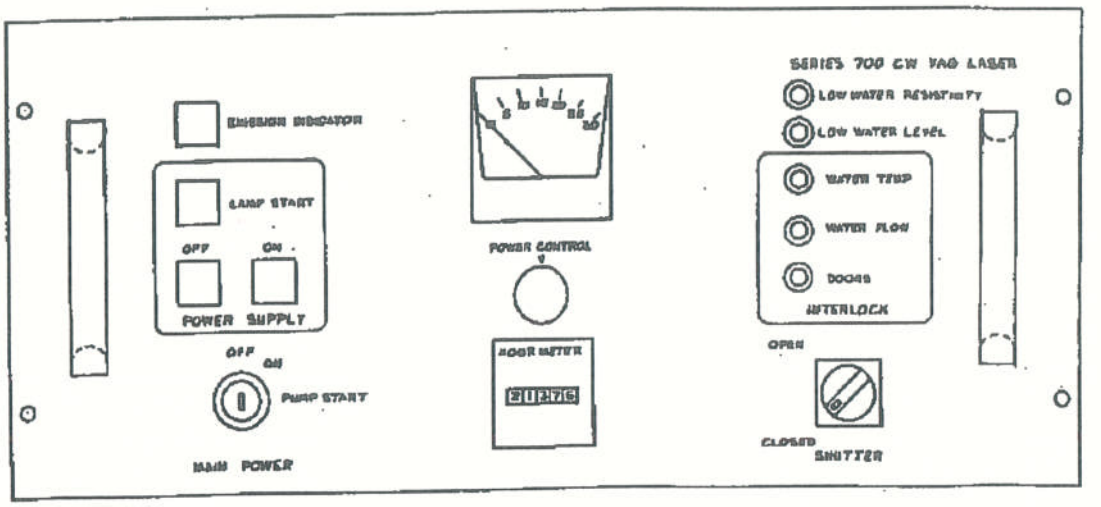


Figure 6-1. Power supply front panel.

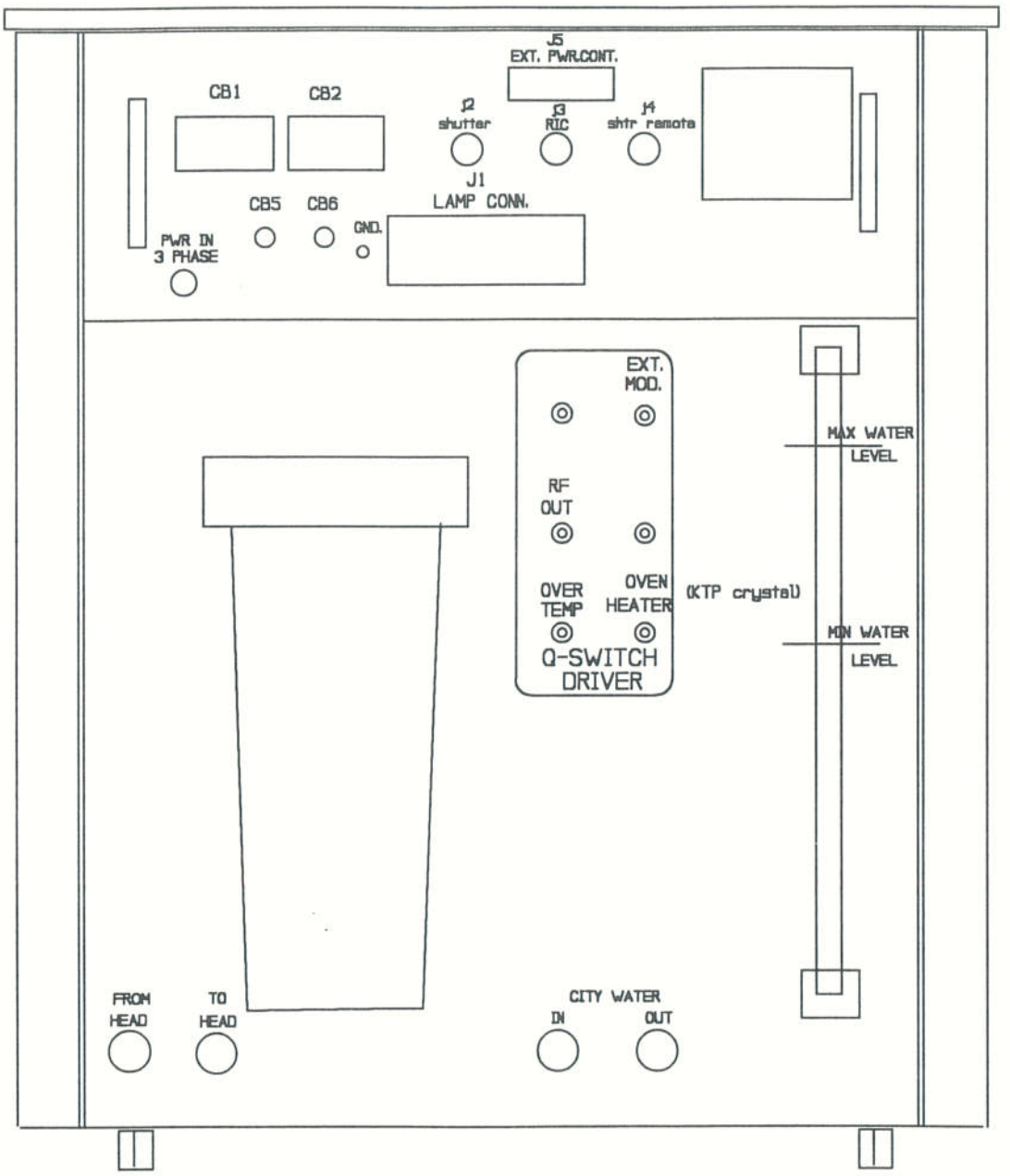
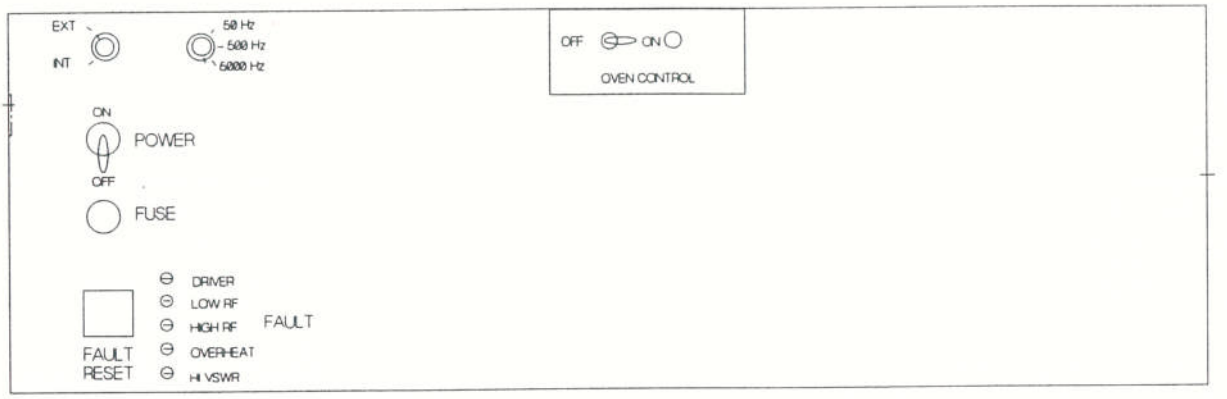


Figure 6-2. Back of Q-switch and power station.



Addendum: The oven control switch and front panel indicator have been eliminated.

Figure 6-3. Q-switch driver (front panel)

6.2 Initial system checks

The following procedure should be followed for initial turn-on (first time following initial installation) of the **ORC-1000** system to ensure that the installation is correct, and to acquaint the user with the system controls:

1. Verify that the correct input power is supplied to the laser (see system specifications in Section 3.0). ***Do not connect the laser power station to the ac power source at this time.***

2. Check the umbilical connections between the laser head and the power station, and ensure that they have been made in accordance with the instructions in Sections 5.3.2 and 6.1.

3. Before connecting the main power cable to the ac power source, check to ensure that all the applicable procedures and precautions in Section 2.0, SAFETY, and Section 5.0, INSTALLATION, have been followed.

4. Turn OFF the main circuit breaker (CBl) on the rear panel.

5. Turn the main key switch to the OFF position.

6. Turn the POWER CONTROL to the full counterclockwise position.

7. Set the SHUTTER control to the CLOSED position.

8. Set the POWER ON/OFF switch to the OFF position.

NOTE: This completes the initial start up procedure following first time installation. Follow the procedures in Section 6.3 for normal start up of the laser system.

6.3 Normal system start up

The following procedures should be used during normal start up and operation of the ORC-1000 laser systems.

6.3.1 Cooling system start up

CAUTION: Make sure the cooling water hoses are connected as described in Section 5, INSTALLATION, the water reservoir has been filled to the proper level with clean deionized water, and the incoming city water has been turned on.

1. Connect the main power cable to the incoming ac power source.

2. Set the main power circuit breaker (CB1) to the ON position.

3. Turn the main power key switch to the ON position. The EMISSION INDICATOR, WATER FLOW interlock light, and the POWER SUPPLY OFF light should be illuminated. The cooling pump should not be running at this time. For troubleshooting see Section 8.

4. Turn the key switch to the PUMP START position and hold momentarily until the pump starts. (Note that on the initial turn on, it may be necessary to turn the pump on and off several times in order to prime the system). Release the key and it will return to the ON position. The WATER FLOW indicator light should now be OFF.

5. Turn the key switch OFF to shut down the pump.

6. Check all the water fittings on the power supply, laser head, and Q-switch for leaks, and tighten as required.

7. If there are no leaks the cooling system can be restarted following Steps 3 and 4 above.

6.3.2 Lamp power supply start-up

NOTE: Prior to turning the power supply on, check the operation of the safety shutter by actuating the SHUTTER OPEN/CLOSED switch. With the switch in the OPEN position, the safety shutter should be open. This must be done with the key switch in the ON position. Note that the time delay will inhibit this action for approximately 3-5 minutes.

The contacts on J4 SHUTTER REMOTE on the rear panel must be shorted with the shorting cap provided, or must be connected to an external interlock with the contacts on the interlock closed.

1. Turn the key switch on to energize the water pump and oven heater. It will take approximately 5 minutes for the oven heater to warm up.

2. Turn the POWER CONTROL fully counterclockwise. Turn the Q-switch main power control to the OFF position.

3. Turn the SHUTTER switch to the CLOSED position. If the SHUTTER switch is in the OPEN position the lamp cannot be energized.

4. The DOORS interlock indicator should be OFF.

5. Push the POWER SUPPLY ON button to turn on the power supply. The POWER SUPPLY OFF indicator should go off, and the POWER SUPPLY ON indicator should light.

NOTE: The power supply will be shut down if the remote interlock circuit is opened while the power supply is running.

6. The LAMP START indicator should gradually light in approximately 30 seconds indicating the capacitors are fully charged.

7. Press the LAMP START switch to fire the krypton arc lamp. The LAMP START indicator should go off, and the lamp current meter should indicate approximately 20 A.

8. Set the current to the desired operating level by rotating the POWER CONTROL knob clockwise while observing the current meter.

NOTE: Laser output is not optimized at this time; it may take approximately 20 minutes of system warm up time.

9. lasing can be initiated by setting the SHUTTER SWITCH to the OPEN position. (Note that the built in time delay will inhibit the shutter opening upon initial turn on)

10. Under normal conditions, no alignment will be required to achieve the correct operating levels. If the output needs adjustment, refer to the following section.

6.4 LASER ALIGNMENT

CAUTION: In order to avoid damaging the crystal, initial adjustments should always be made in the cw-mode. Do not Q-switch laser with the crystal misaligned.

6.4.1 CW-mode alignment

1. Allow at least 10 minutes warm up prior to alignment.

2. The Q-switch driver must be turned OFF.

3. Adjust current to approximately 25 Amps.

4. Maximize 532 nm output power by adjusting both the horizontal and vertical tilt controls of mirror M-4 and the horizontal tilt control only on the KTP mount. Proceed slowly and carefully to ensure that you have achieved operation on the maximum KTP peak. (Minor peaks can be observed on either side of the main peak)

6.4.2. Q-switch mode alignment

WARNING! When the laser is being Q-switched, the KTP crystal is vulnerable to damage if adjustments are made to reduce conversion of infrared to green light. For this reason, it is desirable to operate at relatively low peak power (high repetition rates and low lamp current). Additionally, do not make large adjustments to the crystal temperature or crystal position while the laser is Q-switched. Make only small adjustments to the crystal angle while the RF is on, and do this carefully in order to maintain a high green conversion efficiency.

1. Turn laser on to 25 amps. Allow laser to warm up for five (5) minutes.

2. Select Internal, 5.0 kHz mode on the Q- switch control panel.

3. Turn RF on.

4. Very carefully make minor adjustments to mirror M-4 horizontal and vertical tilt controls and to the horizontal tilt control only on the KTP mount to maximize the laser output. (This compensates for the slight variations between CW and Q-switched optimum alignment). Do not translate the KTP crystal in the X or Y axis. The X and Y translation adjustments are factory set. Translating the KTP may void the Clark_MXR warranty.

5. This closes the initial alignment procedure. Further alignment should not be necessary.

7. MAINTENANCE

7.1 Cooling system maintenance

Except for replacement of the deionization filter, periodic maintenance is not required on the cooling system. The deionization filter should be replaced every six months. All hose clamps should be checked for tightness at that time. Replacement of the cooling water will normally not be required unless it becomes contaminated. Ensure that only de-mineralized (deionized) or distilled water are used in the cooling system. Otherwise, internal components of the laser head including the laser rod, KTP crystal, and the Q-switch can be damaged. Check water line strainers periodically. Check filter on secondary water system, if used.

7.2 Power supply maintenance

Under normal operation, periodic maintenance is not required on the power supply.

7.3 Lamp replacement

- De-energize the circuit breaker. Remove the main power plug from the wall outlet.
- Remove the top cover of the **ORC-1000** laser head by removing the four screws securing it in place.
- Remove the Nylon top plate and white protective blocks from the lamp housing, then measure across both terminals for ***zero*** volts.
- Put on protective eye wear to protect against possible lamp explosion.

  WARNING! Because of potential danger from an exploding lamp, protective eye gear must be worn before removing top from lamp housing.

- Remove the eight socket cap screws from the lamp housing . Lift the top of the lamp housing slightly, (do not completely remove top) and let housing sit momentarily to enable any excess water to drain out.

- Remove the top cover. The lamp is attached to the back of the top cover.
- Remove two button-head screws from each of the lamp mount connectors.
- Note carefully the orientation of the anode and cathode of old lamp. The lamp base coded red is the anode and should be connected to the "+" power station lead. (The lamp anode tip is rounded while the cathode tip is pointed.)
- Slide lamp out either end.

WARNING! Do not touch the envelope of the new lamp with your bare fingers. If this happens, clean the lamp with acetone or methanol before installing it.(This prevents skin oil from etching the lamp)

- Check orientation of anode and cathode of new lamp in holders. Attach lamp mount connectors on each end. Make sure the lamp is centered within the holders, both lamp bases should be equally inserted into the spring end connectors. Screw two button-head screws into mounts.
- Replace lamp power leads, white protective blocks, nylon protective top, and securing screws.(Note that the "+" power station lead connects to the terminal closest to mirror M-1.)
- Replace the De-ionizing filter on the back of the power supply.
- "Defeat" the system interlock by pulling it into the up position.
- Turn pump on and verify that there are no water leaks. Bring the system up. Realignment should not be necessary but if so, you should only need to adjust M4 to optimize the output.

- Shut down system and push interlock defeat switch to the down position. Replace and secure the cover.

7.4 Laser rod replacement

- Turn system off, de-energize breaker, remove plug from the wall.
- Remove top cover of laser head (as described previously). The lamp will be attached to the top cover.
- Carefully remove the glass shield located above the rod. Do not touch with fingers.
- Remove the brass beam tubes from the rod/lamp flooded cavity.
- Remove the four socket cap screws attaching the rod/lamp cavity to the base plate. Lift the cavity off the base plate slightly (It is still attached to the water lines under the base plate) in order to gain access to the white plastic seals securing the rod and beam tubes.
- Loosen and remove the three socket cap screws attaching the white plastic seals at each end of the cavity and gently pull the white seal assembly away from the rod assembly at both ends.
- Unscrew the four cap screws securing the rod assembly to the cavity.
- Lift the rod assembly (including a portion of the ceramic reflector) out of the cavity. This whole assembly will be replaced.
- Check that housing is fully dry before installing new rod.
- Check that there is absolutely no water on the faces of the new YAG rod.
- Reverse the above sequence to install the replacement assembly.
- Plug main power cable into wall outlet and energize the water pump. Verify the absence of water leaks.

Verify the system performance. If not satisfactory, It may be necessary to perform a realignment of the laser at this time. (See Section 6.4)

7.5 Replacement and cleaning of Q-switch

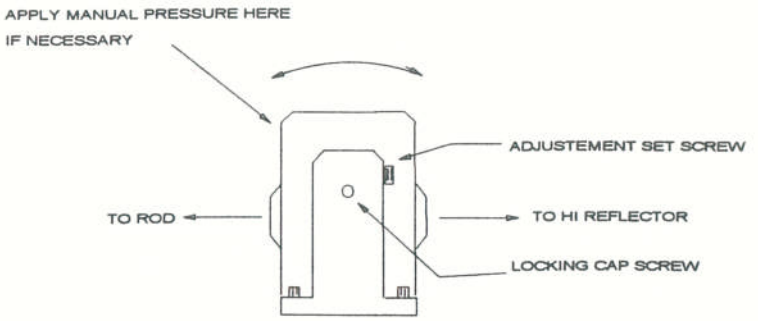
- Turn system off (laser and Q-switch).
- Disconnect power to power supply.
- Disconnect the BNC cable (RF and overheat protection) from the Q-switch.
- Remove the 6-32 socket head cap screws from the Q-switch mount. (Two or three screws are used to secure the Q-switch.) Lift up the Q-switch and remove the water lines from the Q-switch.
- Connect water lines to new Q-switch and verify the absence of leaks.
- Loosely install the new Q-switch to the mount. (the Q-switch should sit square to the mount, with the top of the Q-switch flush with the top of the mount.) Install the BNC cables (RF and overheat protection).
- Turn system back on. It will be necessary to perform a realignment at this point as described in 7.5.1 below.

7.5.1 Q-switch alignment

7.5.1 Q-switch alignment

1. Ensure that the Q-switch Coaxial cables are attached.
2. Turn laser on a, set to approximately 25 amps, and allow to warm up for ten minutes.
3. Set the Q-switch to external but provide ***no*** external drive signal. (This will maintain a continuous drive ,hence a continuous hold off, by the Q-switch .)

4. Loosen the Q-switch socket cap screw (on the side of the mounting plate) enough such that the Q-switch is free to rotate. A rotation adjustment set screw is used to rotate the Q-switch to obtain maximum hold off. An internal spring is used to hold the Q-switch rotation mechanism against the adjustment set screw. Because of the resistance offered by the beam enclosure tubes, it may be necessary to manually put pressure on the Q-switch mount to force it against the adjustment set screw.



5. Open the shutter and slowly increase the current until lasing is observed. This is "leakage" that the Q-switch can not hold off. Iterate between rotating the Q-switch and adjusting the lamp current until maximum "holdoff" is found. There will be two "dips" or angles corresponding to maximum holdoff. Either one may be used.

6. Secure the mount to prevent further rotation by tightening the cap screw on the side of the mounting plate. Observe the green leakage while tightening to ensure that the Q-switch remains at the optimum position.

7. Verify that the Q-switch hold off is optimized. This can be achieved by operating the laser at 500 Hertz, increasing the lamp current, and observing the pulse shape and pulse energy. The pulse shape should remain "clean" up to at least the 10 mj level.

8 It may be necessary to fine tune the laser slightly with mirror M4 and or *very slight* adjustments of the KTP horizontal tilt. Note that adjusting mirror M4 will have a slight effect on the Q-switch "hold off".

9 If satisfactory performance is still not achieved, it may be necessary to repeat the above procedures starting at step three above. Very small rotation adjustments of the Q-switch have a very large effect on the ultimate "hold off" characteristics of the laser.

7.6 KTP assembly replacement

The KTP crystal is factory positioned within a temperature controlled oven . This requires that the full assembly should be replaced if replacement is indicated. Contact Clark-MXR prior to replacement of the KTP assembly. Unauthorized replacement of the KTP may void the Clark-MXR warranty.

1. Turn system off.

2. Disconnect power supply from AC source.

3. Disconnect the connector from the KTP assembly.

4. Loosen the set screw on the M3 mirror mount and slide the beam tube located between M-2 and M-3 towards M-2 .

5. Remove the mirror assembly M-3 by removing the two socket head cap screws securing the mount to the base plate.

6. Remove the water cooled aluminum assembly attached to the crystal stage by removing the two 4-40 socket head cap screws.

7. Remove the KTP crystal and oven assembly (The black anodized plate with the connector attached to it.) by removing the four 4-40 socket head cap screws securing the assembly to the tilt/translation stage.

8. Carefully unpack the new KTP/oven assembly (It is extremely important that no dust or other contaminants are on the crystal due to the high peak power densities encountered under operation.) If necessary, use clean dust-free air to dust off the KTP crystal.

9. Reverse the above steps to install the new KTP assembly, remembering to reconnect the KTP oven connector.

10. Remove the top black cover on the ORC-1000 power supply (it lifts off) and connect a ohm meter across the two white test points on the oven temperature controller. *The controller is mounted on the right top side of the power supply (looking from the front of the power supply).* Turn on the power supply and allow to stabilize for 5 minutes. Verify that the resistance reading is between 725 and 775 ohms. If necessary, adjust with the "fine adjust" screw on the oven controller (the fine and coarse adjust adjustment screws are labeled on the controller and are located on the same assemble as the test points).

7.6.1 Centering the KTP crystal

CAUTION: In order to avoid damaging the crystal, initial adjustments should always be made in the cw-mode. Do not Q-switch laser with the crystal misaligned.

1. Remove mirror M1 to prevent lasing.

2. Remove the beam tube between the KTP assembly and mirror M-4. Remove front cover from crystal mount. (The cover closest to M-4.) Place a small piece of lens tissue (to use as a viewing screen) close to the KTP. The lens tissue should be on the M4 side of the KTP.
3. Open the laser shutter and increase current to obtain a green image on the lens tissue. Adjust the X and Y controls on the KTP mount to center this spot on the KTP crystal.

4. Close the shutter, replace mirror M1 and turn the current all the way down.

5. Verify that the KTP is centered by opening the shutter and increasing the current until lasing threshold is achieved and observing the scatter on the KTP surface.

6. Remove the "O ring" from the M4 beam tube mount with to prevent reflections from the face of the KTP burning the "O ring". A tweezers or forceps will work here.

7. Place power meter to monitor the 532nm output. Adjust KTP horizontal angle adjustments for maximum green. Peak M4 for maximum green.

8. Repeat peaking 532 nm output until no further increase appears and verify that the beam is still centered on the KTP.

NOTE: The KTP crystal will show multiple 532 nm output peaks as the horizontal angle is adjusted, ensure that the strongest peak has been selected.

9. Replace the "O ring", KTP cover, and beam tubes.

10. Proceed with the alignment as described under section 6.49.

8. TROUBLESHOOTING

The following guide is provided to assist the user in diagnosing problems which may occur. Problems which cannot be corrected by the user should be referred to Clark-MXR, Inc. for prompt assistance.

8.1 Power supply & cooling station

Symptom 1) No Emission/Water flow indicators are shown.

Solution:

1) It indicates phases are not correct. Exchange any two wall power lines. This is only for initial installation.

2) Check phase detect circuit on A2 interlock board.

Symptom 2) Emission indicator is on, but no "Water Flow" indicator.

Solution:

1) Water flow switch is stuck on upper position. Tap flow switch lightly.

2) Check A2 interlock board

3) Check "Water Flow" Indicator lamp.

Symptom 3) "Low Water" indicator is on.

Solution:

1) Add DI water to water tank.

2) Check water level switch.

Symptom 4) "Water Temperature" indicator is on.

Solution:

1) DI water temperature is too high. No city water

2) Over temperature sensor is open or broken wire. Check J9 on side panel.

3) Check A2 interlock board.

Symptom 5) "Low Water Receptivity' indicator is on.

Solution:

1) Let cooling system run.

2) Change DI Filter

Clark-MXR, Inc.

ORC Lamp Replacement

NOTE: Whenever the arc lamp is replaced, the YAG rod mounting/seal assemblies should be examined for signs of degradation induced by optical radiation from the arc lamp.

1. Turn off ORC power supply (turn the key on the front panel to the off position). Ensure that the pump is not running. This will ensure that the lamp is not being powered.

2. Remove the top cover above the ORC laser head by removing the four (4) screws securing it in place.

3. Remove the white protective blocks from the lamp housing. In the ORC standalone unit it will also be necessary to remove the NYLON top plate. Measure across both terminals for zero (0) volts. Use a high voltage probe.

NOTE: It takes several minutes for the lamp voltage to dissipate off the filter capacitors.

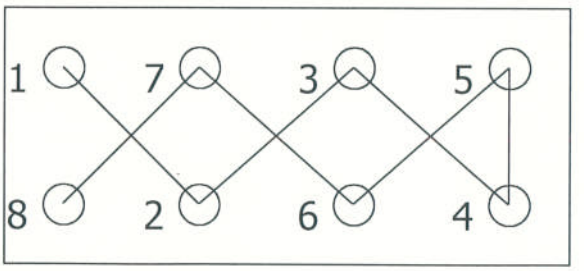
4. Put on protective goggles to guard against possible lamp explosion.

WARNING! Because of the potential danger from an exploding lamp, protective goggles must be worn before removing the top from the lamp housing.

5. Remove the eight (8) socket cap screws from the lamp housing. Loosen these screws using a "boot-lace" pattern (see Figure 1). Lift the top of the lamp housing slightly (do not completely remove the top) and let the housing sit momentarily to enable any excess water to drain out.

Figure 1 "Boot-lace" pattern.

Top View of the Lamp Housing.



"Boot-Lace" Pattern

6. Remove the top cover. The lamp is attached to the back of the top cover.

7. Remove the two (2) button head screws from each of the lamp mount connectors.

8. Carefully note the orientation of the anode and cathode of the old lamp. The lamp base coded red is the anode and should be connected to the "+" power station lead. (The lamp anode tip is rounded while the cathode tip is pointed)

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9. Slide the lamp out either end. Visually inspect the spring end connectors for any discoloration. If there is any discoloration, remove the spring connectors and clean with methanol or acetone and then re-insert.

WARNING! Do not touch the envelope of the new lamp with your bare fingers. If this happens, clean the lamp with acetone or methanol before installing it. This prevents skin oil from etching the lamp.

10. Check the orientation of the anode and cathode of the new lamp in the holders. Attach the lamp mount connectors on each end. Make sure the lamp is centered within the holders. Both lamp bases should be equally inserted into the spring end and connectors. Screw two (2) button head screws into the mounts.

11. Replace the white protective blocks, the nylon protective top (ORC standalone unit only) and the securing screws (DO NOT over tighten the eight (8) securing screws). Replace the securing screws using several iterations of the "boot-lace" pattern (Figure 1) until all of the screws are tight (DO NOT over tighten).

12. Replace the de-ionizing filter on the back of the power supply.

13. "Defeat" the system interlock (on the side of the casting in the ORC cavity) by pulling it into the "up" position.

14. Turn the pump on and verify that there are no water leaks. Realignment should not be necessary. Bring the system up using the standard start-up procedure. Set the current to 20 amps and let the laser run for twenty minutes at this setting. After letting the system run at 20 amps for twenty minutes you may now return the system back to it's normal operating parameters. This procedure should add longevity to the life of your lamp.

15. Shut down the system and put the interlock defeat switch to the down position. Replace and secure the cover.

ORC Maintenance Kit: ORC-1000-MK
ORC Rod Seal Kit: ORC-1000-RSK

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