

**OPERATION, SAFETY, AND MAINTENANCE MANUAL**

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# **CINCINNATI<sup>®</sup>**

## **CL-900 SERIES LASER SYSTEM**

**5x10, 6x12, 8x20 FRAME**

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**CL900** 



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# **CINCINNATI<sup>®</sup>**

CINCINNATI INCORPORATED  
CINCINNATI, OHIO 45211

EM-573 (N-04-18)

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# MANUAL GUIDE

To get the maximum benefit of your new CINCINNATI INCORPORATED machine, read this manual thoroughly and refer to it often for guidance and information.

**IMPORTANT:** Before you operate the machine, read and understand thoroughly, **Section 3** on Safety.

## SIGNAL ICONS

This manual contains important icons that are associated with a signal word like “Danger,” or “Warning,” or “Note”. The icon and/or signal word indicate the severity of the condition or situation. Be sure to read these statements and take special care to follow the instructions.

SIGNAL WORD	DESCRIPTION	ICON
<b>DANGER</b>	Means that there is a condition or situation that will cause death or severe injury if you do not follow the instructions given.	
<b>WARNING</b>	Means that there is a condition or situation that will cause moderate injury if you do not follow the instructions given.	
<b>CAUTION</b>	Means that minor injury or machine damage could occur if you do not follow the instructions given. You may also have to start a procedure over if you do not follow the instructions in a caution statement.	
<b>IMPORTANT</b>	Means that the text gives additional information that must be followed for safety or other significant reason.	
<b>NOTE</b>	Means that the text gives additional information, clarification, or helpful hints.	



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## INTRODUCTION

### CINCINNATI CL-900 SERIES LASER SYSTEM - FIBER LASER

The Fiber Laser System produces two-dimensional contoured shapes from flat material by moving a focused laser beam along a programmed path. The beam comes from a stationary laser generating unit and is directed to a moving lens by a fiber optic cable routed through a moving gantry. The workpiece remains stationary while a narrow strip of material is removed along the path made by the lens. Material is removed by vaporization and melting where the lens concentrates laser power into a small spot on the workpiece. Assist gas is also used to control the cutting process.

The gantry moves the lens to produce the programmed workpiece geometry. A motion controller commands servo drives to control the gantry motion. The program provided by the user includes commands to specify feed rate, laser power, and assist gas.

### PART QUALITY

The following factors affect part quality:

- Machine condition
- Operator ability
- Setup and Programming
- Quality and type of material

CINCINNATI machines are designed to be rugged and durable. However, improper adjustment or lack of maintenance can reduce the quality of parts produced on the machine. The quality of a laser-cut edge depends on the combination of a uniform laser beam of adequate power, properly focused on the workpiece with an adequate supply of the correct assist gas, traveling at a speed compatible with the material removal rate.

Critical manual adjustments are: lens focal point location and lens-to-nozzle centering. The Auto Focus Cutting Head eliminates manual focal point adjustment.

Part quality depends on the program to command the correct combination of laser power, assist gas, and feed rate for the material type and thickness being processed. Part accuracy depends on the program for proper use of kerf width compensation and for selection of feed rate within radius contouring accuracy limits.

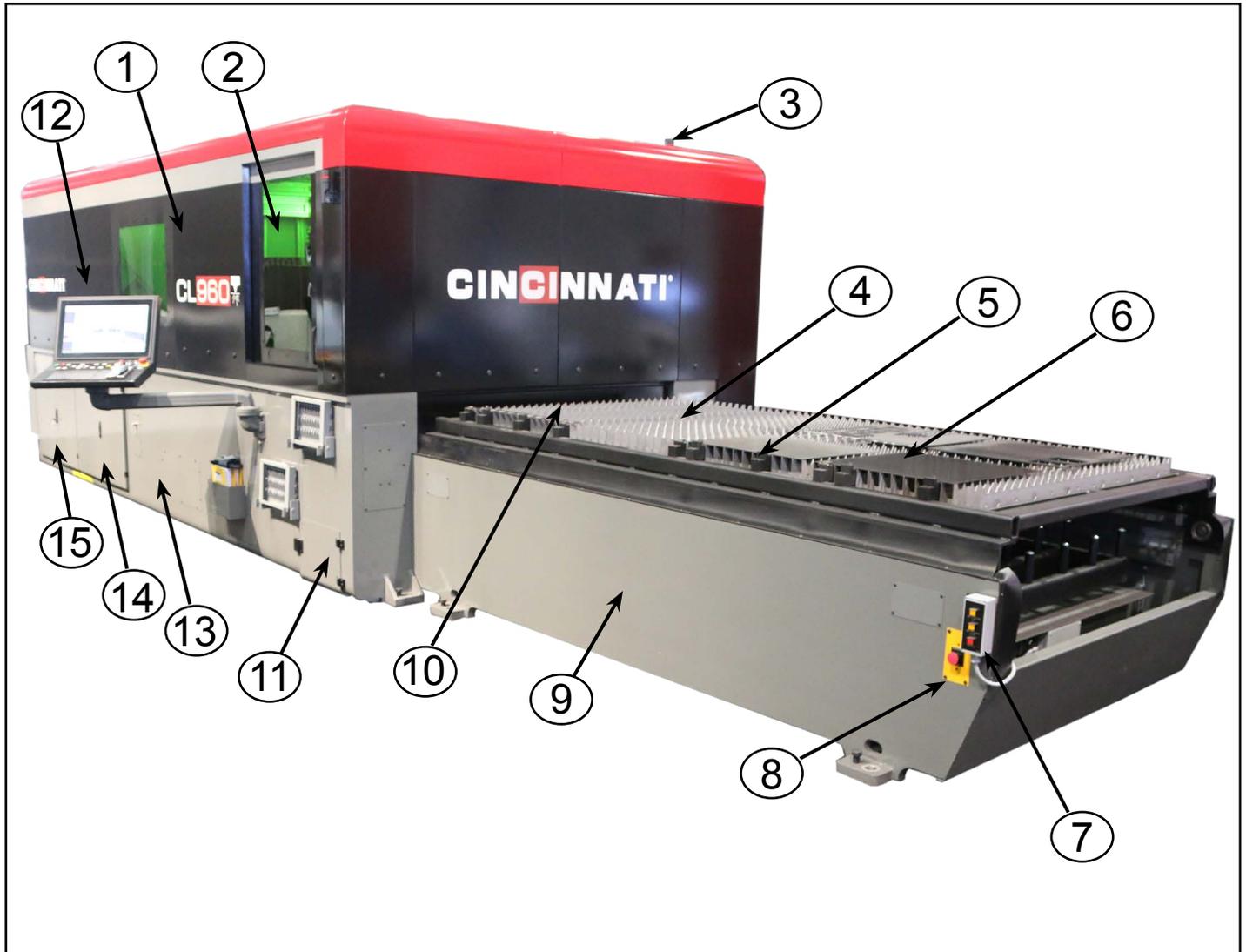
Material quality can affect the repeatability of process parameters. Material with uniform composition, uniform thickness, and a smooth, clean surface will minimize variations in part quality.



# SECTION 1

# IDENTIFICATION

## CINCINNATI CL-900 SERIES LASER SYSTEM - FIBER LASER



- |                                 |                              |
|---------------------------------|------------------------------|
| 1. ENCLOSURE                    | 9. LOAD FRAME                |
| 2. OPERATOR DOOR                | 10. PALLET DOOR              |
| 3. LASER STATUS INDICATOR LIGHT | 11. SCRAP BIN ACCESS DOOR    |
| 4. MATERIAL SUPPORTS            | 12. OPERATOR CONTROL STATION |
| 5. MATERIAL CLAMPS              | 13. MAIN FRAME               |
| 6. UPPER PALLET                 | 14. CONTROL ENCLOSURE        |
| 7. BALL TRANSFER REMOTE (OPT)   | 15. POWER ENCLOSURE          |
| 8. E-STOP BUTTON                |                              |

Figure 1-1 Front View



- 1. GAS AND WATER CONNECTIONS
- 2. ENCLOSURE ACCESS
- 3. ELECTRICAL CONNECTION

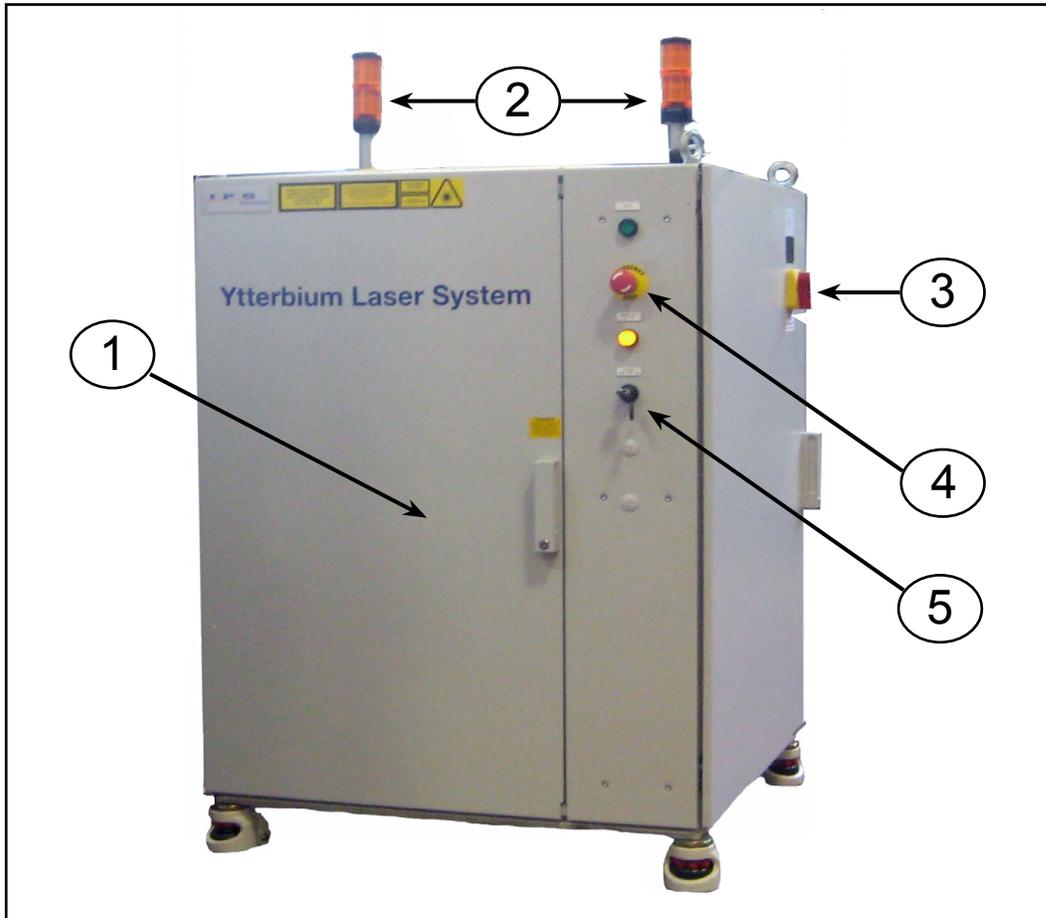
- 4. MAIN DISCONNECT
- 5. POWER ENCLOSURE
- 6. CONTROL ENCLOSURE

*Figure 1-2 Rear View*



- 1. LASER STATUS INDICATOR LIGHTS
- 2. CONTROL KEY
- 3. FIBER LASER E-STOP

*Figure 1-3 nLight Source*



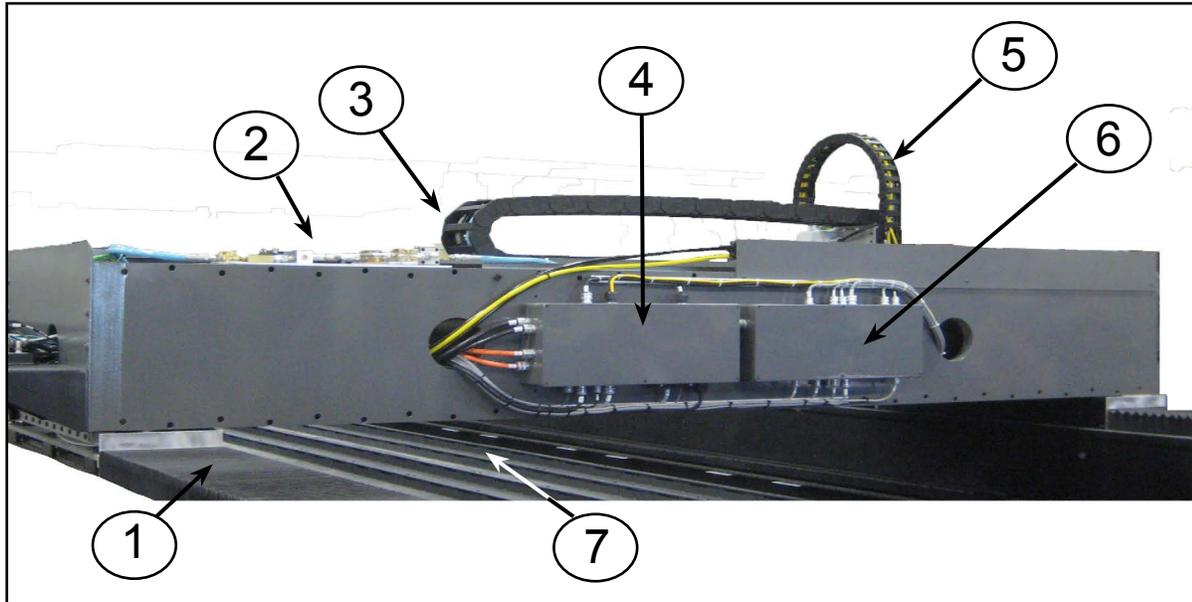
- |                                  |                       |
|----------------------------------|-----------------------|
| 1. ENCLOSURE                     | 4. FIBER LASER E-STOP |
| 2. LASER STATUS INDICATOR LIGHTS | 5. KEYSWITCH          |
| 3. FIBER LASER MAIN DISCONNECT   |                       |

**Figure 1-4 IPG Light Source**



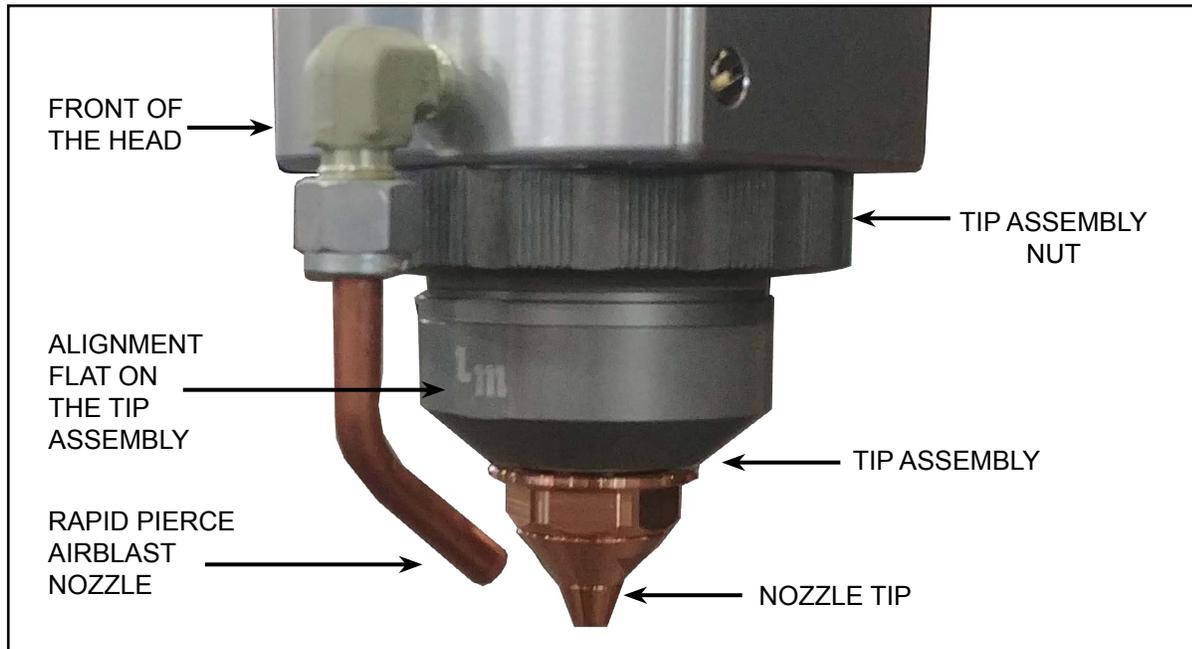
- |                            |                     |
|----------------------------|---------------------|
| 1. ENCLOSURE               | 4. MAIN DISCONNECT  |
| 2. STATUS INDICATOR LIGHTS | 5. CAREL CONTROLLER |
| 3. CONTROL SWITCH          |                     |

*Figure 1-5 Chiller*

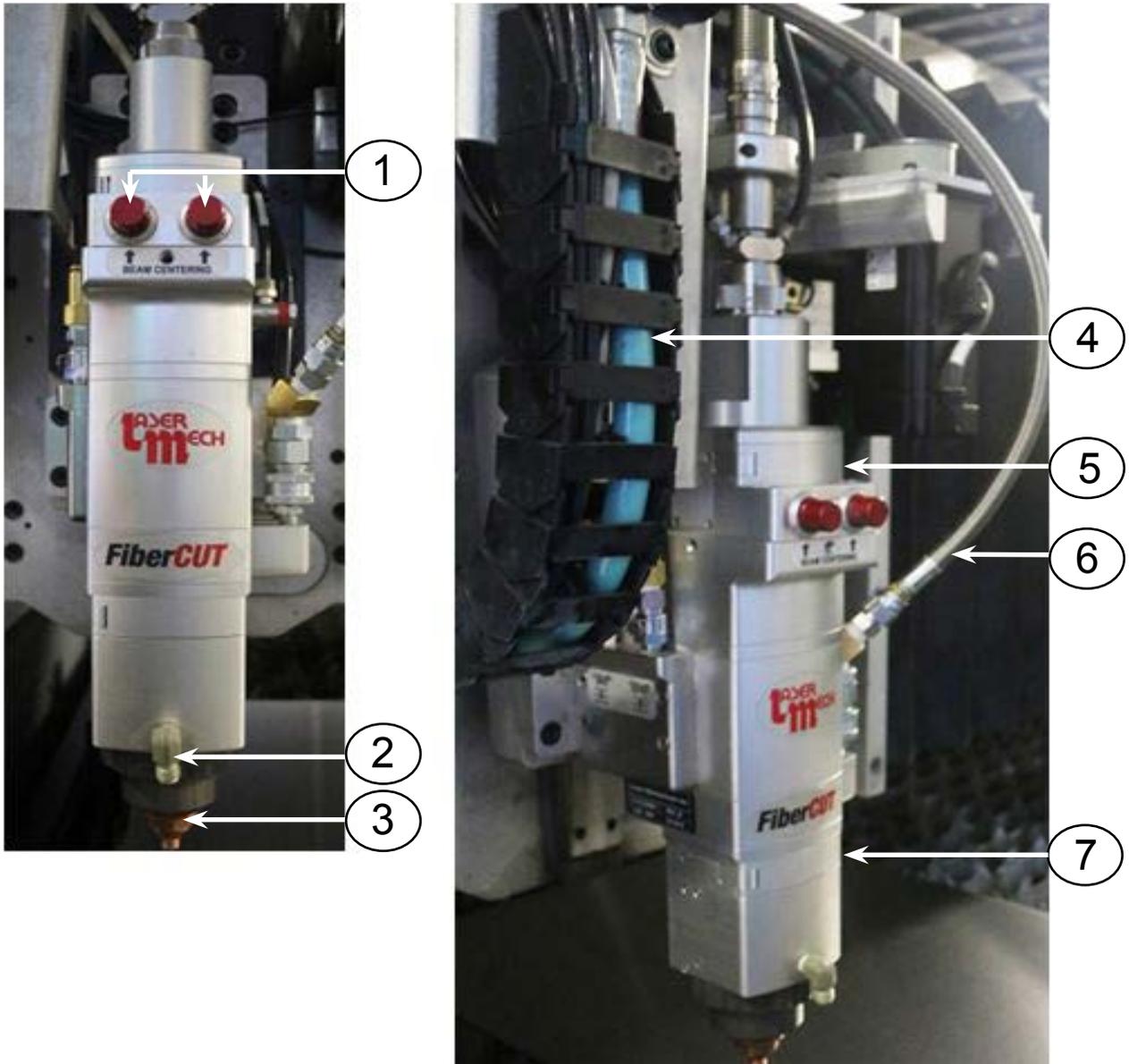


- |                                   |                               |
|-----------------------------------|-------------------------------|
| 1. X-2 AXIS WAY COVER             | 5. Z-AXIS FIBER CABLE CARRIER |
| 2. ASSIST GAS PROPORTIONAL VALVES | 6. RIGHT GANTRY ENCLOSURE     |
| 3. Y-AXIS CABLE CARRIER           | 7. SCRAP TRAY ASSEMBLY        |
| 4. LEFT GANTRY ENCLOSURE          |                               |

**Figure 1-6 Rear View of the Gantry**



**Figure 1-7 Complete Tip Assembly**



- 1. BEAM CENTERING ADJUSTERS
- 2. AIR BLAST
- 3. COMPLETE TIP ASSEMBLY
- 4. Z-AXIS CABLE CARRIER

- 5. UPPER COVER GLASS DOOR
- 6. ASSIST GAS HOSE
- 7. LOWER COVER GLASS DOOR

**Figure 1-8 Y-Plate and Auto Focus Head Assembly**

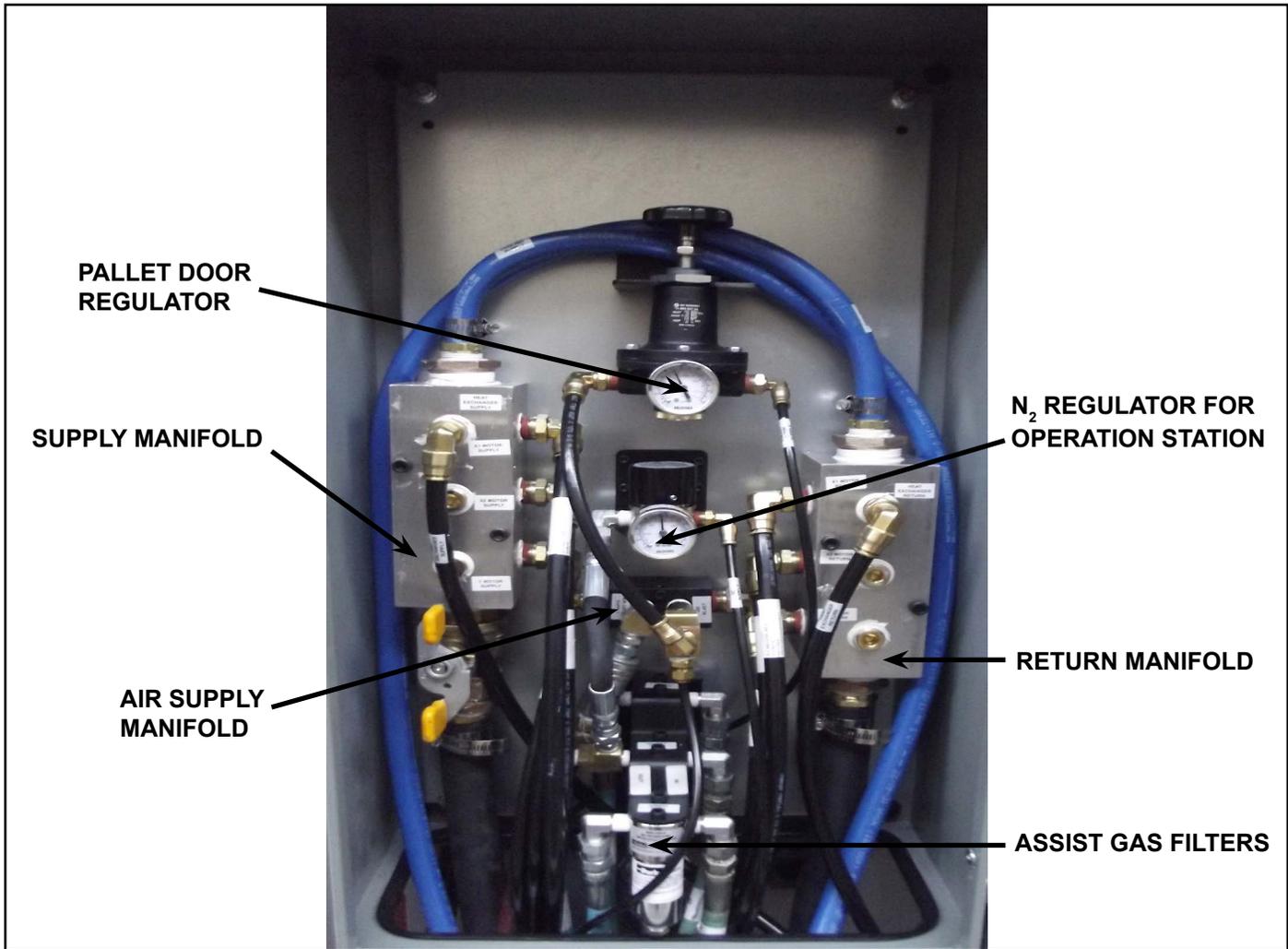


Figure 1-9 Pneumatic Enclosure



Figure 1-10 Y - Plate Manifold

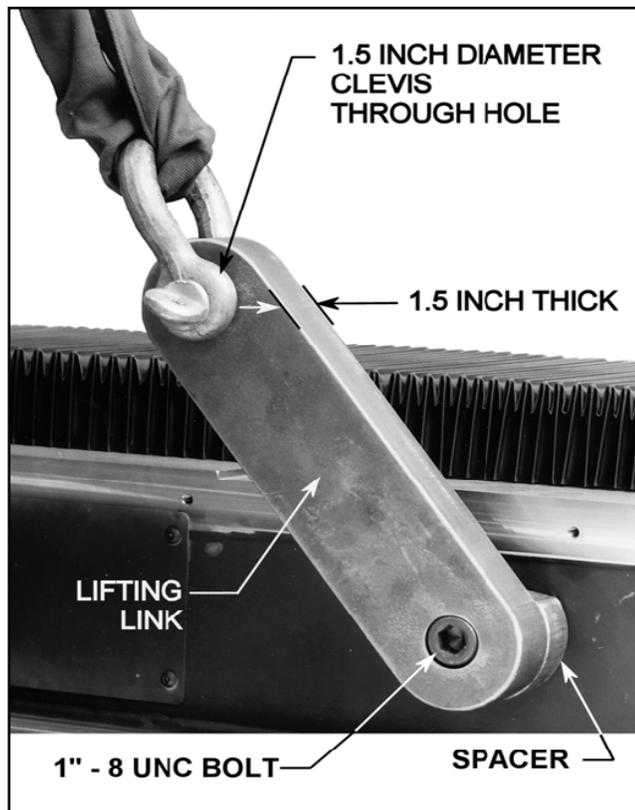


Before Proceeding contact a CINCINNATI Laser Service representative for pre-installation instructions.

## LIFTING AND MOVING

Machine weights are provided in **Section 4 - SPECIFICATIONS**.

The main frame is lifted by using four standard lifting clevises attached to four lifting links (C.I. P/N #920584) with spacers (C.I. P/N #921838). The four lifting links (supplied by CINCINNATI) are attached to the inside of the main frame with 1"-8 UNC SHCS bolts. See *Figure 2-1*.



*Figure 2-1 Lifting Main Frame*

When lifting with chains, cables, or straps, use the maximum length possible, to reduce the side loading generated at the lift points. Use spreader bars or intermediate lifting beam if ceiling height will not allow a high pick.

### **⚠ DANGER**

Before lifting the main frame, be sure that lifting links (C.I. # 920584) and spacers (C.I. # 921838) are installed. Do not use eyebolts or other devices that are not designed for excessive side loads. Using improper lifting devices could result in serious injury or death to bystanders and/or cause extensive damage to the main frame and fiber laser.

 **Extreme care must be taken not to subject the machine to shock loads. The machine must be lifted and set down gently.**

The load frame can be lifted using straps with S-hooks at each of the four outer corners. The S-hooks are hooked in the access holes located at the bottom of the load frame. Adequate padding must be used at all points to protect the machine's finish. The straps can be gathered and lifted with a hook attachment. See Figure 2-2.



**Figure 2-2 Lifting Load Frame**

## **FOUNDATION**

A Foundation Plan drawing is provided shortly after the machine is ordered. This drawing provides the user with detailed information required to locate the equipment and the eight machine anchors.

The customer should prepare the eight anchor locations prior to arrival of the equipment. The eight pads must be pre-leveled to lie in the same plane within .50 inches (12.7 mm), and the anchor holes should be drilled as specified on the Foundation Plan drawing. CINCINNATI INCORPORATED provides anchors, studs, nuts, and shims for final leveling.

If the machine is going to be installed near shock inducing equipment, such as punch presses, turret punches, etc., contact CINCINNATI INCORPORATED.

## **INSTALLATION OF THE MACHINE**

After setting the machine on the anchor studs, place washers and nuts on studs, but do not tighten. Follow these steps for proper installation:

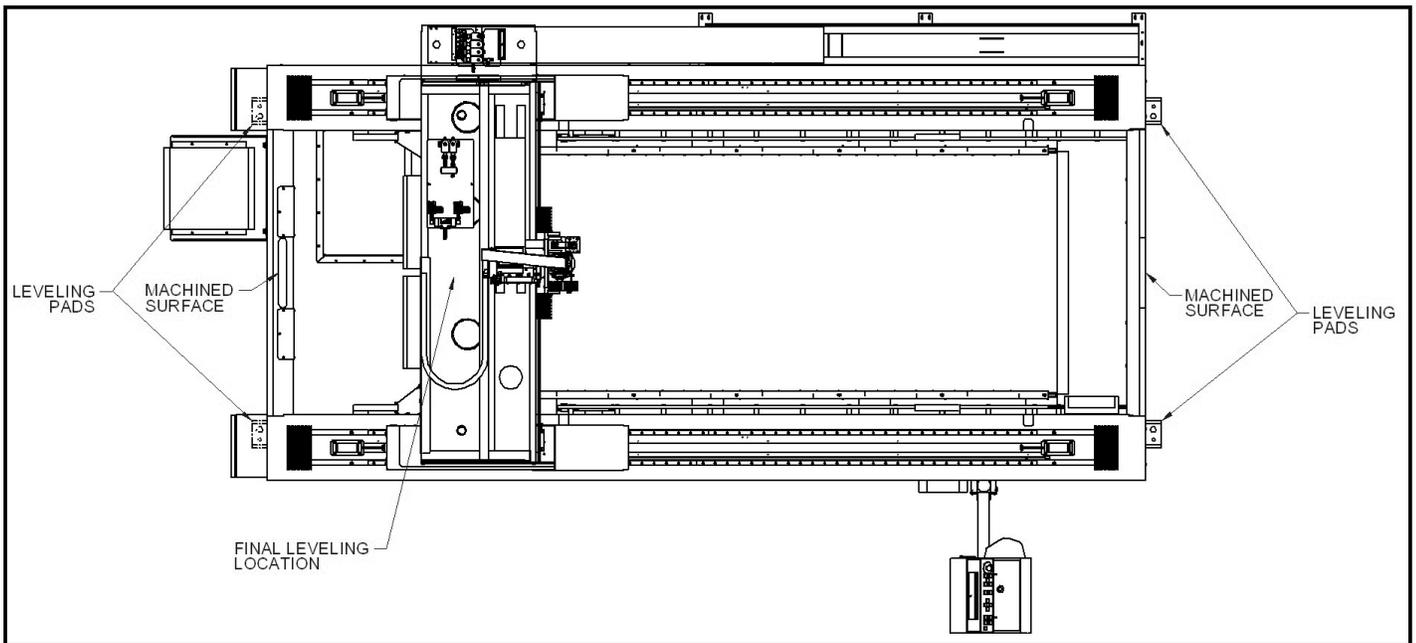
1. Remove lifting clevises and spacers.
2. Remove all steel banding and protective wrappings.
3. Install fume fan (optional) and fume duct connecting to fume plenum with flange and fasteners provided. Seal connection with a bead of RTV silicone. Make the electrical connection to the fan drive motor with wiring provided.
4. Connect the (customer-furnished) fume exhaust system to the fume duct exit port.
5. Complete preliminary leveling procedure described below.
6. CINCINNATI Service will install the operator control station and complete final electrical connections to the control.
7. Install gas lines, wiring, and hoses as described in the pre-installation manual.

## CHILLER

The water chiller is a free-standing unit requiring only floor support. Cooling lines are connected to the main frame and laser at the gas and water location mounted to the rear of the machine. Hoses are furnished to connect the chiller when located as shown on the Foundation Plan. If an alternative chiller location is required, consult CINCINNATI INCORPORATED. See **Section 4 - SPECIFICATIONS** for chiller fluid specifications.

## LEVELING

Main frame leveling adjustments are made using jackscrews provided at the mounting pads. Figure 2-3 shows the mounting pads. The machine foot mounting or leveling pads are located on the outside surface of the main frame in the four corners. Slotted shims are inserted between the machine foot and steel spacer block as shown on the Foundation Plan drawing. After shims are inserted, jackscrews are to be backed off or removed. The procedure for leveling is described in the next sections.



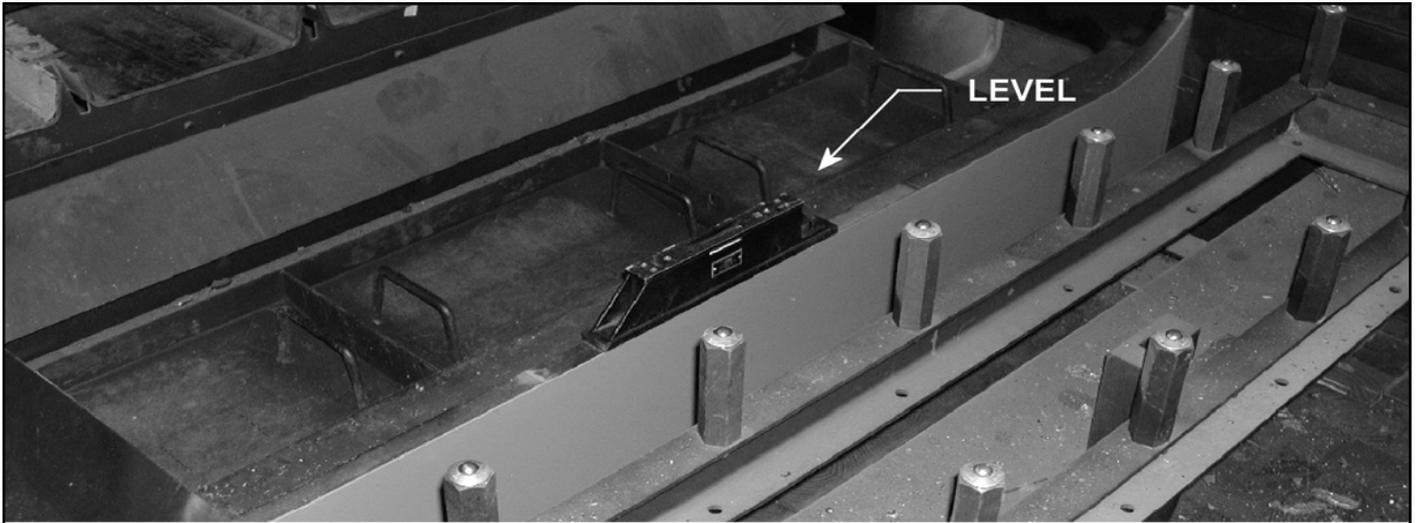
*Figure 2-3 Main Frame Leveling Adjustments*

## PRELIMINARY LEVELING

1. To check cross-leveling, place a precision level on machined pads on each end of the main frame. For preliminary leveling, a level with .004 inch/ft. precision is sufficient (0.33 mm per meter). See *Figures 2-3. and 2-4.* Lift machine with jackscrews and shim under mounting feet (shims are provided).
2. Longitudinal level is checked on the top of the X-axis guide way. Adjust as described above. See *Figure 2-5.* Longitudinal leveling does not require a precision level.

### **⚠ WARNING**

**A very powerful magnetic field surrounds the magnet track. Keep all metal (steel) tools away from this track. Place a piece of wood (2x4) over the magnetic track to protect it and personnel.**



**Leveling pads are located at each end of main frame.**

*Figure 2-4 Cross Leveling (Preliminary)*



*Figure 2-5 Longitudinal Leveling*

## FINAL LEVELING

Final leveling should be done with a CINCINNATI INCORPORATED Service Representative present.

The purpose of final leveling is to ensure that the gantry does not rotate about the X-axis as the gantry moves from end-to-end. Excessive rotation will cause laser beam misalignment during operation. Follow these steps for Final Leveling:

1. Use a 15 inch (380 mm) precision spirit level with a sensitivity of .0005 inch/ft. (0.04 mm per meter).
2. Place the level on the top of the gantry and position the gantry at X = zero. See Figure 2-6. The gantry may be moved by manually pushing it when drives are off, or by using JOG mode when drives are on.
3. The top of the gantry is not machined. Therefore, it will be necessary to shim one or both ends of the level to establish a reference reading and make the level sit solidly in place. Paper shims can be used for this purpose.

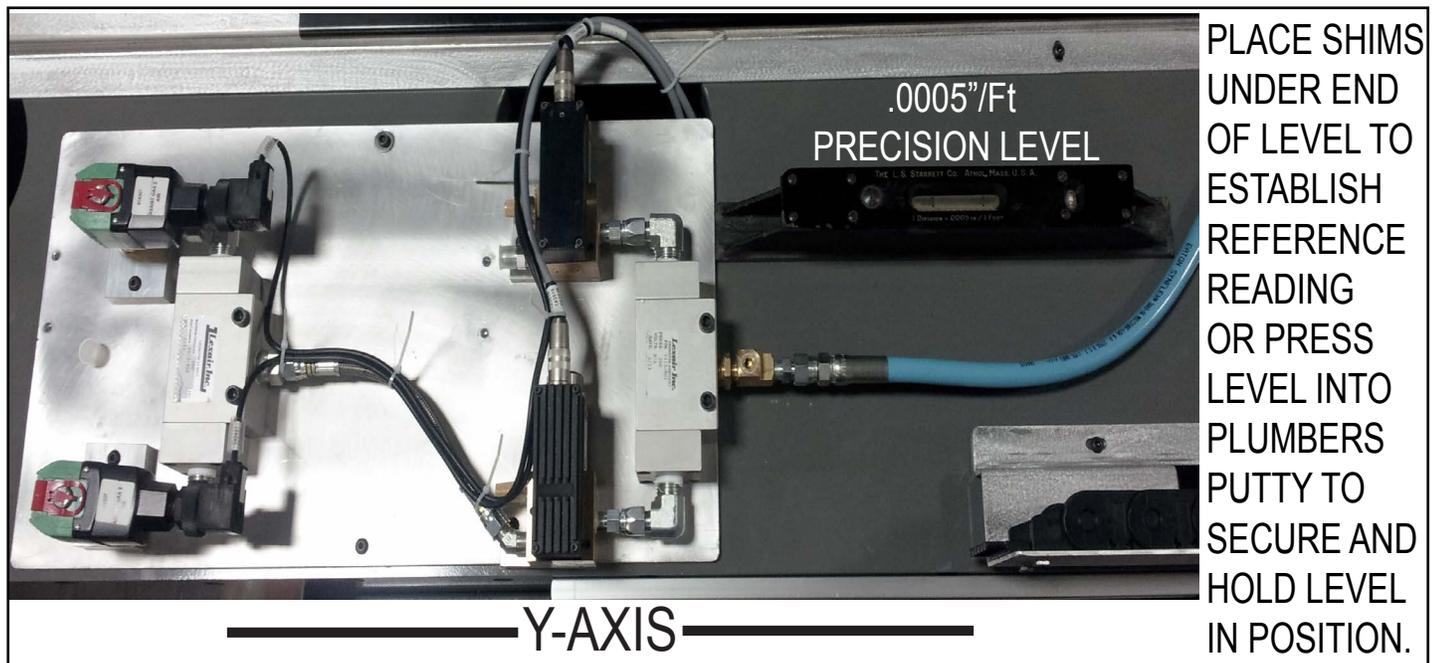


Figure 2-6 Final Leveling with Precision Level

4. Observe the position of the bubble while moving the gantry from X = zero to X = maximum travel. The maximum acceptable deviation is one division of the level (.0005 inch per ft. or 0.04 mm per meter) as the gantry moves from end-to-end. This ensures that the frame is not in a twist. Adjust as described above, using jackscrews to add or remove shims under mounting feet.
5. When Step 4 is complete, lightly tighten anchor nuts and recheck level as specified in Step 4. Verify that jacking screws are backed off and not supporting the machine
6. Tighten the anchor nuts.
7. Repeat Step 4 as a final level check.

## ELECTRICAL CONNECTION

Each Laser System customer is supplied a complete set of Foundation Plan drawings prior to machine shipment. The electrical load requirements and connection points are called out on these drawings.

Be certain that a suitably sized wire is brought to the main disconnect and the proper voltage is supplied. The standard electrical input is 460 volt, three phase, and 50/60 hertz. For direct connection without a transformer the service must be WYE connected 460 VAC  $\pm$ 10%.

The machine must be properly grounded in accordance with the National Electric Code NFPA 70, 2008 edition, article 250, sections 50 through 70. Place ground electrode per installation documents.

Do not start the machine until **Section 3 - SAFETY** of this manual has been read thoroughly and a CINCINNATI INCORPORATED Service Representative is present.

The machine controls have been designed to operate satisfactorily with good quality incoming electrical power. It is important that the electrical power be free of excessive noise and power fluctuations. Refer to the pre-installation instructions for details of input power requirements.

## SAFETY DEVICES



***DO NOT START THE MACHINE UNTIL SECTION 3 - SAFETY OF THIS MANUAL HAS BEEN THOROUGHLY READ AND A CINCINNATI INCORPORATED SERVICE REPRESENTATIVE IS PRESENT.***

**SAFETY IS EVERYONE'S JOB**

The CINCINNATI Laser System - Fiber Laser manufactured by CINCINNATI INCORPORATED has been designed to meet the highest order of reliability and ease of operator use. This system has been certified under Federal Regulations 21 CFR, subpart J, as a Class 4 Laser product as required by the Federal Radiation Control for Health and Safety Act of 1968. This certification is on file with the Food and Drug Administration "Center for Devices and Radiological Health" (CDRH) Division, Office of Compliance, 10903 New Hampshire Avenue, Silver Spring, MD 20993.

CINCINNATI INCORPORATED recommends the customer read and understand the requirements of the American National Standard ANSI B11.21 entitled "Safety Requirements for Design, Construction, Care, and Use of Machine Tools Using Lasers for Processing Materials" and ANSI Z136.1 entitled "American National Standard for Safe Use of Lasers". They are available from the American National Standards Institute, 25 West 43rd Street, New York, New York 10036.

For additional safety information, CINCINNATI recommends:

1. Obtaining applicable safety data from:

National Safety Council  
1121 Spring Lake Drive  
Itasca, Illinois 60143-3201

The Laser Institute of America, Suite 128  
3501 Ingenuity Drive  
Orlando, Florida 32826

2. Determining responsibilities under state and local safety codes.
3. Requesting assistance from the loss prevention department of the workmen's compensation carrier.

Personnel responsible for the Laser System operator training program, maintenance, and manufacturing operations must read and understand this Operation, Safety, and Maintenance manual. No one should set up, operate, or maintain this Laser System until thoroughly understanding it and knowing how to do the job safely. Read this manual in its entirety.

**INTRODUCTION TO LASER SAFETY**

The laser beam is a strong, highly directional beam of energy that, if directed, reflected, or focused upon an object, will be partially absorbed. This absorbed energy can raise the temperature of the object enough to cause material changes at the point where the laser beam hits the object. This process can also produce adverse biological effects in human tissue.

**A BRIEF DISCUSSION ON RADIATION**

Radiation is energy radiated or given off in the form of waves or particles. It is a general term used to describe energy emitted from a wide range of sources. Some sources are man-made, such as radio waves, and some occur naturally, such as the rays coming from the sun.

To keep track of all the various kinds of radiation, scientists developed a system to separate radiation by the length of the wave (or frequency) being sent out by the source. This is called the "electromagnetic spectrum". This spectrum covers the entire range of energy wavelengths from the very short gamma rays to the much longer wavelength of commercial electricity sent out from the electric company (for example, 60 cycle current).

All forms of electromagnetic radiation travel at the speed of light, but at differing frequencies. The longer the wavelength is, the lower the frequency. The energy transmitted by radiation is also related to its frequency. Higher frequency radiation can transmit greater energy.

Some radiation interferes with the internal energy that holds atoms together as molecules. If the energy of a ray of radiation is great enough, it will attract electrons away from an atom or add additional electrons to it. This is called “ionizing” radiation. X-rays are an example of this type of radiation. CINCINNATI Laser System - Fiber Lasers **DO NOT** use ionizing radiation.

Radiation that lacks the energy to deform atoms is called “non-ionizing” radiation. This is the type used in CINCINNATI Laser System - Fiber Laser. The IPG or nLight product is a diode-pumped ytterbium fiber laser. The laser beam is emitted in a continuous wave (CW) at a fixed wavelength of 1.07 micrometers. This wavelength is invisible to the human eye. It is just outside the visible spectrum in the near-infrared region and has high heat energy.

Non-ionizing radiation can cause harm. This is a result of the energy being absorbed and raising the temperature of the part of the body being hit. Over time, the heat energy being absorbed will reach a harmful level. This injury is similar to a burn received by standing too close to a bonfire for too long or the burn from being out too long in the sun.

If the body part exposed to non-ionizing radiation is the hardened, dead-cell tissue of the outer skin, minor harm will be done. A reddening of the tissue and mild soreness might be the only result. However, if that same radiation energy gets inside the body to less well-protected tissue, the tissue may not only be heated, but may become permanently damaged as well.

For example, the eyes are very susceptible to radiation. The cells of the cornea and retina are not protected by a layer of dead skin and thus can be damaged much easier than the skin. The eye should always be protected from radiated energy. Eye hazards and eye protection are covered in more detail later in this section.

Figure 3-1 is a chart of the electromagnetic spectrum. The CINCINNATI Laser System - Fiber Laser operates at a wavelength of 1.07 micrometers. As shown in the chart, this wavelength is just above the visible light spectrum in the infrared zone.

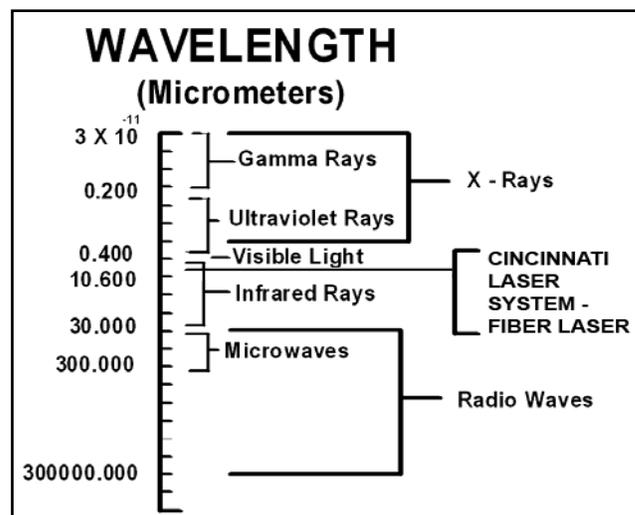


Figure 3-1 Electromagnetic Spectrum



*This brief introduction was prepared to alleviate any unwarranted concerns regarding laser radiation safety. A more detailed discussion can be obtained in OSHA Publication 8-1.7 entitled “Guidelines for Laser Safety and Hazard Assessment”.*

## SAFETY STANDARDS AND PUBLICATIONS

There are a wide variety of laser safety standards and publications. These include regulations of the federal government and of several state and local governments. Additionally, there are non-regulatory standards, such as the ones of the American National Standards Institute (ANSI) and of the American Conference of

Governmental Industrial Hygienists (ACGIH). Internationally, the World Health Organization (WHO) has laser safety guidelines, and the International Electrotechnical Commission (IEC) has been developing laser safety standards.

In 1968, the U.S. Government passed a law regulating products used in the United States that radiate energy. The law is the “Radiation Control for Health and Safety Act of 1968”. This law sets standards of performance for electrical products that emit radiation.

Laws like these are called U. S. Federal Laser Product Performance Standards or FLPPS. Manufacturers use FLPPS to ensure the design and manufacture of their product properly controls radiation hazards before the product is released to their customers. Examples of some of the products covered under this law are x-ray machines, microwave ovens, hair dryers, and all types of lasers.

The Federal Standards covering Lasers and Laser Products (for example, devices or machines containing a laser) are covered in the Federal Register at 21 CFR Part 1040.

Based on these standards, the level of radiation accessible to persons is used to group lasers into one of four classes. The classes are Class I, Class I.A., Class II, and Class IIIA., and Class IIIB, Class IV. These classes or risk categories establish the hazard controls required in the product’s design before a manufacturer can turn a product over to a user.

Research studies, along with an understanding of the hazards of sunlight and conventional, man-made light sources have permitted scientists to establish safe exposure limits for nearly all types of laser radiation. Laser safety specialists call these limits Maximum Permissible Exposures (MPE’s).

The standards and publications listed below will be the most helpful to users of CINCINNATI Laser Systems:

1. ANSI B11.21 “American National Standard for Machines Using Lasers”. The contents of this standard came from the users and manufacturers of the machines that use laser generated beams to process material.
2. ANSI Z136.1 “American National Standard for Safe Use of Lasers”. This standard, which is technical in content, was developed by the research and health community to cover all types of lasers and laser applications.
3. OSHA “Guidelines for Laser Safety and Hazard Assessment”. This was developed for OSHA Publication 8-1.7 field personnel to help in their job of enforcing workplace safety standards.

## LASER HAZARD CLASSIFICATION

Virtually all of the U.S. domestic as well as all international standards divide lasers into six major hazard categories called the laser hazard classifications. The classes are based upon a scheme of graded risk. They are based upon the ability of a beam to cause biological damage to the eye or skin. In the FLPPS, the classes are established relative to the Accessible Emission Limits (AEL) provided in tables in the standard. In the ANSI Z 136.1 standard, the AEL is defined as the product of the Maximum Permissible Exposure (MPE) level and the area of the limiting aperture. For visible and near infrared lasers, the limiting aperture is based upon the “worst-case” pupil opening and is a 7 mm circular opening.

Lasers and laser systems are assigned one of six broad Classes (I to IV) depending on the potential for causing biological damage. The biological basis of the hazard classes are summarized in the table below.

**Class I:** Cannot emit laser radiation at known hazard levels (typically continuous wave: cw 0.4  $\mu$ W at visible wavelengths). Users of Class I laser products are generally exempt from radiation hazard controls during operation and maintenance (but not necessarily during service).

Since lasers are not classified on beam access during service, most Class I industrial lasers will consist of a higher class (high power) laser enclosed in a properly interlocked and labeled protective enclosure. In some cases, the enclosure may be a room (walk-in protective housing) which requires a means to prevent operation when operators are inside the room.

- Class I.A:** A special designation that is based upon a 1000-second exposure and applies only to lasers that are “not intended for viewing” such as a supermarket laser scanner. The upper power limit of Class I.A. is 4.0 mW. The emission from a Class I.A. laser is defined such that the emission does not exceed the Class I limit for an emission duration of 1000 seconds.
- Class II:** Low-power visible lasers that emit above Class I levels but at a radiant power not above 1 mW. The concept is that the human aversion reaction to bright light will protect a person. Only limited controls are specified.
- Class IIIA:** Intermediate power lasers (cw: 1-5 mW). Only hazardous for intrabeam viewing. Some limited controls are usually recommended.
- Class IIIB:** Moderate power lasers (cw: 5-500 mW, pulsed: 10 J/cm<sup>2</sup> or the diffuse reflection limit, whichever is lower). In general Class IIIB lasers will not be a fire hazard, nor are they generally capable of producing a hazardous diffuse reflection. Specific controls are recommended.
- Class IV:** High power lasers (cw: 500 mW, pulsed: 10 J/cm<sup>2</sup> or the diffuse reflection limit) are hazardous to view under any condition (directly or diffusely scattered) and are a potential fire hazard and a skin hazard. Significant controls are required of Class IV laser facilities.

**TABLE III:6-4. LASER CLASSIFICATIONS--SUMMARY OF HAZARDS**

APPLIES TO WAVELENGTH RANGES				HAZARDS			
Class	UV	VIS	NIR	IR	Direct ocular	Diffuse ocular	Fire
I	X	X	X	X	No	No	No
IA	--	X†	--	--	Only after 1000 sec	No	No
II	--	X	--	--	Only after 0.25 sec	No	No
IIIA	X	X††	X	X	Yes	No	No
IIIB	X	X	X	X	Yes	Only when laser output is near Class IIIB limit of 0.5 Watt	No
IV	X	X	X	X	Yes	Yes	Yes

**Key:**  
**X** = indicates class applies in wavelength range.  
**†** = Class **IA** applicable to lasers “not intended for viewing” *ONLY*.  
**††** = CDRH Standard assigns Class **IIIA** to visible wavelengths *ONLY*.  
 ANSI Z 136.1 assigns Class **IIIA** to all wavelength ranges.

Because of the power needed to cut metal, **all** lasers used to cut metal are Class 4 lasers. Some Class 4 lasers are embedded in enclosures or rooms and called Class 1 laser products or Class 1 laser systems. However, control measures **must** still be established to insure that the enclosure is maintained and that proper operating procedures are followed.

## CONTROL MEASURES

The CINCINNATI Laser System - Fiber Laser has been designed and manufactured using the highest engineering control measures practical. However, even these high standards have limitations.

Laser safety requirements call for administrative and procedural controls to be incorporated in the use of lasers in order to minimize or eliminate the potential of personal injury during laser operation.

Laser safety experts have determined that the best way to control hazards presented by laser products is to establish a clear plan of hazard control that spells out specific responsibilities for all workers involved.

The plan has four worker categories. The Laser Safety Officer (LSO) is one category. The other three categories are for personnel working in laser operations, plant maintenance, and laser service.

### LASER SAFETY OFFICER

When an organization uses powerful laser products such as those strong enough to cut metal, it is recommended that someone in the organization be designated the Laser Safety Officer (LSO). This is especially true when dealing with Class 4 lasers whether they are embedded in a full enclosure and called Class 1 systems or not.

The LSO should be an employee who is part of the management organization. The LSO must be given the responsibility and authority to monitor and enforce the procedures established for controlling laser hazards. Unless a great number of laser products are involved, this will not be a full-time job but daily auditing of work procedures is often a good idea.

The LSO is responsible for seeing that written standard operating procedures (SOP) for the laser system are available. The information needed to establish these SOP's will come from the material provided by the laser system manufacturer, auxiliary equipment providers, and company safety rules. Each operator, maintenance person, or laser service person should have access to these SOP's and fully understand their content.

### OPERATING PERSONNEL

These people are responsible for the productive use of the laser cutting system over the full range of its intended function. These persons should be thoroughly familiar with all operating controls, adjustments, and hazards associated with their function.

### MAINTENANCE PERSONNEL

Laser safety procedures classify Maintenance level tasks as those done on machinery when the laser beam hazards are not present. Therefore, maintenance personnel are responsible for procedures that are completed in and around a laser system with the laser power off. Maintenance personnel should be thoroughly trained in the performance of those procedures.

### SERVICE PERSONNEL

Service personnel do the work required to maintain the laser system. They **must** have the complete knowledge of laser hazards and the controls provided by the system manufacturer for their protection from those hazards. They are responsible for doing the procedures and adjustments described in the manufacturer's service manual. The duty of a service person requires a higher level of training and education than that of the maintenance function.

### SAFETY PROGRAM

A strong commitment from management **must** exist in order for an effective safety program to be established with personnel involved in the use of the CINCINNATI Laser System - Fiber Laser. Additional information concerning this topic can be located in the American National Standard B11.21 and Z136.1. Refer to Appendix D of the ANSI Z136.1 standard for a guide for organizing and implementing a laser safety and training program.

## EXPLANATION OF LASER RADIATION

Light is a form of energy that is released from individual atoms or molecules in a substance. To understand how a laser works, it is necessary to know something about the nature of atoms and how they interact with light and other forms of energy.

Every atom is a storehouse of energy. The amount of energy in an atom depends in part on the motion of the electrons that orbit the atom's nucleus. When an atom absorbs energy, the energy levels of the electrons increase and the atom is said to be excited. The atoms of a substance become excited when they absorb heat, light, or other forms of energy that pass through the substance. An excited atom can return to its normal energy level by releasing its excess energy in the form of light. When this release of light occurs randomly, it is called spontaneous emission.

In spontaneous emission, excited atoms release light irregularly. As a result, the light has different frequencies, different phases, and travels in different directions. Light released in this way is called incoherent light. Such light is produced by the sun and by ordinary electric light bulbs.

Excited atoms also may release light systematically. This kind of release is called stimulated emission. It is the main process that takes place in a laser. Stimulated emission occurs when the energy released from one atom interacts with another atom that is still excited. The interaction stimulates the excited atom into releasing its own energy as light.

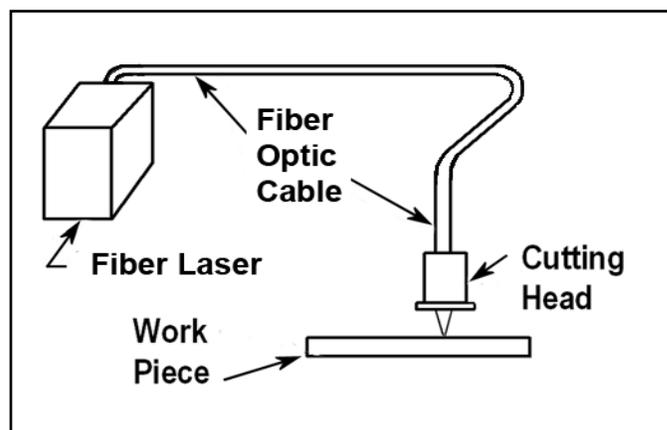
Most of the light produced by stimulated emission has the same frequency and same phase as the stimulating light. It also travels in the same direction, and so it combines with and amplifies the triggering light. Such light is called coherent radiation.

## LASER TYPES

There are four major types of lasers. The difference between them is the material used inside the laser that will emit the energy after being excited. These four types are:

- Solid-state lasers
- Gas lasers
- Dye lasers
- Semi-conductor lasers.

CINCINNATI Laser System - Fiber Laser uses solid-state diodes to generate the cutting beam. The actual laser-generating unit is located at the end of the CINCINNATI Laser System - Fiber Laser, and the beam is delivered to the cutting head through a fiber optic cable. See *Figure 3-2*.



*Figure 3-2 Fiber Optic Cable*

The enclosure at one end of the CINCINNATI Laser System - Fiber Laser is the fiber laser generating unit where the laser beam is created. The laser beam is delivered in a fiber optic cable, through the X, Y, and Z-axis carriers to the collimator. The beam enters the collimator where the beam paths are aligned in parallel before entering the cutting head. The cutting head uses lenses to focus the beam to a point as the beam travels out of the nozzle and onto the work piece.

In order to cut (vaporize) steel, a power density of over two million watts per square centimeter must be generated. To help visualize this concentration of power, Table 3-1 compares power densities of various conditions.

Condition	Power Density
Sunlight on the earth's surface	0.10 w/cm <sup>2</sup>
100 watt light bulb surface	1.0 w/cm <sup>2</sup>
Soldering Iron Tip	100 w/cm <sup>2</sup>
4000-watt laser beam, 1.00 inch (25.4 mm) diameter.	800 w/cm <sup>2</sup>
4000-watt laser beam, 0.010 inch (0.254 mm) focus spot diameter.	8 million w/cm <sup>2</sup>
Steel Threshold	2 million w/cm <sup>2</sup>

TABLE 3-1 Power Density Comparisons

## HAZARDS - CINCINNATI LASER SYSTEMS - FIBER LASER

### EYE HAZARDS

The beam of a CINCINNATI Laser System - Fiber Laser is a potential eye hazard. If the beam directly or indirectly hits the eye, there is a potential for injury to several different areas, depending upon which eye part absorbs the most radiant energy.

Laser radiation in the infrared, a range-generated by the CINCINNATI Laser System - Fiber Laser, can cause cataract and retinal damage. This light is invisible radiation. Therefore the laser should be operated **only** when the cut area safety enclosure doors and access panels are completely closed.

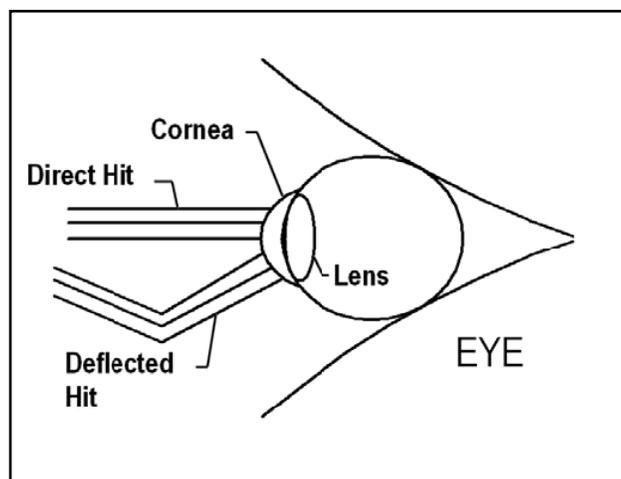


Figure 3-3 The Eye

The type and style of eye protection to use should be worked out with the supplier of shop eye protection.

Staring at the cutting plume is not necessary or advisable. The light energy being sent out by the cutting process is a mixture of many wavelengths. Besides the reflection of the laser beam there is the scattered radiation of the cutting process. The plume emits visible light and ultraviolet light.



*It is the users responsibility to establish and enforce an eye protection program.*

## SKIN HAZARDS

Laser radiation striking the skin is reflected, absorbed, and transmitted. The percentage of each depends upon the characteristics of the skin at the wavelengths of concern.

Effects on the skin from absorbed radiation may vary from mild redness to blistering and/or charring, depending upon the total energy absorbed and the rate at which it is absorbed. Unnecessary exposure of the skin to laser radiation should be avoided regardless of the level of radiant energy.

The CINCINNATI Laser System - Fiber Laser has been tested and found to have **no** detectable x-ray emissions and related hazards.

In general, the hazards presented by the CINCINNATI Laser System - Fiber Laser will be severe burns, lacerations, and possible amputation if members of the body are exposed to the direct beam or reflected beams of high energy.

The design of the Laser System provides engineered protection from these hazards for personnel while properly using this equipment. This basic design should not be altered or modified in any manner.

## NOMINAL HAZARD ZONES

Safety standards define a laser's Nominal Hazard Zone (NHZ) as "the space within which the level of the direct, reflected, or scattered radiation during operation exceeds the applicable Maximum Permissible Exposure (MPE)".

When considering a CINCINNATI Laser System - Fiber Laser, the radiation hazard is the laser beam which is strong enough to cause severe burns to the surface of the eye or skin if a worker is directly in its path or hit by the beam as it is reflected off machine or piece part surfaces.

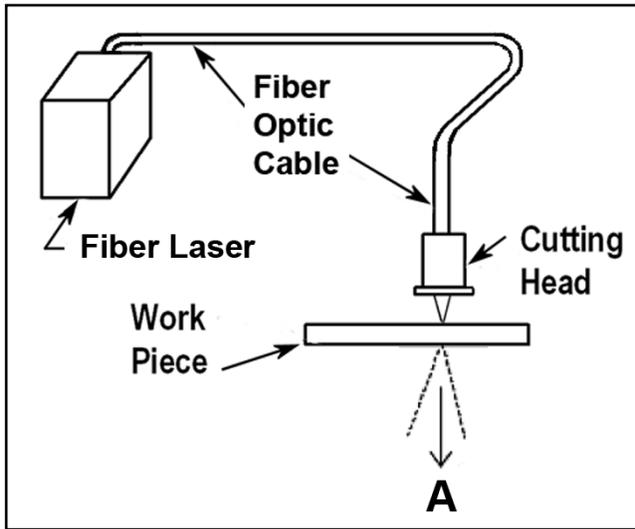
The NHZ is the space in all directions away from the beam where the heat from the beam is strong enough to cause injury. The NHZ can be calculated using the formulas and charts contained in the ANSI Z136.1 Safety Standard and used in this manual.

During piece part cutting, the beam is fully contained within the fiber optic cable and exits only at the cutting head. Figure 3-4 shows the usual path of the laser beam. At the cutting head, the lens focuses the beam downward to a spot as the beam exits to process material.

## BEAM EXPOSURE CATEGORIES

There are three categories of potential laser beam exposures on any laser cutting system:

- Intra-beam Exposure
- Specular Reflection Beam Exposure
- Diffuse Reflection Beam Exposure



LASER WATTAGE	DIRECTION	HAZARD DISTANCE
2000	A	1,725 ft. (525 m)
4000	A	2,437 ft. (743 m)
6000	A	2985 ft. (910 m)
8000	A	3446 ft. (1051 m)

**Figure 3-4 Uncontained Beam Hazard Distance**

The CINCINNATI Laser System - Fiber Laser’s design deals with beam exposure categories in various ways:

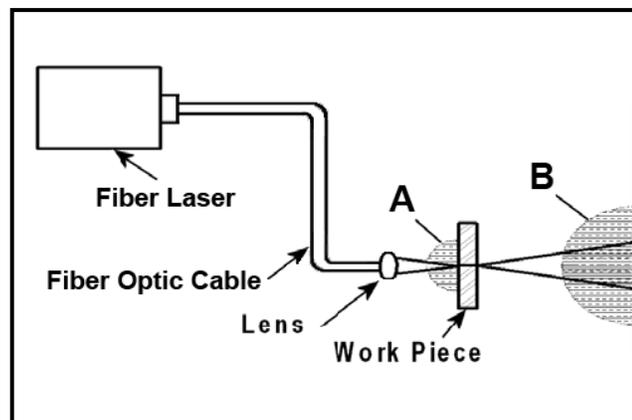
- Intra-beam (Direct) Exposure occurs when an object is in the beam’s path. The fiber optic cable fully contains the beam to the fiber head. The fiber optic cable is interlocked so that if the cable is damaged, the laser beam is disabled. The fiber head is also interlocked with the collimator so that if the fiber head is not connected to the collimator, the laser beam is disabled. The cutting head and collimator provide for a fixed downward beam direction, with two-axis motion. Automatic beam shutdown occurs through redundant mechanisms if the cutting head is knocked off or rises more than 1-1/2 inch (38 mm) above the top of the cutting pallet.

- Specular Reflection occurs when the beam reflects off a mirror-like object.

This mirror-like reflection of the focused beam off a work piece is directed upward into the cutting head and gantry due to the fixed downward beam direction and the horizontal work piece orientation.

- Diffuse Reflection occurs when the beam reflects off the work piece during cutting or when the unfocused beam hits an object.

The energy of the focused beam while cutting or the energy of the unfocused beam when it hits an object radiates away from the cut and decreases in intensity the farther it travels. Examples of diffuse reflection are shown in *Figure 3-5*.



**Figure 3-5 Diffuse Reflection**

“A” indicates energy reflecting off the material being cut.

“B” indicates energy reflecting off an object hit by the beam after the beam was focused.

The distance the diffusing energy must travel (in Figure 3-5 examples “A” or “B”) in order to be weak enough in intensity to not burn the skin or eyes can be calculated. The main variables in the calculation are the laser power and the reflective nature of the object being hit.

FIBER LASER		Φ POWER (WATTS)	NOMINAL HAZARD ZONE RADIUS	
SUPPLIER	MODEL		(CM)	(IN.)
IPG	YLS-2000	2000	356	140
IPG	YLS-4000	4000	505	199
IPG	YLS-6000	6000	618	244
nLight	alta-8000			
nLight		8000	714	281

**TABLE 3-2 Nominal Hazard Zone Radius**

Table 3-2 lists calculated distances for the CINCINNATI Laser System - Fiber Laser. This calculation assumes that the object being hit reflects all of the energy (the worst-case situation). The calculated distance, called the Nominal Hazard Zone Radius in the ANSI Z136.1 standard, was obtained using the method shown in this section.

**Calculation:**

Nominal Hazard Zone Radius =  $(P\Phi\text{Cos}\theta / \pi\text{MPE})^{0.5}$

P = Spectral Reflection of a Diffuse Object = 100% (worst case)

Φ = Total Radiant Power Output of a CW Laser or Average Radiant Power of a pulsed laser, in watts

θ = Viewing Angle in Degrees = 0° (worst case)

MPE = Maximum Permissible Exposure Level in watts per CM<sup>2</sup>. For Ytterbium laser beam exposure lasting more than 10 seconds, the MPE is 0.005 watts per CM<sup>2</sup>.

The features provided to keep workers far enough away from the hazards presented by diffuse reflection are:

- The Main Frame
- The Safety Enclosure

**ASSOCIATED HAZARDS**

**FIRE**

A fire hazard exists in the cutting area because of the interaction between the laser beam and the materials processed. Debris and fine particles generated from laser cutting some material. For example: plastics, aluminum, fabrics, etc., can create a fire hazard if allowed to accumulate in significant quantities. Good housekeeping practices should always be followed. The area under the pallets should be inspected daily and any accumulated material should be removed. The fume box and fume duct should be cleaned often.

Obtain Material Safety Data Sheets (MSDS) for the materials cut on the Laser System. These will contain information on the potential fire hazards and the type of fire fighting equipment that may be needed.

A mixture of aluminum particles and iron oxide particles is extremely hazardous if ignited. The reaction is self-sustaining and will generate temperatures as high as 5500°F (3038°C). Such temperatures are high enough to

melt nearly all metals and will melt through the bottom of the steel fume box. Hot sparks from the cutting process can be drawn into the fume box initiating this reaction. Fighting this type of fire requires a “Class D” dry powder fire extinguisher.

This hazard can be eliminated by avoiding accumulations of aluminum particles with iron oxide particles.



***Stainless steel will not contribute to this reaction.***

Cutting ferrous metal produces iron oxide particles. If the laser cuts only ferrous metal, clean the fume box and duct every 5000 hours; if cutting only aluminum, every 1000 hours. However, if the laser cuts a mixture of ferrous metal and aluminum, clean the fume box and duct every 500 hours.

There is an access panel in the fume duct below the blower, which can be removed to inspect and to clean the duct. The fume box can be cleaned by removing the cap retaining screws, removing the caps and sliding the scrap tray to expose one half of the box. After cleaning this half, the tray can be slid the other way to clean the other half of the box. This cleaning operation will require two to four hours, depending on the type of system and the tools available.

<p style="text-align: center;"><b>⚠ DANGER</b></p> <p><b>Before entering the main frame area or the area enclosed by the cut area safety enclosure, set Drives keyswitch on the machine operator panel to the “LOCK/OFF” position and remove the key. Also turn the High Voltage keyswitch to the “LOCK/OFF” position and remove the key.</b></p>
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A fire hazard exists when cutting highly reflective materials if the beam is not turned off immediately when the material does not absorb the laser energy. A fire hazard also exists when using the Rapid Pierce option due to high temperature slag ejected from the pierce zone.

When cutting highly reflective materials like aluminum or polished stainless steel, or when using the Rapid Pierce option, never operate the machine unattended unless fire and smoke detectors are provided.

Additional fire hazards exist in the electrical controls enclosed in the Laser System cabinets. Appropriate fire equipment should be available and operating personnel should understand how to use them. Follow these basic fire fighting procedures:

## **FUMES AND DUST**

<p style="text-align: center;"><b>⚠ DANGER</b></p> <p><b>Poisonous fumes may be formed by laser cutting. Do not breathe fumes.</b></p>
--

Use the Laser System only when there is adequate ventilation or respirators. A professional, qualified to assess ventilation control requirements should determine the ventilation requirements.

The Laser System can be equipped with an optional exhaust system that draws air down from the cutting surface. A professional qualified to assess ventilation systems should determine the optimal exhaust rate for a specific application.

The OSHA-required Material Safety Data Sheet for the material being processed should be reviewed to aid in

determining the nature and composition of the fumes being released. A qualified professional should determine the need and subsequent design of a device to eliminate poisonous emissions from the ventilation exhaust.

As mentioned previously, the process generates debris and fine particulate. This material should not be allowed to accumulate in the duct leading to the final exit point or control device. Combustible materials, like plastics, fabrics, aluminum, etc., could present a larger hazard than mild or stainless steel materials. A qualified professional should evaluate this hazard.

Operation of the Laser System and its ventilation system/control device may be subject to local, state, and federal environmental and occupational protection laws and regulations.

A professional qualified to assess environmental and occupational protection laws and regulations must be consulted before the Laser System is installed and operated.

## **GAS STORAGE**

The Laser System uses various gases to assist in the laser cutting process or to perform auxiliary functions. Gases commonly used include: oxygen, nitrogen, carbon dioxide, helium, and compressed air (or shop air). These gases are commonly available in compressed gas cylinders. Oxygen, nitrogen, and helium are also available as cryogenic liquids. Carbon dioxide, while not classified as a cryogenic, is also widely available in liquid form.

The next section will address safety consideration when storing and handling compressed gas cylinders. Additionally, there will be a discussion on safety precautions concerning cryogenic liquids.

## **COMPRESSED GAS CYLINDERS**

### **HANDLING**

Serious accidents may result from the misuse, abuse, or mishandling of compressed gas cylinders. Workers handling pressurized cylinders should be properly trained and should work only under competent supervision. Observing a few basic rules will help control hazards in the handling of compressed gas cylinders.

- Because of their shape, smooth surface, and weight, cylinders are difficult to carry by hand. Cylinders may be rolled on their bottom edge but **never** dragged. Cylinders weighing more than 40 pounds (18.2 kg) total should be transported on a hand or motorized truck, suitably secured to keep them from falling.
- **Do not** lift compressed gas cylinders with an electromagnet. Where cylinders must be handled by a crane or derrick, carry them in a cradle or suitable platform and take extreme care that they are not dropped or bumped. Do not use slings.
- **Do not** drop cylinders or let them strike each other violently.
- **Do not** use cylinders for rollers, supports, or any purpose other than to contain gas.
- **Do not** tamper with safety devices in valves or on cylinders.
- When empty, cylinders are to be returned to the vendor. Mark them EMPTY or MT with chalk. Close the valves and replace the valve protection caps if the cylinder is designed to accept a cap.
- **Always** consider cylinders as being full and handle them with corresponding care. Accidents have resulted when containers under partial pressure were thought to be empty.

### **STORING**

Cylinders should be stored in an upright position in a safe, dry, well-ventilated place prepared and reserved for that purpose. Flammable substances, such as oil and volatile liquids, should not be stored in the same area.

Cylinders should not be stored near elevators, gangways, stairwells, or other places where they can be knocked down or damaged.

- Oxygen cylinders should **not** be stored within 20 ft. (6 m) of cylinders containing flammable gases or near the location of other highly combustible materials.
- Cylinders are not designed for temperatures in excess of 130°F (54°C). Accordingly, they should **not** be stored near sources of heat, such as radiators or furnaces, or near highly flammable substances like gasoline.
- Cylinder storage should be planned so that cylinders are used in the order they are received from the supplier. Empty and full cylinders should be stored separately, with empty cylinders being plainly identified to avoid confusion. Empty cylinders that held the same type of material should be grouped together.

## USAGE

Safe procedures for the use of compressed gas cylinders include:

- Use cylinders in an upright position and secure them against accidentally being knocked over.
- Unless a recess in the head protects the cylinder valve, keep the metal cap in place to protect the valve when the cylinder is not connected for use. A blow on an unprotected valve might cause gas under high pressure to escape.
- Make sure the threads on a regulator or union correspond to those on the cylinder valve outlet. Do **not** force connections that do not fit.
- Open cylinder valves slowly. A cylinder not provided with a hand wheel valve should be opened with a spindle key or a special wrench or other tool provided or approved by the gas supplier.
- **Do not** use a cylinder of compressed gas without a pressure-reducing regulator attached to the cylinder valve, except where cylinders are attached to a manifold, in which case the regulator will be attached to the manifold header.
- Before making connection to a cylinder valve outlet, “crack” the valve for an instant to clear the opening of particles of dust or dirt. **Always** point the valve and opening away from the body and not toward anyone else.
- Use regulators and pressure gages **only** with gases for which they are designed and intended. **Do not** attempt to repair or alter cylinders, valves, or attachments. Only the manufacturer should do this work.
- **Do not** attempt to stop a leak between the cylinder and regulator by tightening the union nut, unless the cylinder valve has first been closed tightly.
- **Do not** expose the cylinder or attachments to sparks, molten metal, electric currents, excessive heat, or flames.
- **Never** use oil or grease as a lubricant on valves or attachments of oxygen cylinders. Keep oxygen cylinders and fittings away from oil and grease, and do not handle such cylinders or apparatus with oily hands, gloves, or clothing.
- **Never** use oxygen as a substitute for compressed air. Use oxygen only to assist the cutting process.
- Before a regulator is removed from a cylinder valve, close the cylinder valve and release the gas from the regulator.
- Cylinder valves **must** be closed when work is finished.

## REGULATORS

Pressure regulators **must** be used on cylinders to maintain a uniform gas supply at the correct pressure. The oxygen regulator should be equipped with a safety relief valve or be so designed that, should the diaphragm rupture, broken parts will be contained. Workers are advised to stand to one side and away from regulator gage faces when opening cylinder valves.

- High-pressure oxygen dial gages should have safety vent covers to protect the operator from flying parts in case of an internal explosion. Each oxygen dial gage should be marked OXYGEN - USE NO OIL OR GREASE.
- Serious, even fatal, accidents have resulted when oxygen regulators have been attached to cylinders containing fuel gas, or vice versa. Cylinder valve outlet threads have been standardized for most industrial and medical gases. Different combinations of right hand and left hand threads, internal and external threads, and different diameters to guard against wrong connections are now standard.
- The regulator is a delicate apparatus and should be handled carefully. It should **not** be dropped or pounded on. Regulators should be repaired only by qualified persons or sent to the manufacturer for repairs.
- Leaky or “creeping” regulators are a source of danger and should be withdrawn from service at once for repairs. For example, continuous creep occurs when the low-pressure (delivery) gage indicates a steady buildup of pressure while demand is off. If a regulator shows continuous creeping, close the cylinder valve and remove the regulator for repairs.
- If the regulator pressure gages have been strained so the hands do not register properly, the regulator must be replaced or repaired before it is used again.
- When cylinder valves are open, they should be fully open to the top of seat.
- When regulators are connected but are not in use, the pressure-adjusting device should be released. Cylinder valves should never be opened until regulator is drained of gas and pressure-adjusting device on the regulator is fully released.

These procedures should be followed in detail when a regulator or reducing valve is attached to a gas cylinder.

## CRYOGENIC LIQUID

### CHARACTERISTICS OF CRYOGENIC LIQUIDS:

A cryogenic liquid has a normal boiling point below  $-238^{\circ}\text{F}$  ( $-150^{\circ}\text{C}$ ). The most commonly used industrial gases that are transported, handled, and stored at cryogenic temperatures are oxygen, nitrogen, argon, hydrogen, and helium.

Many safety precautions that must be taken with compressed gases also apply to liquefied gases. However, some additional precautions are necessary because of the special properties exhibited by fluids at cryogenic temperatures.

Both the liquid and its boil-off vapor can rapidly freeze human tissue and can cause many common materials such as carbon steel, plastic, and rubber to become brittle or fracture under stress. Liquids in containers and piping at temperatures at or below the boiling point of liquefied air ( $-318^{\circ}\text{F}$  or  $-194^{\circ}\text{C}$ ) can cause surrounding air to condense into a liquid.

Extremely cold liquefied gases (helium, hydrogen, and neon) can even solidify air or other gases to which they are directly exposed. Most cryogenic liquids are odorless, colorless, and tasteless when vaporized to a gas. As liquids, most have no color; liquid oxygen is light blue. However, whenever the cold liquid and vapor are exposed to the atmosphere, a warning appears. As the cold boil-off gases condense moisture in the air, a fog extends over an area larger than the vaporizing gas forms.

## GENERAL SAFETY PRACTICES

The properties of cryogenic liquids affect their safe handling and use.

- **Always** handle cryogenic liquids carefully. They can cause frostbite on skin and exposed eye tissue. When spilled, they tend to spread. The vapors emitted by these liquids are also extremely cold and can damage delicate tissues.
- **Never** allow any unprotected part of the body to touch non-insulated pipes or vessels that contain cryogenic fluids. The extremely cold metal will cause the flesh to stick fast to the surface and tear when withdrawn.

## SPECIAL PRECAUTIONS

Some liquefied gases require special precautions. For example, when oxygen is handled, all combustible materials, especially oil or gases, should be kept away. Smoking or open flames should **never** be permitted where liquid oxygen is stored or handled. NO SMOKING signs should be posted conspicuously in such areas.

Oxygen will vigorously accelerate and support combustion because the upper flammable limit for a flammable gas in air is higher. In an oxygen-enriched air atmosphere, fire or explosion is possible over a wider range of gas mixtures.

## ASPHYXIATION

All gases, except oxygen, will cause asphyxiation by displacing breathable air in an enclosed workplace. These gases should be used and stored in well-ventilated areas.

Only oxygen will support life. The presence of these gases cannot be detected without instrumentation. Asphyxiation can be sudden or may occur slowly without the worker being aware that there is trouble.

Unless large quantities of inert gas are present, using proper ventilation at **all** times will easily prevent asphyxiation. Nitrogen should be vented outside to safe areas to prevent any possible problems.

## TRAINING

The best single investment in safety is trained personnel. Some workers will need detailed training in a particular type of equipment or operation. Others will require broader training in safe practices for a variety of operations.

The location and maintenance of safety and fire fighting equipment are important. Outside personnel also should be informed of **all** necessary safeguards before entering a potentially hazardous area. In general, practicing good housekeeping rules and demanding a high level of worker conduct everywhere in the plant will minimize negligence.

## MACHINE HAZARDS AND WARNINGS

### MOVING MACHINE MEMBERS

- **Never** walk or stand on the sheet support grids. Severe injury can result from falling on sharp support tips.
- **Do not** approach the gantry or enter the cutting area while drive power is on. Severe injury can result from being struck by the moving gantry. A safety enclosure provides protection on the operator side of the machine. Ensure that the gates are installed and are operating properly.
- **Never** go into the cutting zone or climb inside the main frame with the gate closed. Opening any Cut Area Enclosure door will disable the laser preventing the delivery of the laser beam. Turn off the red light, flash the on screen Laser Ready button and remove power from all axes and pallets except the autofocus lens assembly. This ensures protection for the operators who must enter the cutting area temporarily to perform adjustments or retrieve parts.

- **Do not** climb on or between work pallets while DRIVE power is on. Severe injury can result from being trapped between moving pallets. Exercise extreme caution when pallet movement is performed. Remember that when the “Pallets Not Ready” button is not illuminated, the pallets will switch automatically when the cutting program commands the proper code.



**To turn drive power off and prevent unintended motion of the gantry and pallets, turn the DRIVES keyswitch to the “LOCK/OFF” position and remove the key.**

## WARNING (AWARENESS) LIGHTS

The laser systems have several light sources that provide notice to personnel regarding the status of the laser beam and laser generating unit.

The IPG has a flashing amber beacon on top of the laser generating unit. This light is illuminated any time the laser main voltage is turned on. Its purpose is to make personnel in the area of the Laser System aware of the potential for a laser beam to be present inside the fiber laser cabinet. The IPG also has a red beacon on the operator’s side that indicates the status of the laser. If the beacon is flashing, the laser has all of its enables turned on and is ready for emission. If the beacon is on solid, then laser emission is on and laser energy will be delivered to the cutting head.

The nLight has white emission lights that are illuminated any time the laser main voltage is turned on.

Numerous other indicators and displays located on the Laser System Control Touchscreen serve to inform personnel of the status of various Laser System functions. Read **Section 6 - CONTROLS** of this manual to become familiar with the purpose of these illuminated switches and displays.

## CUT AREA ENCLOSURE

The Cut Area Enclosure completely contains the laser beam and any reflected radiation, below the maximum permitted exposure limitations. The cut area enclosure forms the Nominal Hazard Zone. The cut area enclosure also provides localized protection from strike and pinch hazards caused by the automatic motion from the gantry, cutting head, and pallets. The Cut Area Enclosure has an operator door, service door, and pallet door, which are safety interlocked and disable the laser if opened.

In operation, the flashing red light on the side of the enclosure indicates the laser is enabled and ready to cut or is cutting. Opening any Cut Area Enclosure door will disable the laser preventing the delivery of the laser beam, turn off the red light, flash the on screen Laser Ready button and remove power from all axes and pallets except the autofocus lens assembly. This ensures protection for the operators who must enter the cutting area temporarily to perform adjustments or retrieve parts. The MAIN DRIVES light will remain ON even though the drives power is off. If Laser Ready is flashing, when the gate is closed, the Laser will be enabled, indicated by the flashing red light and a solid green Laser Ready button. Press Reset to re-enable the drives and pallets.

To make repairs, the Drive key and High Voltage key should be turned to the Lock/Off position and the keys removed.



**Never be in the Cut Area Enclosure or climb inside the main frame with all gates closed.**

To resume automatic operation, close all Cut Area Enclosure doors, press the MAIN DRIVES button, wait 3 seconds for the servo drives to power up, then press RESET. If a part program was interrupted, pressing the CYCLE START will allow the program to resume from the start of the block where it was interrupted.

## SAFETY SIGNS

To warn laser operators and maintenance personnel of certain potential hazards that may exist, unless specified procedures are followed, a number of warning signs are attached to CINCINNATI Laser Systems.



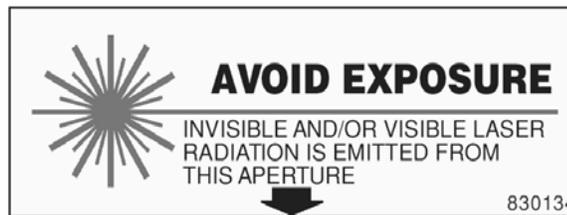
**Warning signs are not intended to be a substitute for reading and understanding this section and the machine Section 7 - Operation Supplement Manual, EM-574.**

The warning signs are placed at strategic points on the Laser components for the most effective use. They are a permanent part of the machine and, therefore, **must not** be removed, covered, hidden, or defaced. A six-digit number, usually located in the lower right corner, identifies all signs installed on machines by CINCINNATI INCORPORATED. If any of these signs become damaged or defaced, new ones should be ordered by contacting the factory or the nearest CINCINNATI Sales and Service Office.

The following images illustrate warning signs that are commonly used on the laser system. However, other signs may be furnished, due to special equipment or machine features, to cover possible hazards. The laser manufacturer furnishes additional signs on the laser generating unit and laser power supply. The user management should also provide additional warning signs to cover any hazards that may be presented by customer-added auxiliary equipment.

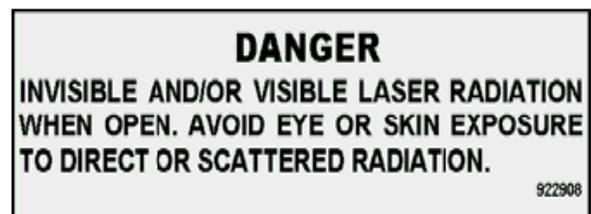
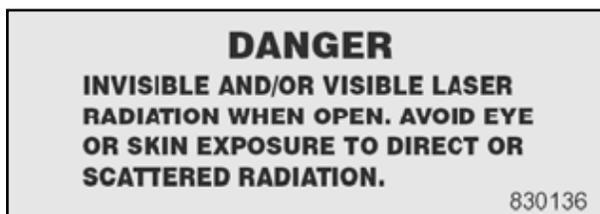
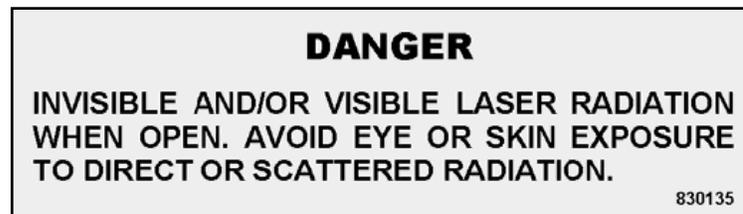
### AVOID EXPOSURE - APERTURE (830134)

This sign is mounted on the bottom front of the cutting head assembly. It warns of laser radiation emitted from the cutting head. This sign is also mounted above the aperture of the laser head and warns of laser radiation emitted from the laser head.



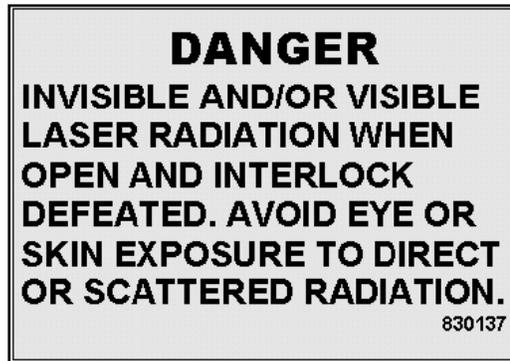
### DANGER - LASER RADIATION (830135, 830136, and 922908)

These signs warn of a laser radiation hazard that will be present when a cover is removed from the machine. The signs are located on removable covers and on the interior surfaces that are exposed when the cover is removed. The warning descriptions on the signs are identical; the only difference between the signs is their physical size.



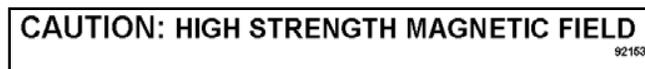
### DANGER - LASER RADIATION (830137)

This sign is mounted above the cutting head assembly on Z-axis block cover. This sign warns that if the cutting head is removed and the breakaway interlock is defeated, then laser radiation may be present.



### HIGH STRENGTH MAGNETIC FIELD (921533)

This sign warns that a high strength magnetic field is present. The sign is located underneath both X-axis and Y-axis bellows. Caution must be used when servicing the linear motors and linear bearing rails. The magnetic fields from the magnets are strong enough to rip steel tools from the user's hands.



### DANGER – TO REDUCE THE POSSIBILITY OF SERIOUS INJURY (913208)

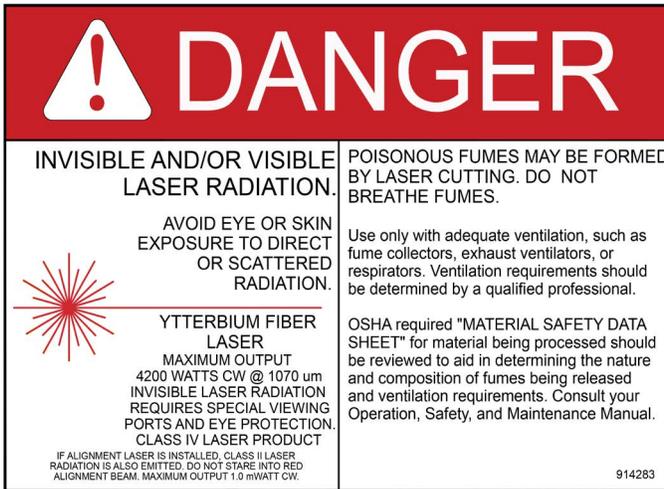
This sign is mounted on the sides and rear of the cut area enclosure. It warns against the dangers of climbing on the material support grids or machine frame and defeating the safety mat. It instructs operators to wear safety glasses, and instructs all personnel to read and understand this manual before operating or servicing the machine.



### DANGER - LASER SPECIFICATIONS / POISONOUS FUMES (914283, 916254)

The left side of this sign is a warning to avoid exposure to laser radiation. Below the warning is a list of specifications for laser type, power, and class. The large, bold lettering warns persons working around the laser to be aware of potential radiation hazards.

In small letters at the bottom of the left side is a warning for the optional positioning (red beam) laser. It warns persons not to stare into the red beam, which can cause eye injury. Operators use this visible beam to locate the cutting head position. Maintenance personnel use the visible beam to align the beam delivery system.

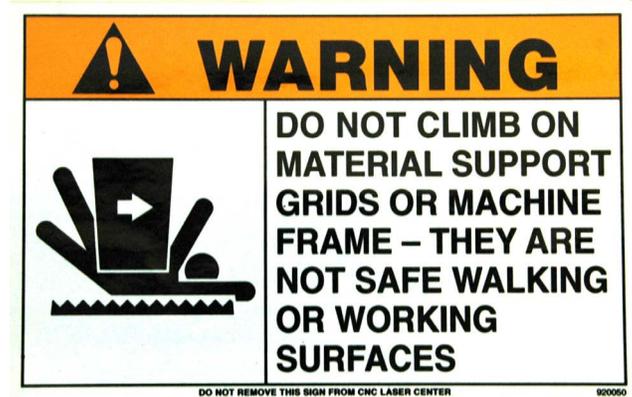


The right side of the sign warns that laser cutting may form poisonous fumes, and that the nature and ventilation of these fumes must be determined.

This sign is mounted at three places: one sign is on the operator's and non-operator's side of the cut area enclosure and third sign is mounted on the rear of the cut area enclosure.

**WARNING – DO NOT STAND ON MATERIAL SUPPORT GRIDS OR MACHINE FRAME (920050)**

This sign is mounted on each side of the load frame. It warns against standing on the material support grids or machine frame. These structures are not designed as walking or working surfaces and could collapse, resulting in severe injury. It is also possible to be struck by the moving gantry or trapped between the gantry and the material support grids, resulting in severe injury or death.



**WARNING – DO NOT ENTER AREA BETWEEN THE PALLETS (921341)**

This sign is mounted on both sides of the load frame near the main frame. It warns against entering the area between the two pallets unless unintended motion of gantry and pallets is prevented.



## **SAFETY GUIDELINES**

The following guidelines should be followed to ensure safety:

- Safeguarding, such as panel covers, are in place and working.
- All safety interlocks are engaged and operating properly.
- No portion of the body is exposed to laser beam when performing service work.
- Personal protective equipment, such as safety glasses, gloves, shoes, and hand tools are in use.
- The work area is free of non-essential tools and equipment.
- Small pieces are supported to reduce the possibility of tip-up during and after cutting.
- Know the controls; be familiar with emergency shutdown procedures.
- Fume and dust control system is operating properly.
- Do not position any part of the body where it may be struck or crushed by machine movement.
- Turn off or lock-out operating controls while not using Laser.
- Make sure everyone is clear of the pallets and gantry before operating.
- Warning signs and lights are visible to all personnel.
- There are no obstructions between the laser cutting head and the material being processed.
- Use material handling devices for movement of heavy work pieces.
- Do not stack material on the idle pallet.

## **SAFETY MAINTENANCE CHECK**

- SAFETY ENCLOSURES operating properly.
- ALL service access panels bolted in place.
- PINCH POINT guarding properly installed.
- OPERATOR CONTROLS working properly.
- OPERATING MODES functioning properly.
- GANTRY and CUTTING HEAD positioning properly.
- SAFETY SIGNS clean and easily read.
- PROCESSING AREA and fume plenum area clear of debris.
- AIR FILTRATION UNIT received recommended scheduled cleaning.
- ELECTRICAL WIRING in good condition.
- AUXILIARY EQUIPMENT checked and working properly.
- HAND TOOLS and personal protective equipment in good order and readily available.
- SAFETY MANUALS and OPERATOR MANUALS in holder near the Operator Control Station.
- SCHEDULED NORMAL MAINTENANCE work completed.

***SAFETY IS PART OF THE JOB... THE MORE ATTENTION PERSONNEL PAY TO DEVELOPING SAFE HABITS, THE LESS CHANCE OF INJURIES TO EVERYONE INVOLVED.***

# SECTION 4

# SPECIFICATIONS

## DIMENSIONS

COMPONENT	MODEL	WIDTH		LENGTH	HEIGHT	WEIGHT
		Shipped	Installed			
		In. (mm)	In. (mm)	In. (mm)	In. (mm)	Lbs. (kg)
MAIN FRAME	5 X 10	125	189	268	100	23,200
	(1.5 X 3.0 m)	(3175)	(4801)	(6808)	(2540)	(10524)
	6 X 12	144	208	268	100	27,200
	(2.0 X 4.0 m)	(3658)	(5283)	(6807)	(2540)	(12338)
	8 X 20	160.5	274	414.2	99.1	?
	(2.5 X 6.1 m)	(4077)	(6960)	(10521)	(2517)	(11135)
LOAD FRAME	5 X 10	84.25		134	40	8,750
	(1.5 X 3.0 m)	(2140)		(3404)	(991)	(3969)
	6 X 12	103		161	40	10,200
	(2.0 X 4.0 m)	(2616)		(4090)	(991)	(4631)
	8 X 20	122.25		270	41	22,900
	(2.5 X 6.1 m)	(3105)		(6858)	41	22,900
CHILLER	CL-920 (60 Hz)	28		50	66	900
		(711)		(1270)	(1677)	(409)
	CL-940 (60 Hz)	28.5		42	64	1110
		(915)		(1474)	(1626)	(544)
	CL-960 (60 Hz)	35.5		50	64	1400
	CL-980 (60 Hz)	35.5		50	64	1400

## SPECIFICATIONS

LASER	RATED POWER	TYPICAL RANGE
YLS-2000	2000 W	200-2000 W
YLS-4000	4000 W	400-4000 W
YLS-6000	6000 W	600-6000 W
alta-6000		
alta-8000	8000 W	800-8000 W

**WAVELENGTH:** 1.07 micron

**MODE:** CW, QCW

**LASER:** Class IV

### MAXIMUM WORKPIECE:

MODEL	WORKPIECE DIMENSIONS		EVENLY DISTRIBUTED LOAD
	X	Y	CAPACITY *
5 X 10	120 in. (3048 mm)	60 in. (1524 mm)	2292 lb. (1134 kg)
6 X 12	157.5 in. (4000 mm)	78.75 in. (2000 mm)	3948 lb. (1588 kg)
8 X 20	240 in. (6096 mm)	98.5 in. (2500 mm)	6690 lb. (3035 kg)

\* ACTUAL PROCESSING CAPACITY DEPENDS ON MATERIAL TYPE

**MAXIMUM MATERIAL THICKNESS FOR CLAMPING:** .63 inch (16 mm)



*The nozzle must be at least 0.80 inches (20 mm) above the material to avoid interference with the clamps. If the nozzle is closer to the material (for example, after cutting), then the program must raise the Z-axis before moving the cutting head near the material clamps.*

**CUTTING RANGE:** The cutting head can move through the range of X and Y-axis machine coordinates as shown in the table. A restricted area can be enabled around each material clamp, preventing the cutting head from moving through these areas. Alternately, the material clamps can be repositioned or removed entirely. The minimum distance between the Autofocus head and a clamp is one inch (25.4 mm). See Figure 1-1 for material clamp locations.

CUTTING RANGE			
MODEL	X-AXIS	Y-AXIS	Z-AXIS
5 X 10	0 TO 120 in (0 TO 3048 mm)	0 to 60 in (0 to 1524 mm)	0 to 1.5 in. (0 to 38 mm) above each pallet
6 X 12	0 to 157.5 in. (0 to 4000 mm)	0 to 78.75 in (0 to 2000 mm)	
8 X 20	0 to 240 in. (0 to 6096 mm)	0 to 98.5 in. (0 to 2500 mm)	

Except in the restricted areas, if enabled, the cutting head can move approximately 0.5 inches (12 mm) beyond the specified cutting range. The program can use this extra movement for workpiece edge detection (optional) or to cut off an oversized workpiece.

**ACCURACIES:**

- ◆ Absolute Positioning (X and Y-axis):  $\pm .001$  inch (0.025 mm)
- ◆ Repeatability (X and Y-axis): .001 inch (0.025 mm)

**MACHINE SPEEDS (Programmed moves):**

- ◆ Cutting feed rate is programmable up to the Rapid Traverse Speed. Maximum feed rate depends on material type and thickness.
- ◆ Rapid Traverse Speeds
  - X and Y-axis: 8500 IPM (3.6 m/sec.)
  - X and Y-axis Simultaneous: 12020 IPM (5 m/sec.)
  - Z-axis: 1700 IPM (0.7 m/sec.)
- ◆ Accelerations
  - X and Y-axis: 5 X 10: 1.35 G (13.2 m/sec<sup>2</sup>)
  - X and Y-axis: 6 X 12: 1.15 G (11.3 m/sec<sup>2</sup>)
  - Z-axis: 1.50 G (14.7 m/sec<sup>2</sup>)

**MACHINE SPEEDS (In JOG Mode):**

- ◆ Normal jog (X and Y-axes): 300 IPM (0.1 m/sec.)
- ◆ Rapid traverse jog (X and Y-axes): 1200 IPM (0.5 m/sec.)
- ◆ Z-axis Speed: 250 IPM (0.1 m/sec.)

**PROGRAMMABLE ASSIST GASES:** Three

**PROGRAMMABLE ASSIST GAS PRESSURE:** 0-270 PSIG (34 to 2000 kPa) for Oxygen and 0-363 PSIG (34 to 2500 kPa) for Nitrogen and Air.

**CHILLER FLUID:**

- ◆ Circuit #1: This circuit services the laser source, and should be supplied with distilled water only.
- ◆ Circuit #2: This circuit services the rest of the machine (linear motors, cutting head, control enclosure, etc.), and should be supplied with distilled water only.
- ◆ Dowtherm SR-1, is used on machines with Serial numbers 056507 and earlier (except 056455). Please contact Cincinnati Laser service.

**CHILLER TEMPERATURE SET POINT:**

- ◆ Circuit #1: 71.6°F (22°C)
- ◆ Circuit #2: 80°F (26.6°C)

**FUME EXHAUST RATING:**

MODEL	EXHAUST FLOW	WATER STATIC PRESSURE
5 X 10 6 X 12	4500 SFCM (127 m <sup>3</sup> /min.)	0.75 in. (19 mm)
8 X 20	6500 SFCM (184 m <sup>3</sup> /min.)	4.0 in. (102 mm)



*Fume exhaust ratings are nominal recommended rates that will provide adequate fume removal when cutting mild steel or stainless. The optional fume blower (see Section 8 - OPTIONS) can achieve an exhaust rate of up to 6500 SCFM (184 m<sup>3</sup>/min).*



*Fume exhaust flow rate depends on customer-installed exhaust ducts. Longer or smaller diameter duct runs may reduce flow to an unacceptable level. The diameter of the duct should match the diameter of the fume fan connection flange. Consult with a professional HVAC engineer for recommendations.*



*Always review Material Safety Data Sheet for the material being processed which aids in determining the nature and composition of fumes being released. See Section 3 - SAFETY of this manual for more information.*

**PIPING CONNECTIONS**

**Assist Gasses:** Three male 9/16 inch-18 straight thread, 37° JIC fittings are supplied for assist gas connections. These fittings are threaded into 1/4 inch NPT ports on the gas inlet filters manifold and may be removed if a different type of connection is required.

**Fume Exhaust:** The exhaust connection is a flange for 20.38-inch (508 mm) diameter duct. The flange has holes for eight bolts .312-inch (8 mm) diameter equally spaced on a 23.25-inch (552.5 mm) diameter bolt circle. The customer must provide connecting exhaust duct with minimum 20-inch (508 mm) diameter.

The optional fume blower for the 8x20 model is a rectangular port. The dimensions and bolt pattern are shown on the foundation plan drawing.

## OPTICAL ELEMENTS

**Fiber Coupling:** The fiber optic cable terminates at a quartz block. This quartz block is then mounted in the collimator by a special coupling called the QBH fiber coupling. This coupling has an interlock that only allows the laser beam to be delivered if it is connected to the collimator.

**Laser Head Optics:** The standard cutting head uses a collimator, focus lens and two cover glasses.

## GAS REQUIREMENTS

The Laser System uses different independently regulated gas supplies to assist the cutting process, and to protect the beam delivery optics. Gas requirements are listed in Table 4-1.

GAS USE	GAS TYPE	MANIFOLD LABEL	GAS PURITY	TYPICAL PRESSURE	REGULATOR SPECIFICATION	APPROXIMATE GAS USAGE
ASSIST GAS #1	Oxygen (O <sub>2</sub> )	Assist Gas #1	99.80 %	See TABLE 4-2	10 to 650 PSI O <sub>2</sub> Compatible CGA 540	See TABLE 4-2
ASSIST GAS #2	Nitrogen (N <sub>2</sub> )	Assist Gas #2	99.80 %	See TABLE 4-3	10 to 650 PSI CGA 580	See TABLE 4-3
ASSIST GAS #3	Air	Assist Gas #3	See TABLE 4-5	See TABLE 4-4	0.50 in. NPT	See TABLE 4-3
NOZZLE COOLING	Dry Compressed Air or N <sub>2</sub>	Air Blast	No oil or water droplets	Variable 60 to 90 PSI	10 to 300 PSI 0.25 in. NPT	Variable
NOZZLE COOLING	Dry Air from Air Dryer	N / A	No oil or water droplets	N / A	N / A	90 SCFH *

\* This table specifies purge and nozzle cooling gas requirements for the laser system. The air dryer also requires 188 SCFH of "self purge" air. See the foundation print for total air flow requirements at machine inlet.

**TABLE 4-1 Gas Requirements**

- Programmable Assist Gas:** Two programmable valves control the assist gas pressure commanded by the program for piercing and cutting. One valve is for oxygen and the other is for nitrogen or air. The oxygen has a pressure range from zero to 290 PSI (0 to 2000 kPa) and the nitrogen and air has a pressure range from zero to 363 PSI (0 to 2503 kPa).

For accurate pressure control, the supply pressure maintained at the machine inlet port must be higher than the desired nozzle pressure in a dynamic flow condition. The additional pressure required at the inlet port increases with the gas flow rate. At maximum flow, the inlet pressure must be 100 PSI (690 kPa) above the nozzle pressure. The maximum static system pressure for oxygen must not exceed 290 PSI (2000 kPa) and the maximum static system pressure for the nitrogen and air must not exceed 508 PSI (3503 kPa).

The gas supply system **must** be capable of delivering assist gas at the required flow determined by the nozzle pressure and orifice size (see *Tables 4-2 and 4-3*).

Tables 4-2 and 4-3 apply to single orifice nozzles. To estimate assist gas flow for nozzles with more than one orifice, contact CINCINNATI INCORPORATED Laser Applications.

Nozzle Pressure (PSI)	Approximate Flow (SCFH) Required for Nozzle Orifice		
	.060 in.	.080 in.	.060 in. Double
15	82	157	82
25	111	209	111
50	181	333	181
75	252	471	252
100	322	610	322

**TABLE 4-2 Oxygen Gas Flow**

Nozzle Pressure (PSI)	Approximate Flow (SCFH) Required for Nozzle Orifice			
	.060 in.	.080 in.	.100 in.	.125 in.
15	87	164	230	398
25	118	216	320	532
50	192	345	530	867
75	268	485	732	1324
100	342	624	939	1649
150	492	896	1347	2320
200	641	1168	1758	2878
250	790	1440	2166	3548
300	940	1712	2576	4219
350	1090	1984	2988	4900

**TABLE 4-3 Nitrogen or Air Assist Gas Flow**

When using air for assist gas, the flow and pressure capacity of the air supply system (compressor and piping) determines the maximum pressure available to the cutting head. To find the required air flow, see Table 4-3. To find the required air supply pressure for typical nozzle pressures, see Table 4-4. Do not exceed the 250 PSI (1724 kPa) maximum inlet pressure of the refrigerated air dryer if used.

Nozzle Pressure (PSI)	Air Supply Pressure (PSI) Required for Nozzle Orifice			
	.060 in.	.080 in.	.100 in.	.125 in.
100	125	145	176	196
105	131	156	183	202
110	136	157	189	209
115	142	163	196	216
120	148	170	202	223
125	153	176	208	230
130	156	182	216	236
135	164	188	221	244
140	176	196	228	251
145	179	201	236	256
150	181	207	241	264
155	187	213	247	276
160	192	216	256	278
165	196	226	260	285
170	203	232	266	292
175	209	238	273	296
180	216	244	276	306
185	220	250	286	316
190	226	256	292	320
195	231	263	296	327
200	236	276	305	334
205	242	279	316	341

210	248	282	318	348
215	256	288	324	355
220	259	294	331	362
225	264	296	337	359
230	270	306	344	376
235	276	316	350	383
240	281	319	357	390
245				
250	292	336	370	404
255	296	338	376	411
260	303	344	382	418
265	309	350	389	425
270	316	356	395	432
275	320	362	402	439
280	326	369	408	446
285	331	375	415	453
290	337	381	421	460
295	342	387	428	467
300	348	393	434	474
305	353	400	440	481
310	359	406	447	488
315	365	412	453	495
320	370	418	460	502
325	376	425	466	
330	381	431	473	
335	387	437	479	
340	392	443	486	
345	398	449	492	
350	404	456	498	
355	409	462	505	
360	415	468		

**TABLE 4-4 Nitrogen or Air Assist Gas Supply Pressure**

Compressed air used for assist gas must meet the following purity specifications at the cutting head:

<b>Air Assist Gas Purity</b>	
<b>Residual Oil Carryover</b>	< 0.003 PPM by weight, including vapors
<b>Particle Carryover</b>	< 0.01 micron, 99.999% DOP (Diocetyl Phthalate) test
<b>Pressure Dew Point</b>	≤ +38 °F

**TABLE 4-5 Air Assist Gas Purity Specifications**

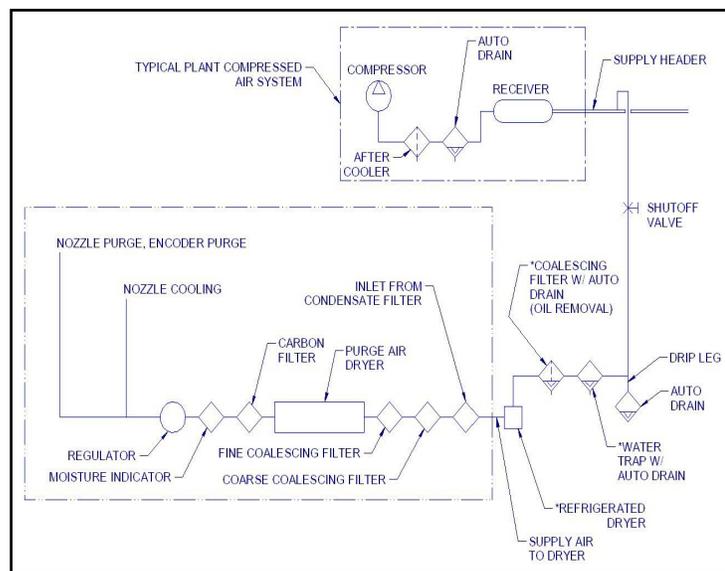
 **Regulated assist gas supply pressure must not exceed 505 PSI (3792 kPa). Over-pressure will cause damage to downstream components.**

## CAUTION

The very low temperature of cryogenic gas supplies may cause hoses in the Laser System to fail when high assist gas flow rates are used. An external evaporator may reduce this effect. Refer to the gas supplier for additional information.

For machines that have the Assist Gas Air Dryer Option, the air supplied at the connection to the machine **must** meet the purity class of ISO 8573-1:2010 [5:6:4]. See purity class summary below. For complete purity class requirements, see ISO 8573-1:2010.

- Maximum number of particles per  $m^3$ :  $\leq 100,000$  particles between the sizes of  $1.0 \mu m$  and  $5.0 \mu m$ .  
**No particles  $> 5.0 \mu m$ .**
  - Pressure dew point:  $\leq +10^\circ C$
  - Concentration of total oil:  $\leq 5 \text{ mg}/m^3$
- 2. Rapid Pierce:** Compressed air is required for the air-blast system used with rapid pierce. The air supplied at the connection to the machine **must** meet the purity class of ISO 8573-1:2010 [5:4:4]. See purity class summary below. For complete purity class requirements, see ISO 8573-1:2010.
- Maximum number of particles per  $m^3$ :  $\leq 100,000$  particles between the sizes of  $1.0 \mu m$  and  $5.0 \mu m$ .  
**No particles bigger than  $5.0 \mu m$ .**
  - Pressure dew point:  $\leq +3^\circ C$
  - Concentration of total oil:  $\leq 5 \text{ mg}/m^3$
- 3. Purge Air Dryer Supply:** The purge air dryer requires up to 314 SCFH (14 cubic meter/ hour), 90 PSI minimum (620 kPa). The air supplied to the machine **must** be less than  $100^\circ F$  ( $38^\circ C$ ) and **must** meet the purity class of ISO 8573-1:2010 [5:4:4]. Air outside of this purity class could overwhelm and contaminate the instrument grade air dryer and the purge systems on the laser machine. This damage is **not** covered by warranty. If incoming air is hot, a refrigerant dryer prior to the instrument grade dryer may be required.



**Figure 4-1 Schematic of compressed air supply system for purge requirements. "Basic" system components and recommended pretreatment (\*) components to comply with air dryer inlet specifications.**

4. **Nozzle Cooling:** The standoff accuracy of the noncontact cutting head can change if the nozzle tip assembly absorbs too much heat. This condition can occur when using Rapid Pierce or when cutting material with a highly reflective surface. A noncontact cutting head with Nozzle Cooling maintains standoff accuracy by reducing the amount of absorbed heat. Compressed air flowing around the outer cone removes heat from the nozzle tip assembly. The Laser System control opens a solenoid valve to provide nozzle cooling whenever the fume exhaust fan is running.

## **AMBIENT TEMPERATURE**

105°F (40°C) maximum

50°F (10°C) minimum

Optional equipment modifications are available to extend the ambient temperature limits. Contact CINCINNATI INCORPORATED Laser Technical Services for more information.

## **CAPACITIES**

Cutting feed rates are determined by material type, thickness, surface condition, required part accuracy, laser power, and proper machine setup.

## **PRINCIPLE OF OPERATION**

The Fiber Laser System produces two-dimensional contoured shapes from flat material by moving a focused laser beam along a programmed path. The beam from a stationary fiber laser is directed to a moving lens by a fiber optic cable routed through a moving gantry. The workpiece remains stationary while a narrow strip of material is removed along the path made by the lens. Material is removed by vaporization and melting where the lens concentrates laser power into a small spot on the workpiece. Assist gas is also used to control the cutting process.

The gantry moves the lens to produce the programmed workpiece geometry. A motion controller commands servo drives to control the gantry motion. The program provided by the user includes commands to specify feed rate, laser power, and assist gas.

The Laser System is equipped with an exhaust system, which draws air down from the cutting area to assist in the removal of process by-products. See **Section 3 - SAFETY**.

## **CONTOURING ACCURACY**

Contouring accuracy is a function of the feed rate and the curvature of the path. The maximum feedrate at which the Laser System can maintain a given hole roundness is a function of the hole diameter.

## LOADING MATERIAL

Each load table or pallet has a stop pin at the X = zero end of the cutting area and a stop bar at each clamp location to locate the Y = zero edge.

Place material on the support grid and position it against the “X” and “Y” stops. Tighten the material clamps enough to hold the material.

## GAUGING

### CUTTING Y-AXIS MATERIAL STOPS

Each pallet has stop bars that locate the edge of the workpiece at Y = zero in the machine coordinate system. In order to accurately represent the Y = zero location along the sheet, these stops are cut by the machine.

**The following procedures must be completed before the Y = zero stops can be cut:**

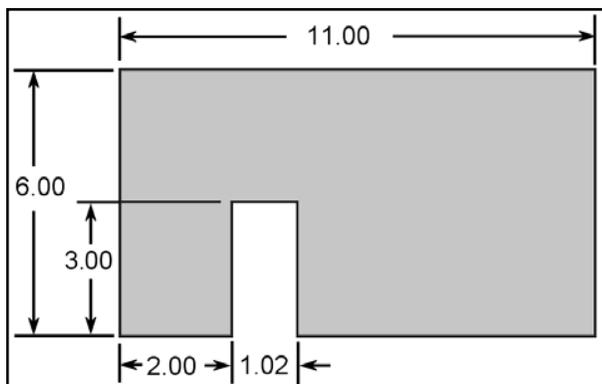
- LASER SETUP, ELECTRICAL (by CINCINNATI Laser Service) specifically setting of Y-axis Home Offset.
- LENS CENTERING
- LENS FOCAL POINT LOCATION
- MACHINE STARTUP

### MATERIAL REQUIRED

- **Y-Stops:** C.I. #923531 - four stops per pallet.
- One piece of mild steel with the same thickness as the Y-stops. C.I. P/N #923531 stops are .50 inch (12.7 mm) thick. Minimum plate size is 7.0 x 12.0 inches (178 x 305 mm).
- One set of feeler gages.
- Programs located in “CNCLSR32\PROGRAM\ Factory Setup” directory.

### PROCEDURE

1. Open the “YSTOPPART.cnc” program, edit the G89 line and feedrate for the required material and then load the program. Jog the cutting head to the lower left corner of an 11 x six (6) inch (280 x 152 mm) area and run the program. The part has an opening to surround the Y-stop as shown in the following sketch:



2. Move the material clamps away from the Y-stops on both pallets.
3. Perform the AXIS HOME procedure as described in **Section 7 - OPERATION, EM-551, START-UP AND SHUT-DOWN**. Confirm the AXIS HOME operation by checking that the machine coordinates are zero on the Axes Position window.

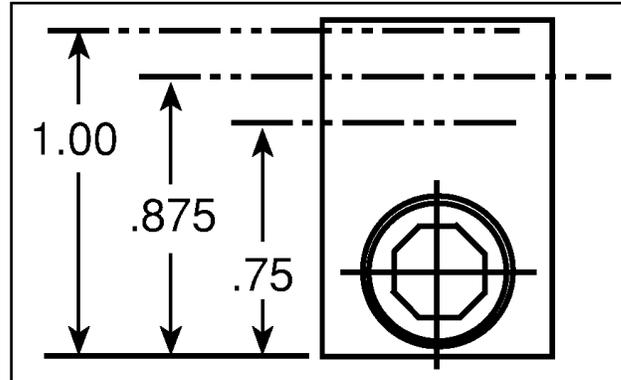
4. The Y = zero machine location will now be checked to be sure the material edge will be under the clamp head.

Load “YSTOP.cnc” program to scribe a line across the stop. The YSTOP.cnc program can be edited for scribing with low power and nitrogen assist by changing the cutting parameters.

I.e.: G89 PMS500O2.LIB

Jog the cutting head in the “X” direction so it is just to the left (-X) of the first stop.

Set the focal point near the material surface. Run the program and then jog the cutting head back (-X), so you can examine the scribed line on the stop. The scribed line should be between .75 inch (19 mm) and 1.0 inch (25 mm) from the back of the stop.



Repeat the step described above on all upper and lower pallet Y-stops. If any of the scribed lines are outside the required .75 inch (19 mm) to 1.0 inch (25 mm) dimension, change the home offset parameter to move the Y = zero machine position. Determine the distance required to move the scribed line inside the .75 inch (19 mm) to 1.0 inch (25 mm) range.



***If the Y-axis home offset parameter is changed, verify that the Y-axis can reach the positive and negative soft overtravel alarm positions without tripping the corresponding hard overtravel alarm. The hard overtravel alarm positions should not be changed.***

5. After the parameter is changed, repeat Steps 3 and 4. When the Y = zero scribed lines on all stops are within the .75 inch (19 mm) to 1.0 inch (25 mm) range, then the stops can be cut.

The scribe program can be edited to cut the stops by changing the cutting parameters:

I.e.: G89 PMS500O2.LIB;

The cutting tool path must be offset by half the kerf width in order to make the edge of the stop as close as possible to Y = zero. To determine the kerf width, cut a test square or other test cut in the support plate and measure the kerf width with a feeler gage. Jog the head so the nozzle is .125 inch (3 mm) to the left (-X) of the stop.

Use the program to cut all Y-stops.

6. Test the Y = zero position:
  - a. Place a piece of material against two stops and clamp in place.
  - b. Program the machine to cut the plate length in the “X” direction at machine “Y” = four inch (100 mm). Set parameters for the plate thickness and run the program.
  - c. Unclamp the four inch (100 mm) part, turn it around to locate the laser-cut edge against the Y-stops, and then clamp it in place.

- d. Edit the program to cut the plate length at machine “Y”= three inch (76 mm) and run program.
- e. Unclamp the three inch (76 mm) part and measure its width. The “Y” position error is:

$$\text{ERROR} = \text{commanded width} - \text{measured width} - (\text{kerf} / 2)$$

Example:

$$\text{ERROR} = 3.000 - 2.996 - (0.006 / 2) = 0.001 \text{ inch}$$

- f. If error is .002 inch (0.051 mm) or less, this procedure is complete.
- g. If error is more than .002 inch (0.051 mm), change the home offset parameter to make machine “Y” = zero coincide with the Y-stop cut edge.
- h. Add the error value to the parameter value.



***If the error itself is negative, the home offset parameter is usually a negative number. The home offset will be made more negative.***

Repeat Step 6 until the error is .002 inch (0.051 mm) or less. It is not necessary to test Y = zero on a second pallet, since all stops were cut at the same machine coordinates and with the same parameter value.

7. To maintain the initial accuracy, repeat Steps 1 through 6 (with new Y-stops) if:
  - The Y-axis Linear Encoder is disconnected from the Y-plate or removed and/or replaced.
  - The Z-axis nozzle support block is removed and/or replaced.
  - The Y-stops are removed and not replaced in the same location.
  - The cam or vee rollers for the pallets are replaced.

## **X AND Y-AXIS SQUARENESS**

The CINCINNATI Laser - Fiber Laser gantry has linear encoder feedback on each of the X-axis servo systems. To make the Y-axis travel perpendicular to the X-axis travel, the “home” position of one X-axis encoder is adjusted relative to the other.

The machine comes from the factory with X and Y-axis squareness preset. Adjustment should **not** be necessary unless one of the following occurs:

- ◆ Encoder read-head has been detached or replaced.
- ◆ Linear encoder has been replaced.

If adjustment is needed, contact CINCINNATI Service for appropriate procedures.



***Setting the squareness parameters can only be done by a CINCINNATI Service Representative.***

## **X-AXIS MATERIAL STOPS**

Each pallet has a stop pin to locate the edge of the workpiece at X = zero in the machine coordinate system of the control. The gantry moves to the machine X = zero position when the AXIS HOME operation is done (see **Section 7 - OPERATION, EM-574, START-UP AND SHUT-DOWN**). This procedure describes how the cutting position of each pallet is adjusted so the edge of its stop pin coincides with machine X = zero.

## MATERIALS REQUIRED

- Inside calipers accurate to .001 inch (.025 mm) over a two inch (50.8 mm) range.
- One set of feeler gages.
- One piece of mild steel, 10 to 16 gauge (1.5 to 3.5 mm thick), approximately 12 inch x 38 inch (300 x 965 mm) or larger.

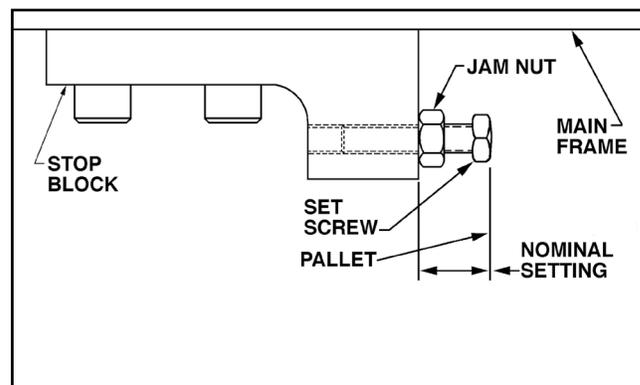
The following procedures must be completed before the X = zero stops can be set:

- LASER SETUP, ELECTRICAL (by CINCINNATI Service), specifically setting of X-axis Home Offset.
- BEAM DELIVERY ALIGNMENT
- LENS CENTERING
- LENS FOCAL POINT ADJUSTMENT
- LASER START-UP
- CUTTING OF Y-AXIS STOPS

 **Do not change X-axis home offset parameters to set the upper or lower pallet zero position.**

## BACKGROUND

When a pallet is driven into the cutting position, a flag on the pallet trips a proximity switch to stop the drive motor and engage its brake. Tension is maintained in the drive cable to hold the pallet against a hard stop at the end of the pallet support rail. A setscrew in the hard stop is used as a fine adjustment for the pallet cutting position. The nominal setting is shown in Figure 5-1.



*Figure 5-1 Pallet Stop Block*

## PROCEDURE

1. Jog both pallets out to the load position. Raise the X-stop pin on the top pallet and load the test sheet with its short dimension against the pin and its long dimension against the Y-stops. Clamp the sheet in the pallet and lower X-stop pin. Jog the top pallet in to the cutting position.
2. If the pallet is not held tight against the set screw in the hard stop, adjust the set screw out to the pallet and jog the pallet in and out several times to make sure contact is repeatable. If the setscrew cannot be adjusted far enough, then the limit switch cam on the pallet will have to be adjusted to stop the pallet in a different location.

When the pallet is repeatedly held tight against the setscrew, the first test cut can be made to check the X-stop pin location.

3. The position of the X-stop pin is checked by cutting the sheet at a programmed machine location away from pin and measuring the actual distance from the pin surface to the edge of the cut.

To accurately interpret the measurement, the kerf width must also be known. First cut a test square or similar test cut out on the sheet (away from the X-stop pin area) and measure the kerf width with a feeler gage. These test cuts will also confirm the cutting parameters for the sheet.

Load the "XSTOP.cnc" program with appropriate cutting parameters. Edit the kerf width value in the program.

Make sure the X-stop pin is down and run the program. Remove the cut-away piece and use the calipers to measure the minimum distance from the surface of the pin to the cut edge in the machine "X" direction. Subtract the programmed cut position from the caliper reading. The result is the pallet position error.

4. Jog the pallet out and adjust the setscrew to correct the pallet position error determined in Step 3. To more accurately change the setscrew position, use the calipers to measure the screw position relative to its support block before and after the adjustment. Lock the setscrew in place with the locknut.

Jog the pallet in and out several times to make sure the pallet is held tight against the setscrew in its new position (see Step 2).

Repeat Step 3 to check the X-stop pin location with a new test cut.

Repeat Step 3 and 4 until the error is .002 inch (0.05 mm) or less.

5. Repeat Steps 1 through 4 for the lower pallet.
6. In order to maintain the initial accuracy, this procedure will have to be repeated if:
  - Either X-axis linear encoder is disconnected from the carriage or removed and/or replaced.
  - Either X-axis carriage assembly is disconnected from the gantry.
  - The pallet limit switch side plate is adjusted.
  - The pallet rollers are replaced or adjusted.





Figure 6-1 Operator Control Station

## OPERATOR CONTROL STATION

This section describes the individual controls located on the Operator Control Station. Refer to Figures 6-1 through 6-6 for actual component locations.

**Touchscreen:** The touchscreen is a device for monitoring various conditions of the Laser System and selecting various control functions. The operator can access several categories of information, such as: Programs, Material Processing Parameter Libraries, Axes Positions, Offsets, Program Modes, and Messages. Buttons displayed on the screen can be selected with the trackball or by touching the screen.

**Front Panel Controls:** Between the touchscreen and keyboard is a panel with pushbutton/indicators and keyswitches to start and stop the machine, reset the control, jog the X, Y, and Z axes, and move the pallets. These controls are described in detail in this section. See Figure 6-2.

**Keyboard:** The keyboard is used to enter alphabetic, numeric, and other characters into the control for program and data entry. The keyboard can also be used to open and close windows in the control application, and to select menu items.

**Trackball:** The trackball assembly provides the functions of a computer mouse without requiring as much space. The operator can rotate the ball to move the cursor, and then press the left or right button to select functions on the screen. The trackball also has a dial to scroll up or down when the selected window supports that function.

## USB Port:

On the side of the Operator Control Station is a USB (Universal Serial Bus) port. If a network server is not available, operators can use the USB Port to load or backup programs and process library files. USB flash drives can be purchased from most computer stores.



Figure 6-2 Front Panel Controls

## MACHINE OPERATOR PANEL

The Operator Control Station has a front panel with several pushbuttons and indicators, and three keyswitches. See Figure 6-1.

### FRONT PANEL CONTROLS

The front panel pushbutton/indicators can be categorized in four groups: Program Controls, Axis Jog Controls, Pallet Controls, and Emergency Stop. See Figure 6-2.

### PROGRAM CONTROLS

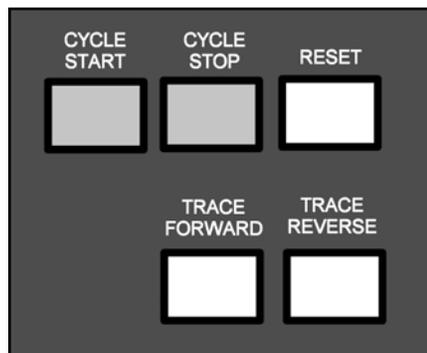


Figure 6-3 Front Panel - Program Controls

#### CYCLE START

##### pushbutton/indicator:

This pushbutton performs different functions depending on the control mode. When the control is in AUTO mode, pushing this button commands the laser system to begin executing the loaded program. If an alarm condition changes the control mode from “Executing” to CYCLE STOP, then correcting the condition and pressing CYCLE START resumes automatic operation. When the control is in CYCLE STOP mode, the operator can also select the TRACING function button and then press CYCLE START to begin TRACING mode. When the control is in AXES HOME mode, pressing CYCLE START begins the automatic AXES HOME sequence.

The laser system illuminates the CYCLE START indicator when executing the program or the AXES HOME sequence.

**CYCLE STOP  
pushbutton/indicator:**

When this button is pushed during automatic operation, axis motion decelerates to a stop, and all cutting functions such as laser beam and assist gas are turned off. Cycle Stop status is indicated by illumination of this indicator. The indicator will be extinguished when the CYCLE START button is pressed or the control is reset. Cycle Stop status can also be achieved by pressing the FEEDHOLD pushbutton located on the Remote Station.

**RESET pushbutton:**

Press this button to reset the axes drives (X, Y, and Z) or cancel an alarm message.

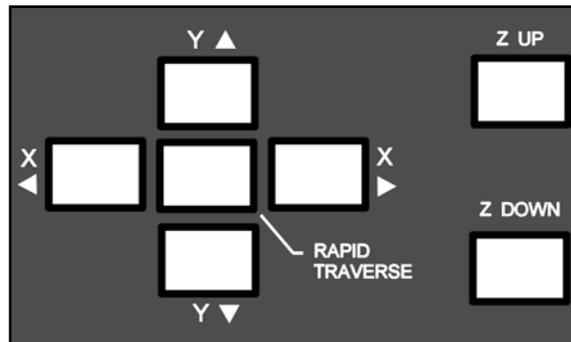
**TRACE FORWARD  
pushbutton/indicator**

This pushbutton is only active when the control is in TRACING mode. It is used to move the axes along the programmed path in the FORWARD direction to a position where cutting is to be resumed. If forward motion is possible while in TRACING mode, this pushbutton will be lit. (See *Cutting Procedures / Error Recovery in Section 7 - OPERATION, EM-574.*)

**TRACE REVERSE  
pushbutton/indicator:**

This pushbutton is only active when the control is in TRACING mode. It is used to move the axes along the programmed path in the REVERSE direction to a position where cutting is to be resumed. This pushbutton will be lit if reverse motion is possible while in TRACING mode. (See *Section 7 - OPERATION, EM-574, for more details.*)

**AXIS MOTION CONTROLS**



*Figure 6-4 Front Panel - Axis Motion Controls*

**X▶ pushbutton/indicator:** Pressing this pushbutton will jog the X-axis in the positive direction if the following conditions exist:

- Control is in JOG mode and the drives have been enabled and homed.
- Remote STATION ENABLE selector is not activated.

Motion will stop when the pushbutton is released.

**X◀ pushbutton/indicator:** Pressing this pushbutton will jog the X-axis in the negative direction if the following conditions exist:

- Control is in JOG mode.
- Remote STATION ENABLE selector is not activated.

Motion will stop when the pushbutton is released.

**Y▲ pushbutton/indicator:** Same as X▶ pushbutton/ indicator except for Y-axis.

**Y ▼ pushbutton/indicator:** Same as X ◀ pushbutton/ indicator except for Y-axis.

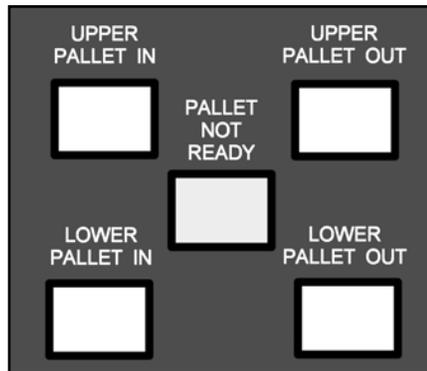
**RAPID TRAVERSE pushbutton/indicator:** When the RAPID TRAVERSE button is illuminated, and the X or Y-axis is jogged from the Machine Operator Front Panel, the jog speed is the value specified by the “X/Y Rapid Jog Speed” parameter in the General page of the Machine Configuration window. This function remains active until canceled by pressing the illuminated RAPID TRAVERSE pushbutton, or enabling the remote station.

 *To jog at the Rapid Traverse rate, the Z-axis must be retracted.*

**Z UP pushbutton/ indicator (+Z):** Same as X ▶ pushbutton/indicator except for Z-axis.

**Z DOWN pushbutton/ indicator (-Z):** Same as X ◀ pushbutton except for Z-axis.  
The Z DOWN indicator will illuminate whenever the Z-axis is moving down; the Z DOWN indicator will also illuminate any time the cutting head is actively tracking the material, using its built-in capacitive sensor.

## PALLET CONTROLS



*Figure 6-5 Front Panel - Pallet Controls*

**UPPER PALLET IN, UPPER PALLET OUT, LOWER PALLET IN, and LOWER PALLET OUT pushbutton/indicators:** Each pallet has two pushbutton/indicators, to jog or indicate motion toward the cutting position (IN) or toward the load position (OUT). The indicators flash on and off whenever the pallet is moving in the corresponding direction (in JOG or AUTO mode). If the control is in JOG mode, the pallet can be moved in the indicated direction by pressing the corresponding button. Releasing the button will stop motion. Each indicator will stop flashing and remain on when a pallet has reached its end-of-travel position. One “in” and one “out” indicator must be illuminated for CNC program execution to be permitted.

**PALLET NOT READY pushbutton/indicator:** After each program starts, the PALLET NOT READY pushbutton/indicator is automatically illuminated. If the program commands M50 (Pallet Exchange), the pallets will not move while the PALLETS NOT READY pushbutton/indicator is illuminated. When operators are unloading or loading material on the pallet in the load frame, this function helps protect them from unexpected pallet motion.

After starting a program, the operator can choose to enable or disable automatic pallet motion by toggling this button ON or OFF before the program reaches the M50 block. If the operator toggles the button OFF before the program reaches the M50 block, the pallets will move when the program commands M50.

If a program is interrupted and restarted, the PALLETS NOT READY light will be illuminated. If the program was stopped while executing M50, the operator can resume the program by pressing the CYCLE START button followed by the PALLETS NOT READY button. For information about the M50 command, *refer to the Laser NC Programming topic in Section 7 - OPERATION, EM-574.*

**DRIVES ON  
pushbutton/indicator:**

When the DRIVES selector switch is at the ENABLED position, pressing the DRIVES ON pushbutton enables all motor drives on the Laser System. The indicator is illuminated when the drives are enabled. To turn the drives off, turn the DRIVES selector switch to LOCK/OFF.



**DRIVES keyswitch:**

Turning this keyswitch to the LOCK/OFF (Left) position or removing the key disables the motor drives in the Laser System. The laser main voltage is also disabled. Turn this keyswitch to LOCK/OFF before entering any area where the gantry or pallet can travel. Turning this keyswitch to the ENABLED position does NOT enable the drives. Pushing the DRIVES ON pushbutton/indicator while this keyswitch is in the ENABLED position will enable the drives.



*Figure 6-6 Drives Controls*

**HIGH VOLTAGE  
keyswitch:**

Turning this keyswitch to the LOCK/OFF (Left) position or removing the key disables the main voltage power supply of the fiber laser. This cancels the action of the Laser Ready touchscreen button. When this keyswitch is in the ENABLED (Right) position, electrical power can be connected to the laser main voltage power supply by selecting the Laser Ready button on the touchscreen.



*The laser system uses three indicators to notify operators when laser main voltage is ON: the amber light on top of the laser generating unit flashes, the red laser status indicator on top of the safety enclosure flashes, and the color of the Laser Ready indicator on the touchscreen changes to bright green.*

**HIGH VOLTAGE INTERLOCK keyswitch:** When the HIGH VOLTAGE INTERLOCK keyswitch is in the ACTIVE (Left) position or the key is removed, the control monitors an interlock between the nozzle assembly and the Z-axis carriage. (The key can be removed only in the left position.) If the nozzle assembly breaks away from the Z-axis carriage, the following will occur:

- Laser main voltage will be disabled.
- All axis motion will stop.
- All auxiliary functions such as assist gas flow will stop.

When the key is in BYPASS (right) position, the nozzle assembly interlocks are defeated. The BYPASS position is only used during IPG laser set-up or diagnostic procedures which require laser emission with the cutting head removed.

The following limitations apply when HIGH VOLTAGE INTERLOCK keyswitch is in the BYPASS position:

- Laser emissions are only enabled when the BEAM FLASH button is pressed while the Beam Flash - Lens Centering dialog is open.
- Program execution is DISABLED.



**THE HIGH VOLTAGE INTERLOCK KEYSWITCH IS INTENDED FOR USE ONLY BY CINCINNATI OR FACTORY TRAINED SERVICE TECHNICIANS.**

## EMERGENCY STOP

Pressing the Emergency Stop pushbutton stops **all** axis motion, turns off the laser main voltage, and inhibits all cutting functions such as assist gas flow. When this pushbutton is pressed during automatic operation, axis motion decelerates to a stop, and **all** cutting functions are turned OFF. To indicate Emergency Stop status, the System Alarms dialog box displays the message “Emergency Stop Pressed”.



The Emergency Stop pushbutton is locked inward when depressed. The method to unlock the pushbutton depends on the button design. This manual applies to laser systems using two types of Emergency Stop pushbuttons. If an arrow is shown on the pushbutton, the button can be unlocked by rotating it 1/4 turn clockwise. Other Emergency Stop pushbuttons can be unlocked by pulling on the button.

The Emergency Stop pushbutton on the Operator Control Station and the Emergency Stop pushbutton on the load frame have the same function. Pressing either pushbutton will produce the “Emergency Stop Pressed” System Alarm, and both must be unlocked to clear the alarm.



*When using the optional CINCINNATI Material Handling Systems, pressing either Emergency Stop pushbutton on the CL-900 will stop both the laser and the HANDLING SYSTEM. However, pressing the Emergency Stop pushbutton on the HANDLING SYSTEM will only stop the HANDLING SYSTEM and not the laser.*

## REMOTE STATION

The Remote Station is a hand-held control connected by a cable to the main frame. This control allows the operator to use the manual functions described below when performing setup or maintenance. Refer to Figure 6-7.



Figure 6-7 Remote Station

### FEED HOLD pushbutton:

This pushbutton has the same function as the CYCLE STOP pushbutton on the Machine Operator Front Panel. When this button is pushed during automatic operation, axis motion decelerates to a stop, all cutting functions such as laser beam and assist gas flow are turned off. FEED HOLD status is indicated by the illumination of the CYCLE STOP indicator on the Machine Operator Front Panel.

### STATION ENABLE keyswitch:

When the key is inserted and this switch is turned clockwise (to the STATION ENABLE position) and the control is in JOG mode, the following changes occur:

- The jog pushbuttons on the Machine Operator Front Panel are disabled (X▶, X◀, Y▲, Y▼, Z UP, Z DOWN, UPPER PALLET IN / OUT, and LOWER PALLET IN / OUT).
- The axis jog pushbuttons on the Remote Station are enabled (X, Y, Z, +/UP, -/DOWN).
- The ARM FLASH keyswitch and BEAM FLASH pushbutton on the Remote Station are enabled. The requirements and functions of these controls are described below.

### ARM FLASH keyswitch:

If the Beam Flash - Lens Centering window is open and the Station Enable keyswitch is in the clockwise position, then turning the ARM FLASH keyswitch 1/8 turn clockwise enables the BEAM FLASH pushbutton for two seconds. The operator must turn and hold the ARM FLASH selector switch in the clockwise position to enable each Beam Flash. The switch returns to the counterclockwise position when released.

**BEAM FLASH pushbutton:**

This pushbutton is used to manually flash the laser beam for the Laser Shot procedure (See **Section 7 - OPERATION, EM-574**). The beam flash will only occur when the following conditions are met:

1. The Beam Flash - Lens Centering window is open.
2. The Remote Station selector switch is turned to "STATION ENABLE".
3. The ARM FLASH selector switch is held in the clockwise position.
4. The BEAM FLASH button is pressed no later than 2 seconds after turning ARM FLASH.
5. There are currently no active alarms.

If the above conditions are met, then the beam will flash for the length of time specified in the Beam Flash - Lens Centering window ("Length of Flash"). Assist gas will be commanded to flow if specified in the Beam Flash - Lens Centering window. If the ARM FLASH selector switch or the BEAM FLASH button is released before the specified "Length of Flash" value, then the laser emission is stopped immediately.

**+/UP pushbutton:**

Use this pushbutton with the X, Y, or Z pushbuttons to jog the X-axis or Y-axis in the positive direction or the Z-axis in the upward direction. These buttons are functional only when the STATION ENABLE keyswitch is in the clockwise position.

**-/DOWN pushbutton:**

Use this pushbutton with the X, Y, or Z pushbuttons to jog the X-axis or Y-axis in the negative direction or the Z-axis in the downward direction. These buttons are functional only when the STATION ENABLE keyswitch is in the clockwise position.

**X pushbutton:**

Use this pushbutton with either the +/UP or -/DOWN pushbutton to jog the X-axis. These buttons are functional only when the STATION ENABLE key is in the clockwise position. Motion will stop when either button is released.

**Y pushbutton:**

Use this pushbutton with either the +/UP or -/DOWN pushbutton to jog the Y-axis. These buttons are functional only when the STATION ENABLE key is in the clockwise position. Motion will stop when either button is released.

**Z pushbutton:**

Use this pushbutton with either the +/UP or -/DOWN pushbuttons to jog the Z-axis. These buttons are functional only when the STATION ENABLE key is in the clockwise position. Motion will stop when either button is released.

## **LOAD FRAME EMERGENCY STOP**

The load frame has an EMERGENCY STOP button on the same side of the machine as the Operator Control Station. This button is near the end of the load frame farthest from the Operator Control Station and has the same function as the EMERGENCY STOP button on the Operator Control Station.



**FOR ADDITIONAL SETUP AND OPERATIONAL INFORMATION FOR THIS MACHINE, REFER TO EM-574, SECTION 7 - OPERATION, A SUPPLEMENT TO THE OPERATION MANUAL FOR THE CINCINNATI CL-900 SERIES PC CONTROL, INCLUDED WITH THIS MANUAL.**

FOR ADDITIONAL SETUP AND OPERATION INFORMATION FOR THIS MACHINE, REFER TO **EM-574, SECTION 7 - OPERATION**, A SUPPLEMENT TO THE OPERATION MANUAL FOR THE CL-900 LASER SYSTEM.



## FUME BLOWER

An optional fume blower and motor are available to draw fumes down through the fume plenum so they can be vented away from the work area. A fume blower is required unless there is a central fume exhaust system or a fume filtration system that will be connected to the exhaust plenum on the laser.

## BALL TRANSFER LOAD STATION



This option, located in the load frame, provides ball bearing transfers to temporarily support the work piece above the material supports in the pallet. Ball transfers allow the operator to easily move material into position on the pallet. The ball transfers rise to a preset height, depending on which pallet is in the load frame.

To use the Ball Transfer Load Station, one pallet must be in the cutting position in the main frame and the other must be fully retracted in the load frame. When the pallets are in those positions, pressing the BALL TRANSFERS UP pushbutton on the load station pendant (*Figure 8-1*) will raise the ball transfers to the correct height. After moving the sheet into position on the pallet, pressing the BALL TRANSFERS DOWN pushbutton on the load station pendant will lower the ball transfers. The pallets will not move unless the ball transfers are lowered.

The FEEDHOLD pushbutton performs the same function as the CYCLE STOP pushbutton on the Operator Control Station. See **Section 6 - MACHINE CONTROLS**.

## CINCINNATI MATERIAL HANDLING SYSTEMS 5X10 and 6X12 Models Only

This system enables fully automated sheet loading integrated with laser operation. A transporter separates the workpiece from a stack of material. The transporter delivers the workpiece to the laser pallet and moves finished nests to a material location. Contact your CINCINNATI INCORPORATED Sales representative for CINCINNATI material handling options and configurations.

## AIR ASSIST GAS FILTER AND DRYER

This option includes a refrigerated air dryer to clean and lower the dew point of shop air for use as assist gas. Shop air should be supplied from an after-cooler. Compressed air assist gas is suitable for cutting thin metals.



*To find the required air flow, see table 4-3. To find the required air supply pressure for typical nozzle pressures, see table 4-4. Do not exceed the 250 psi (1724 KPA) maximum inlet pressure of the refrigerated air dryer.*

## AUTOMATIC NOZZLE CHANGER (ANC)

(Models with FiberCUT 2D Head Only)

An optional nozzle changer is available to automatically change the nozzle on the cutting head. This option allows for six nozzles to be loaded into the machine. The nozzle assembly will be changed to the appropriate nozzle before the program runs, based on the nozzle called out in the material library of the program. If the correct nozzle is not loaded in the nozzle station, a machine set-up error will appear and inform the operator how to resolve the issue. The nozzle station can also be used in Jog mode for manual nozzle changing. See **Section 7 – OPERATION**.



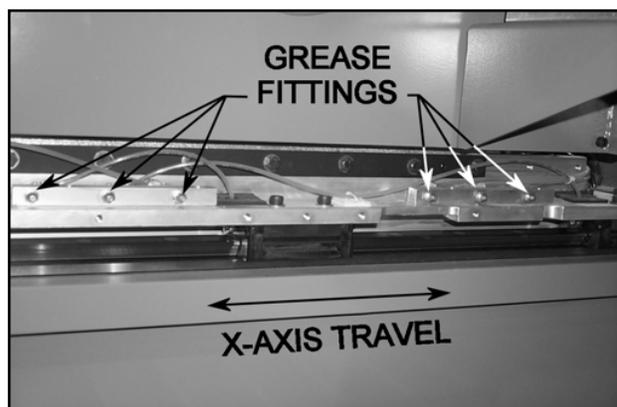
# SECTION 9 MAINTENANCE AND ADJUSTMENTS

## LUBRICATION REQUIREMENTS

### DRIVES LUBRICATION

The X, Y, and Z-axes have “extended lube interval” linear bearings. Lubricate every 2,000,000 feet of X-axis travel, or every six months (2000 hours of operation), whichever occurs first. *Figure 9-1* shows the grease manifolds for one side of the X-axis linear bearings. *Figure 9-2* shows the Y-axis grease fitting on two of the four truck bearings .

To access the manifolds shown in *Figure 9-1*, remove the metal cover on the side of the carriage. Repeat for opposite side. To access the Y-axis linear bearings shown in *Figure 9-2*, pull back the Y-axis way cover. Repeat on other side of Y-plate.

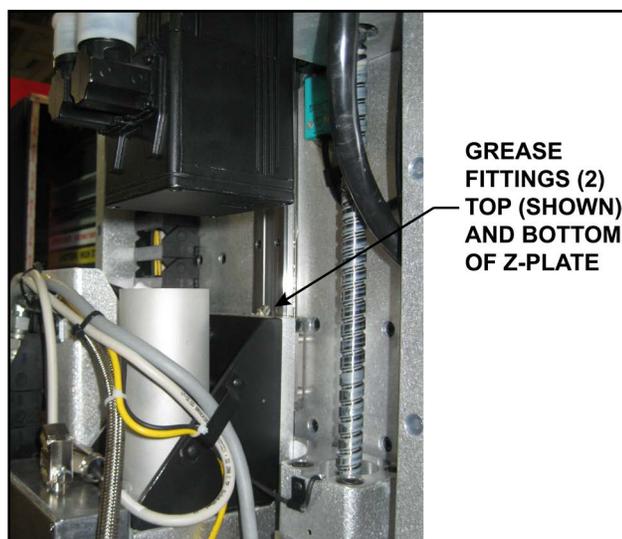


*Figure 9-1 X-axis Linear Bearing Grease Manifolds Operator and Beam Side (Do not over-grease.)*



*Figure 9-2 Y-axis Linear Bearing Grease Fittings (Do not over-grease.)*

*Figure 9-3* shows the Z-axis fitting on one of the two truck bearings. Top bearing truck shown.



*Figure 9-3 Z-axis Linear Bearing Grease Fittings Top Bearing Shown. (Do not over-grease.) (Update Photo)*

## ⚠ CAUTION

Do not over-lubricate the bearings. Excess grease could contaminate the encoder scales located near the linear bearing rails.

CINCINNATI INCORPORATED requires a grease conforming to the following specifications for X, Y, and Z-axis lubrication:

- ◆ Kluber Lubrication Isoflex NCA 15
- ◆ NLGI #2, worked penetration of 280 mm.
- ◆ Calcium Base Grease
- ◆ Anti-fretting and corrosion

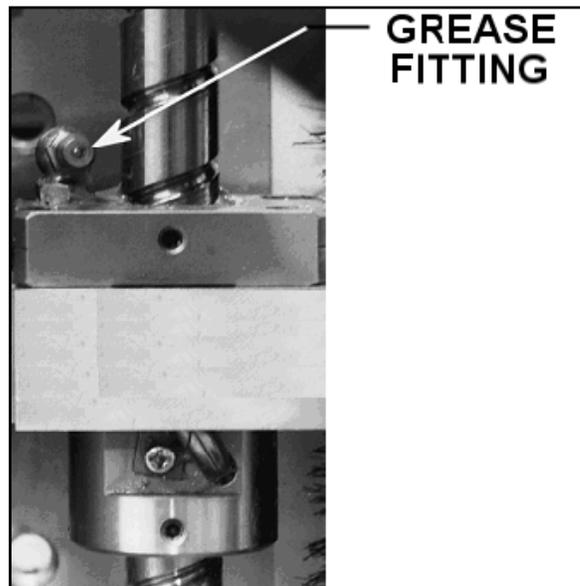


*This grease is available from CINCINNATI INCORPORATED in a 14.1 ounce (400 gram) cartridge C.I. #921695-B.*

The Maintenance | Statistics window includes parameters to display the accumulated time and distance since the bearings were lubricated. After lubricating the bearings, change the parameters labeled “Time Elapsed Since Lube”, “X-axis Travel Since Lube” and “Y-axis Travel Since Lube” to zero.

### Z-AXIS LUBRICATION

The Z-axis ball screw requires manual lubrication every 2000 hours, or every six months, of operation. Figure 9-4 shows the Z-axis ball screw bearing lube point.



*Figure 9-4 Ball Screw Lube Point*

### FUME SYSTEM LUBRICATION

Before adding grease to fan bearings, wipe clean the grease fittings on the side of the fan. While slowly operating a manual grease gun, rotate the fan shaft. Stop pumping when a very slight resistance is felt at the grease gun. Be careful to **avoid** unseating the bearing seals by over lubricating or using excessive pressure.

The 8x20 model has five (5) exhaust gates in the fume collection system. Two (2) bearings support each exhaust gate. Lubricate the exhaust gate bearings every 12,000 hours, or every two years, whichever comes first.

## MATERIAL CLAMP LUBRICATION

The material clamps located on each pallet should be cleaned and lubricated at least weekly. To clean a clamp, remove the cap screw and clamp hook, then wipe the clamp assembly clean and lubricate with a coat of light oil (Ex. SAE20 Non-detergent).

## MAGNETIC TRACK MAINTENANCE



The linear motor drive system consists of a moving linear motor coil and a stationary magnet track. The motor coil is suspended approximately 0.015 inch (0.38 mm) above the surface of the tape covering the magnet track. The tape protects the magnets and provides a wear surface for scraper blades to ride on. The scraper blades push debris on the magnet track toward the ends of travel.



***Do not remove the X Read head to clean the white scraper blade at front of linear motor.***

Clean the tape surface every three months. Pull back the bellows and wipe the entire magnet track surface with a lint-free cloth. Wipe debris toward the extremes of travel and then remove the debris. A mild water-based cleaner can be applied to the cloth. Do not pour cleaning solution on the tracks. Remove any excess grease from the linear bearing rails. Use care around encoder scale.

Check the scraper blades for wear and proper function twice a year. The blades must slide freely within the guide slots on both ends of each linear motor (two X-axis motors and one Y-axis motor).

If the blades do not slide freely, clean the guide area and/or replace the scraper blade. Also, check the bottom of the scraper blade. It must be flat, free of gouges, and not excessively worn. To check wear, measure the distance from the bottom edge to the small screw (centerline). Replace scraper if this distance is less than .125 inch (3.2 mm).

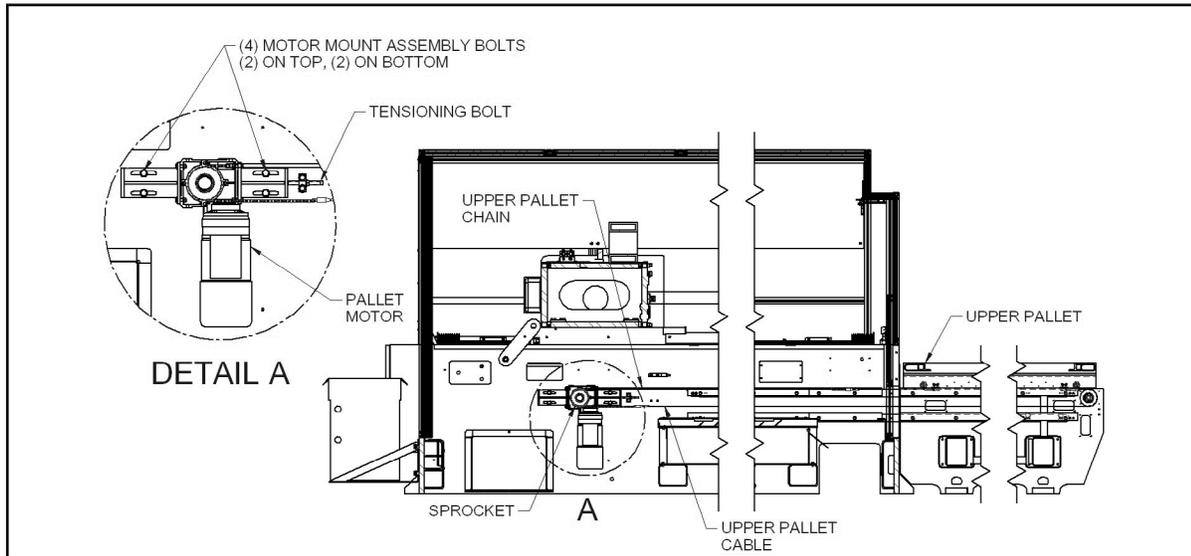
If a squeaking noise develops between the magnet track and scraper blade, a bonded dry Teflon spray (CI P/N #921916) can be applied to the magnet track.

## PALLET DRIVE MAINTENANCE

### CHAIN DRIVE TENSION ADJUSTMENT

Check chain drive tension periodically and adjust if necessary. Follow this procedure to adjust chain tension. See *Figure 9-5*.

1. Move the pallet into the load frame and turn off the main power disconnect.
2. Use a 3/4 inch wrench to loosen the (3) motor mount assembly bolts on the inside of the main frame.
3. Using a 3/4 inch wrench, turn the tensioning bolt to adjust tension in the chain and cable assembly. Tighten the bolt until the cable does **not** contact the plastic guide block at the main frame end of the load frame.
4. Use a 3/4 inch wrench to tighten the (3) motor mount assembly bolts on the inside of the main frame.



**Figure 9-5 Adjusting pallet Cable Tension**

## SCRAP REMOVAL

The scrap removal system is designed to remove scrap material from the cutting area after processing. The system components are: scraper plates attached to the lower pallet, scrap tray mounted on top of the fume collection plenum, and a scrap cart with removable scrap totes.

When cutting has completed on the lower pallet and the pallets change positions, the lower pallet will move from the main frame to the load frame. As the pallet moves, the scraper plates push scrap accumulated on the scrap tray into scrap totes located near the load frame end of the main frame.

When the pallet fills the scrap cart, pull the scrap cart out of the main frame and empty the totes.

Clean the scraper plates to remove laser slag as needed. To remove a plate, pull the pin from the hinge and lift the plate out. Clean the scrap trays if slag build-up prevents the scraper plates from functioning properly or inhibits proper fume collection. Also clean the pull-out totes.

**⚠ WARNING**

**Fire hazard is present in the processing area through interaction of the laser beam with materials present in the work area.**

Debris and fine particulate generated from laser cutting some materials, (i.e. plastics, aluminum, fabrics, etc.), can present a fire hazard if allowed to accumulate. Good housekeeping practice should be followed so the area below the cutting zone is inspected daily and cleaned on an as-needed basis or every 1000 hours of operation. The fume collection plenum (air collection duct) below the cutting zone should also be checked for debris accumulation. Removable covers are provided for this inspection and cleaning. See **Section 3 - SAFETY, FIRE**, for more information.

## PALLET GUIDE RAILS

Maintenance required for the pallet guides consists of periodic cleaning of the guide rails in the Main Frame and Load Frame.

Remove dirt and debris from the entire length of the upper and lower rails on a regular basis. As a guideline, inspect the rails weekly and, if necessary, clean with a stiff brush and a non-flammable, nontoxic solvent.

Stubborn deposits can be removed with an abrasive pad such as Scotch-Brite®, or in extreme cases with 240 grit wet-or-dry silicon carbide paper.

## ENCODER MAINTENANCE

The laser system X and Y-axes have “open style” linear encoders that are covered by flexible bellows. The encoder scales require periodic inspection and cleaning to maintain reliable operation.

### ENCODER CLEANING

The open construction allows access for cleaning the encoder scale. Clean the scale if axis motion is unstable. No signal indicators will be present with the AMO encoders. Clean the scale if the axis motion is unstable or is dirty.



***If encoder scale cleaning does not correct motion instability or restore encoder signal strength, it may be necessary to clean the X-axis Read Head optics. Cleaning the Read Head requires disassembly. Consult CINCINNATI Laser Service before removing the Read Head.***

The X-axis encoder scales are protected by a lacquer coating to help them tolerate handling and contamination. Clean the scale with a soft, dry cloth. To remove oil and grease films, **lightly wet** the cloth with Isopropyl alcohol or h-Heptane solvent.

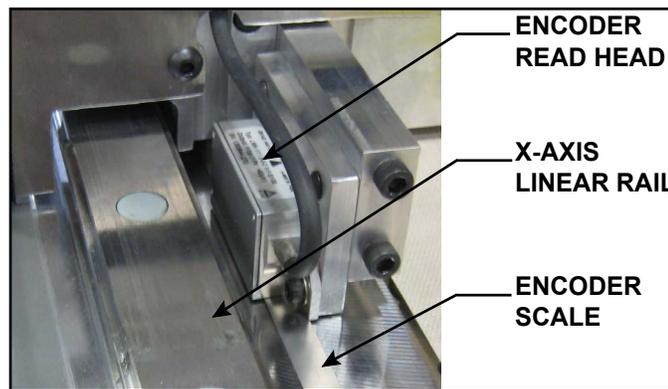


Figure 9-6 X-axis Encoder Read Head with Air Nozzle Scale Purge



***Do not use aggressive solvents (Acetone, Chlorinated Solvents, Benzene, Mentholated Spirits, etc.) to clean X-axis encoder scales; aggressive solvents can damage the lacquer coating.***

Clean the Y-axis scale with a soft, dry, lint-free cloth only.



***Do not use aggressive mechanical cleaning techniques or solvents to clean the Y-axis encoder scale. Debris accumulation is less likely on the Y-axis scale because of its vertical orientation. There are no air purge nozzles or Read Head signal indicators on the Y-axis encoder.***

Inspect the encoder scales monthly. Check for debris and/or grease migration from the linear bearings adjacent to the scales. Clean the scales only as necessary.

## OPTICS HANDLING AND CLEANING

The focusing lens, collimator, cover slides and the fiber optic cable quartz block are the **most** critical components in the beam delivery system. These optical elements are made of materials that transmit the laser beam instead of absorbing it.

An unfortunate drawback of the optical materials, is that they are very easily scratched or chipped, and when damaged, will absorb the beam. Foreign materials such as oil mist, dust, smoke, fingerprints, or water vapor can cause the optic to absorb the energy of the beam. Any excess beam absorption by these optical elements

can cause poor cutting performance and eventual destruction of the optic.

The fiber optic cable quartz block (fiber coupler) is installed and sealed in the QBH receiver. Any time the fiber coupler is connected to the QBH receiver, it is to be inspected for dust, dirt, or damage. Refer to the IPG/nLight manual for proper inspection and cleaning procedure.

Follow procedures for optic cleaning using the **Cincinnati Optics Handling Kit** (C.I. P/N #917261).

 <b>WARNING</b>
<p>Special procedures are required to remove the fiber connector from the collimator. Contamination of the quartz block on the fiber coupler or the collimator lens will cause serious damage to the fiber laser. Contact CINCINNATI Service Department for procedure.</p>

## CLEANING SUPPLIES

- N2 gun set at 80PSI. Refer to training videos at Cincinnati Incorporated: <https://www.e-ci.com/training/>
- Blow off gun
- Optics Handling Kit (C.I. P/N #917261).

## HANDLING

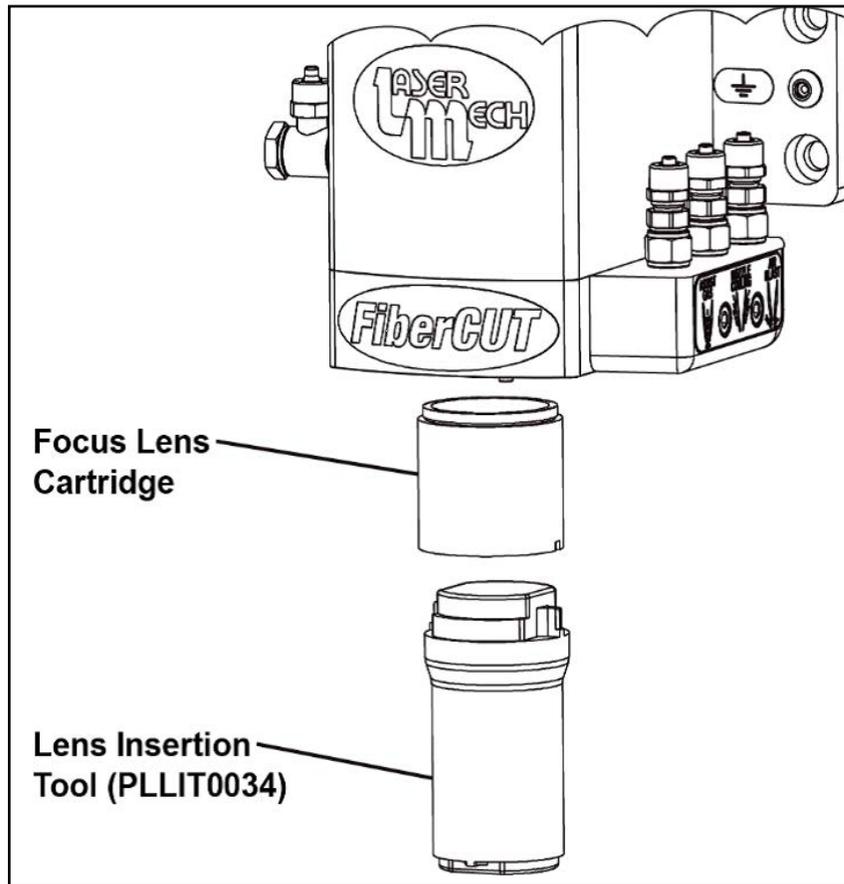
1. Access to optics should be restricted to trained personnel.
2. Handle the optics in a clean area away from the machine. Before handling the optics, make sure your hands are clean and a clean, soft working area is prepared with all cleaning supplies ready. Cover the area where optics may be setting with lens tissue. Finger cots or rubber gloves are required.
3. Handle the optics one at a time and avoid unnecessary handling. **Always** handle the optic by the edge only, and **avoid** sliding the optic on its polished surface.



*Contact with skin will damage the optic coating and shorten optic life.*

## REPLACING THE FOCUS LENS CARTRIDGE

To change the focus lens cartridge, it is necessary to remove the tip assembly and manifold block and relocate them to a clean dry surface See *Figure 9-7*.



*Figure 9-7 Removing Focus lens cartridge*

Follow these steps to replace the focus lens cartridge:

1. Inspect the lens insertion tool
  - Blow off and clean it as necessary.
2. Prepare a clean area near the head with the following items from the Optics Handling Kit (C.I. P/N #917261):  
Optics Handling Kit:
  - Lens tissue or lint-free cloth
  - A LED light
  - Lens insertion tool
  - A new focus lens cartridge in the appropriate protective packaging
  - Scissors
3. Position the focus lens at the bottom of travel.
4. Clean off the dust and/or loose debris from the head and manifold block using an exterior cleaning towel.

5. Unthread the tip assembly and remove it from the head.
6. Verify that both o-rings are present in the tip assembly and installed correctly.
  - There is (1) small o-ring near the threads.
  - There is (1) large o-ring in the center of the tip assembly.
7. Set the tip assembly upside-down on the lens tissue or lint-free cloth.

**For steps 8 to 10, see Figure 9-8.**

8. Loosen the (3) captive M5 x 80 SHCS securing the manifold block to the head.
  - Use a 4 mm hex wrench.
9. Carefully, remove the manifold block.
10. Verify that all (4) o-rings are present on top of the manifold block and installed correctly.
  - There are (3) small o-rings in the upper right corner of the manifold block.
  - There is (1) large o-ring in the center of the manifold.
11. Set the manifold block on one of its flat sides on the lens tissue or lint-free cloth.

 **Do not set the manifold block upside down on the electrical connector.**

12. Use the lens insertion tool to unthread the focus lens cartridge from the head. *See Figure 9-6.*
  - Place the old lens cartridge on the lens tissue or lint-free cloth.



***If necessary, cover the bottom of the head with tape to prevent contamination.***

13. Remove a new focus lens cartridge from the appropriate protective packaging.

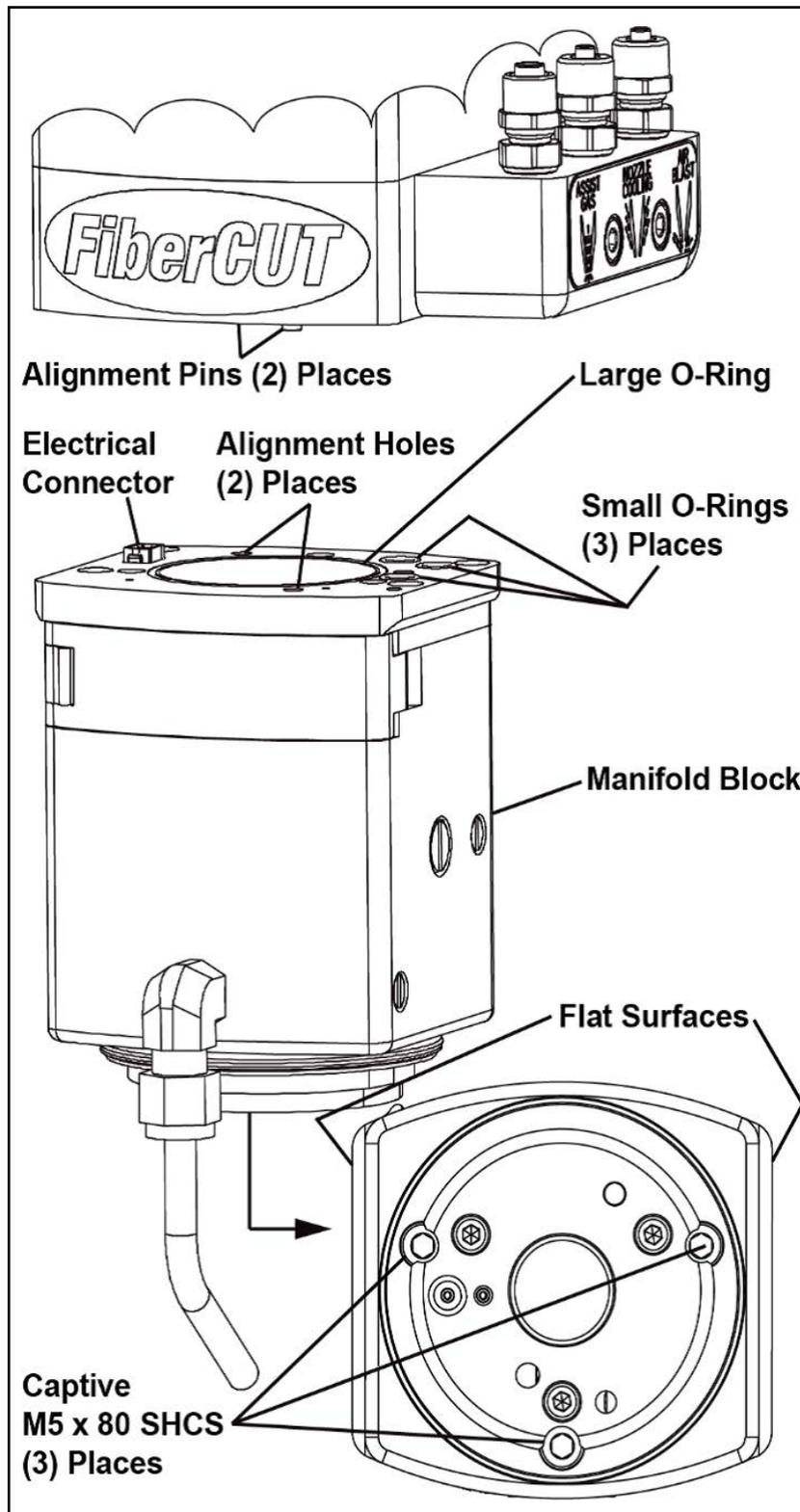
 **DO NOT WIPE OR TOUCH THE GLASS SURFACE.**

14. Inspect each side of the new focus lens while shining the LED light from behind the optic.
15. Blow off any dust or loose particles, if necessary.

 **ONLY use clean dry air or nitrogen to blow off the glass surface.**

16. Inspect each side of the new focus lens while shining the LED light from behind the optic.
  - If the focus lens cartridge is clean, proceed to step 17.
  - If the focus lens cartridge is contaminated, get another replacement or new focus lens cartridge and return to step 13.
17. Use the lens insertion tool to thread the new focus lens cartridge snugly into the head. *See Figure 9-7.*

 **DO NOT OVERTIGHTEN.**



*Figure 9-8 Removing Focus lens cartridge*

For steps 18 to 20, see Figure 9-8.

18. Verify that all (4) o-rings are present on top of the manifold block and installed correctly.

19. Orient the manifold block so:

- The alignment holes are in line with the alignment pins in the head.
- The electrical connector is aligned properly.

20. Tighten the (3) captive M5 x 80 SHCS securing the manifold block to the head.

- Use a 4 mm hex wrench.

21. Verify that both o-rings are present in the tip assembly and installed correctly.

22. Orient the tip assembly on the head so the flat is facing towards the front and thread it on.

23. Push the door latch to release the cover glass door and open it.

24. Grasp the handle on the cover glass drawer and pull it straight out to remove it from the head.

25. Close the sealed cover glass door.



***DO NOT WIPE OR TOUCH THE GLASS SURFACE.***

26. Inspect each side of the cover glass while shining the LED light from behind the optic.

27. Blow off any dust or loose particles, if necessary.



***ONLY use clean dry air or nitrogen to blow off the glass surface.***

28. Inspect each side of the cover glass while shining the LED light from behind the optic.

- If the cover glass is clean, proceed to step 29.
- If the cover glass is contaminated, replace as necessary according (C.I. P/N #914910).

29. Push the door latch to release the cover glass door and open it.

30. Grasp the handle on the cover glass drawer and push it straight into the head.

- The orientation grooves must face up.

31. Close the sealed cover glass door.

32. Verify beam centering in the nozzle tip.

33. Verify focus position.

## **REPLACING THE LOWER COVER GLASS DRAWER**

The FiberCUT® 2D has an upper and a lower cover glass. See *Figure 9-9*.

- The upper cover glass is located just above the collimating lens cartridge.
- The lower cover glass is located just below the focusing lens.

Set the manifold block on one of its flat sides on the lens tissue or lint-free cloth.

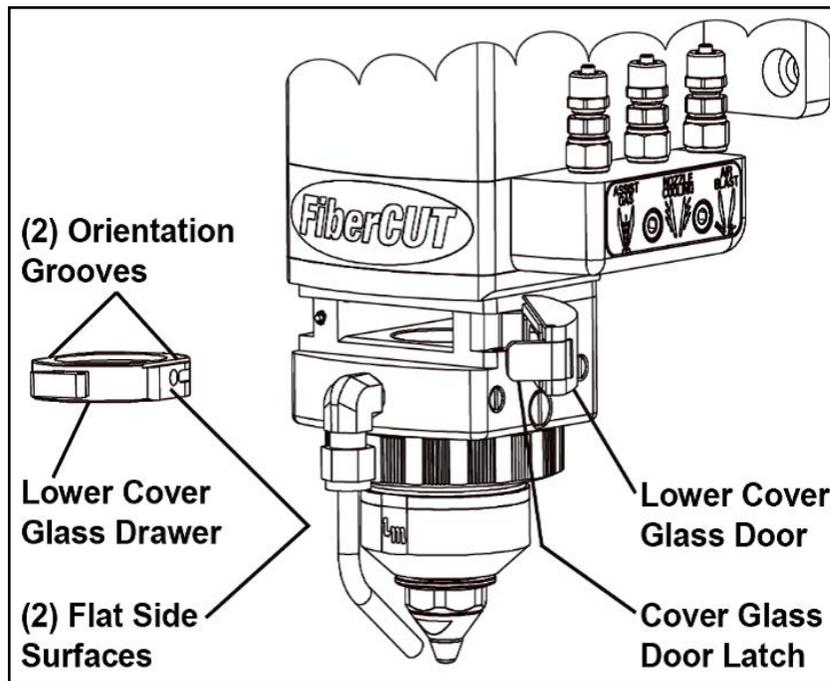


Figure 9-9 Lower Cover Glass



**ONLY OPEN THE UPPER COVER GLASS DOOR WHEN:**

- *The fiber has been removed.*
- *The upper cover glass experiences a temperature fault.*

To Replace the Lower Cover Glass Drawer follow these steps See *Figure 9-9*:

1. Prepare a clean area near the head with the following:
  - Lens tissue or lint-free cloth
  - A LED light
  - A replacement cover glass drawer with a new optic
  - Scissors
2. Clean off the dust and/or loose debris from the cover glass door using an exterior cleaning towel.
3. Push the door latch to release the cover glass door and open it.
4. Grasp the handle on the cover glass drawer and pull it straight out to remove it from the head.
5. Close the sealed cover glass door during service to keep contaminants out.
6. On the lens tissue or lint-free cloth, carefully place the used cover glass drawer sideways on one of the flat side surfaces.



**NEVER set the cover glass drawer or any optical component on a dirty surface such as the machine or a bench.**

7. Remove the replacement cover glass drawer from the appropriate protective clamshell packaging.
  - Open the clamshell sideways.
  - Use the indentations to pick up the drawer and lift it out of the clamshell.

**!** **DO NOT WIPE OR TOUCH THE GLASS SURFACE.**

8. Inspect each side of the new cover glass while shining the LED light from behind the optic.
9. Blow off any dust or loose particles, if necessary.

**!** **ONLY use clean dry air or nitrogen to blow off the glass surface.**

10. Inspect each side of the new cover glass while shining the LED light from behind the optic.
  - If the cover glass is clean, proceed to step 11.
  - If the cover glass drawer is contaminated, get another replacement or new cover glass drawer and return to step 7.
11. Push the door latch to release the cover glass door and open it.
12. Grasp the handle on the cover glass drawer and push it straight into the head.

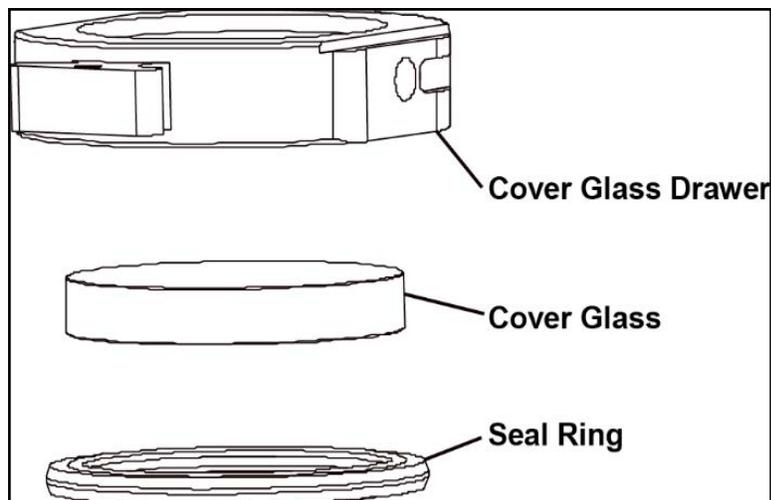
**!** **The orientation grooves MUST be up as shown in Figure 9-9.**

11. Close the sealed cover glass door.
12. Take the used cover glass drawer and clamshell to a clean area or an office.

## REPLACING THE COVER GLASS IN THE DRAWER

To Replace the Cover Glass in the Drawer follow these steps:

1. Go to a clean area or an office and set out the optics handling kit and a pair of scissors. The Laser Mechanisms' Optics Handling Kit (C.I. P/N #917261) includes:
  - (1) 9 inch X 9 inch lint-free cloth
  - 4 inch X 4 inch lint-free tissues
  - Powder free nitrile gloves
  - (1) LED pen light



**Figure 9-10 Cover Glass Drawer**

2. Place the 9 inch X 9 inch lint-free cloth on the work surface.
3. Inspect the top of the used cover glass.



***If there is damage on the top of the cover glass, there may also be damage to the focus lens. Inspect the focus lens too.***

4. Remove the cover glass by using a lint-free tissue to push against the glass, opposite the seal.
  - The seal ring and old cover glass will pop out.
5. Use a lint-free tissue to wipe the seal ring and the empty cover glass drawer.
  - Inspect the seal ring and empty cover glass drawer.
  - Replace if necessary.
6. Open a new cover glass package and remove the new cover glass from the appropriate protective clam shell packaging.
7. Put on a pair of clean, powder free type gloves.
8. Open the clamshell sideways.
  - Use the indentations to pick up the cover glass and lift it out of the clamshell.



***HANDLE THE COVER GLASS BY ITS EDGES ONLY.***



***DO NOT WIPE OR TOUCH THE GLASS SURFACE.***



***It is helpful to tilt the drawer while installing a new cover glass and the seal ring.***

9. Install the new cover glass by placing it into the drawer.
10. Press the seal ring into the drawer to retain the cover glass.
11. Place the cover glass drawer into the clamshell and close it.
12. Place a piece of tape on the top of the clamshell and mark the package: **New CG**
13. Store the clamshell in a clean area for the next use.

## **AUTO FOCUS CUTTING HEAD**

### **MAINTENANCE**

#### **HEAD CLEANING**

To maintain nozzle standoff accuracy, clean the nozzle tip assembly regularly. Contamination or damage to the nozzle tip assembly can cause the following problems:

- Sudden or gradual change in standoff accuracy.
- Z-axis instability.
- Sudden Z-axis movements or following error alarms.

- False tip touch or sensor failure alarms.
- Frequent need to change cutting parameters.

Some water may leak when connecting the lens water lines. Water can contaminate the Auto Focus outer cone and tip retaining nut. After installing the auto focus head, clean the nozzle tip, remove any water. Smoke and fumes from cutting may also leave a conductive residue. Clean periodically (about every two weeks) or any time nozzle standoff is not stable or repeatable.

### CLEANING SUPPLIES

- Nonconductive organic degreasing cleaner (C.I. P/N #843254) effectively removes residue from most cutting applications.
- Electro contact cleaner (C.I. P/N #843512) effectively removes residue produced when cutting some galvanized materials.
- Cleaning rags must be free of dirt, oil and grease. New shop rags work well. Laundered rags may have residual oil, which will be loosened by the cleaning solution to form a film. Multi-layered paper towels contain adhesive that can also leave a residue.
- Soft nylon or fine wire brush.
- 1500 grit wet/dry sandpaper or steel wool. Do not use pads with scouring material such as SOS pads.

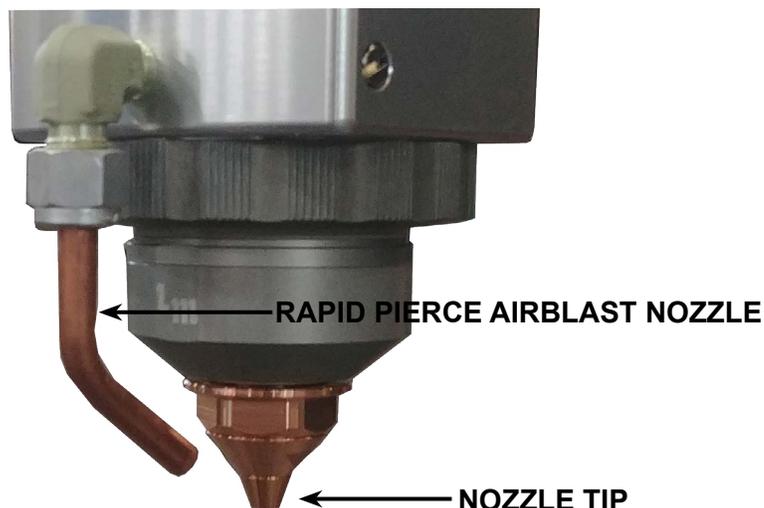
### CLEANING PROCEDURE

1. Wash your hands using the organic cleaner.
2. Unscrew the tip retainer nut and remove the nozzle tip. Use the nylon or wire brush to remove all debris. Be careful not to remove the anodized coating from the Outer Cone. See *Figure 9-11*.

Cutting some materials (such as plastic coated metal) creates a burnt paint-like film on the nozzle. Remove this film with steel wool or sand paper. Polish the copper until it is bright. Remove any debris left from polishing.

3. Clean the threaded surface, inside the outer cone, with the organic cleaner using a cotton swab. Make sure there is no conductive path across the insulator between the Tip Retainer and the Outer Cone.

Do not remove the top cover of the tip assembly for cleaning. The internal parts should remain assembled.



**FIGURE 9-11 Auto Focus Lower Tip**

4. Allow the assembly to dry. If you use shop air to dry the head, make sure the air is oil-free, clean, and dry.
5. Install the nozzle tip to the head and calibrate standoff. (Jog the cutting head over the material, open Standoff Calibration window, select Recalibrate, and press CYCLE START.)

## AUTO FOCUS TROUBLESHOOTING

### Focus Out-Of-Range Error

The control displays this error message when it cannot load a program because a Process Library specifies a focus setting outside the allowable range.

### Auto Focus Head Not Homed

This System Alarm message reminds the operator to “home” the Auto Focus mechanism before starting a program. The control displays the same message if the mechanism fails to complete the home operation due to a fault. This alarm does not interrupt X/Y/Z homing.

### Auto Focus Connection Fault

The Auto Focus control monitors a signal to confirm the cable connection. If the signal changes state during a program, the control displays this System Alarm and interrupts any executing program.



*If the Auto Focus head is installed on the breakaway flange, but the control does not detect the Auto Focus connection signal, then the control operates as if the machine had a (manual focus) noncontact cutting head. In that case, Auto Focus control does not operate and the process status bar indicates Head: NC with no Focus setting.*

## AUTOMATIC NOZZLE CHANGER

Maintenance required for the Automatic Nozzle Changer consists of multiple weekly checks, as well as, one check that need to be done every two months.

The first of the weekly checks is for verifying that the threads of each nozzle assembly are clean and do not have any noticeable damage, as shown in Figure 9-13.



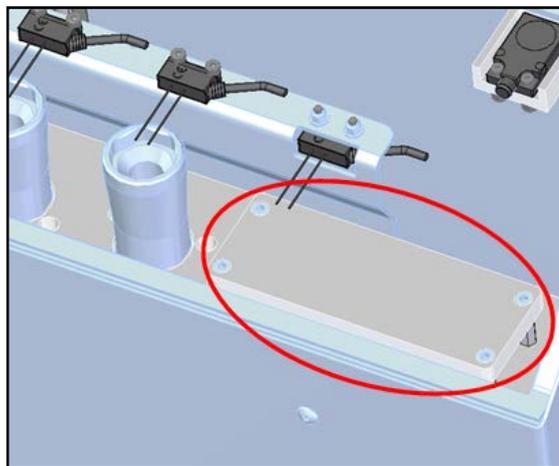
*Figure 9-13 Nozzle Assembly*

The next weekly check, is verifying that the nozzle holders hex sides are not badly damaged. A new holder can be seen in Figure 9-14. While examining the nozzle holders, also make sure to clean the bottom of the cup out removing any debris that may be inside. You want each holder to look like the one in Figure 9-14 in order for the nozzle assembly to sit correctly in the holder.



**Figure 9-14 Nozzle Holder**

The final weekly check is making sure that the calibration pad is clean in order for the HSS to be as accurate as possible. The calibration pad can be seen in Figure 9-15.



**Figure 9-15 Calibration pad**

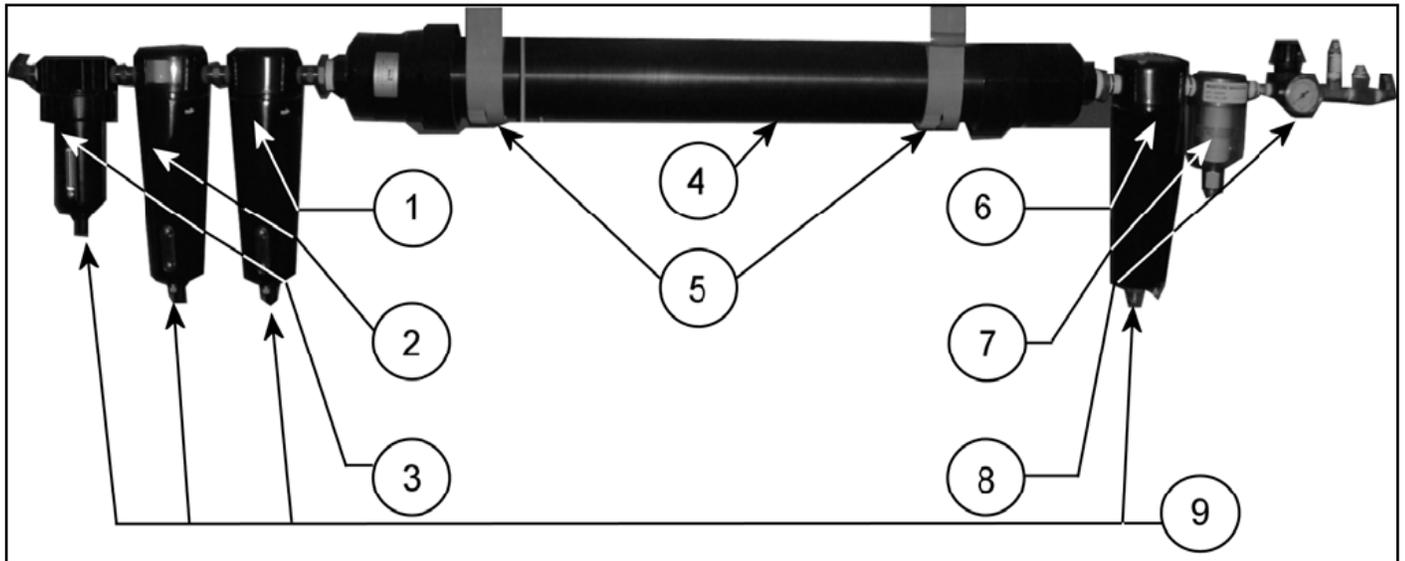
Every two months, check to make sure each of the holders are still fastened to the motor shaft. The holders are attached to the motor shafts by two set screws per holder. If these set screws come loose, it can cause the nozzle station to not function properly. Checking this can be done by rotating each holder clockwise and counterclockwise slowly by hand. If the set screws are tightened correctly, the holder will not spin freely and you will be able to feel that the motor is spinning with it. If the holder spins independent of the motor, remove the back panel of the nozzle station. Once this is done, find the small thru holes that will allow you to access the set screws. Rotate the holder until the two set screws are visible and tighten the loose ones. This can be seen in Figure 9-16.



**Figure 9-16 Small thru holes**

## AIR DRYER

The laser system is equipped with a compressed air dryer. See *Figure 9-17*. This dryer supplies treated, clean, dry air for purging systems on the laser machine.



- |  |   |
|--|---|
| 1. SECOND STAGE<br>COALESCING PRE-FILTER | 6. CARBON FILTER  |
| 2. FIRST STAGE COALESCING PRE-FILTER     | 7. MOISTURE INDICATOR:<br>GREEN: CORRECT OPERATION<br>YELLOW: NEEDS SERVICE |
| 3. SEPARATOR FILTER                      | 8. PRESSURE REGULATOR   |
| 4. MEMBRANE DRYER                        | 9. AUTO DRAINS  |
| 5. MOUNTS TO MAIN FRAME                  |   |

**FIGURE 9-17 Air Dryer System**

### **⚠ WARNING**

**Turn off supply air before changing filters or performing service on air dryer.**

The first stage coalescing filter (Item 2 in Figure 9-17) has a differential pressure indicator, which monitors the pressure drop across the pre-filter. The cartridge on the pre-filters and the carbon filter (Item 1, 2, 3, and 6 in *Figure 9-17*) should be changed when the indicator approaches the red zone (or annually, whichever occurs first).

A filter kit that includes all of these cartridges is available as C.I. P/N #923068. The carbon filter should be changed semi-annually in addition to the annual filter change mentioned above. The replacement cartridge for the carbon filter is C.I. P/N #922903; see assembly drawing, C.I. P/N #914072.

The second stage filter is also a coalescing type, but contains a finer cartridge element. If the second stage filter cartridge captures significant amounts of oil or water, the compressed air supply needs additional treatment (oil and water removal). See *Figure 4-1* for recommended pre-treatment components.

The moisture indicator (Item 7 in Figure 9-17) should turn green within 30 minutes of turning on the dryer. If it does not turn green, change the moisture indicator cartridge with C.I. P/N #923067. If the new cartridge still does not turn green, contact CINCINNATI Laser Service for assistance.

## INPUT AIR REQUIREMENTS

- 314 SCFH (9 cubic meter/hour), 90 PSI minimum (620 kPa).
- Maximum temperature is 100°F (38°C) at the dryer inlet.
- If the 100°F (38°C) inlet air specification **cannot** be met, a small refrigerant dryer is required.
- Compressed air supply system **must** have properly sized after-cooler.
- Drip leg with auto drain should be used if excess water or oil is in the supply line.
- Water and oil droplets **must** be eliminated from supply air to the air dryer.
- See Figure 4-1 for a schematic of a standard compressed air system.

## PREVENTIVE MAINTENANCE

### DAILY MACHINE INSPECTION

1. Empty scrap tray and cart at each shift change.
2. Verify that a sufficient supply of assist gas at the required pressure is available for at least one shift of operation. Verify that assist gas flow can be maintained at the required pressure using the recommended nozzle tip.
3. Verify that a sufficient supply of purge gas is available for at least one shift of operation. Also, check the moisture and differential pressure indicators on the air dryer.
4. Note any machine problems that might require additional attention. Contact CINCINNATI Laser Service for assistance in resolving those problems.
5. Perform the Check Machine Adjustments under **CUTTING PROCEDURES in Section 7 - OPERATION, EM-574.**
6. To clean the touchscreen surface, spray a soft cloth with isopropyl alcohol or a non-abrasive cleaning solution and then wipe the screen.
7. Clean the enclosure windows. The cut area enclosure windows must be washed with a special cleaner. Certain cleaners can damage the window and cause risk to radiation exposure. Cincinnati specifies that our cleaner (C.I. P/N #917263) be used to clean enclosure windows.
8. Check the chiller HMI for warnings and alarms.
9. Blow off Cutting Head Tip cleaning brush on the pallets to remove trapped debris.

### WEEKLY MACHINE INSPECTION

1. Clean the machine. Remove any built-up dirt or slag in and around the cutting area that may affect machine operation. Clean any oil or grease films that might trap dirt or other contaminants. Inspect the pallet guide rails. Clean as necessary.
2. Slide or remove the scrap tray (*see Figure 1-6*) toward the load frame to expose the fume plenum or remove the inspection cover at either end of the fume box, if the machine is equipped with them. Inspect the fume plenum for excess accumulation of fine particulate.

This inspection is **most** important if any materials that produce flammable residue (aluminum, plastics, fabrics, etc.) have been cut. This inspection is also important when the laser system alternates between processing aluminum and steel. Remove excess particulate as required. Refer to Associated Hazards in **Section 3 - SAFETY** for additional information.

3. Remove any debris collected on or near the X and Y-axis encoder scales. Refer to Encoder Cleaning in this section.
4. Inspect the material supports. If the supports show excessive wear or damaged tips, they should be replaced. Material supports with tips on the top and bottom can be reversed, to use both wear surfaces before replacing the supports. Programs to cut new slats can be found on the hard drive in folder “\CNCLSR32\PROGRAM\SLATS”.
5. Clean the material clamps. Lubricate with a light coat of oil.
6. Clean the air filters on the chiller. Dirty filters will reduce the chiller efficiency and lead to poor laser performance.
7. Check the chiller fluid level and refill with distilled water if necessary. Chiller particulate filter elements (C.I. P/N #921929) should be replaced every three months. Chiller deionization filter should be replaced when the chiller gives an alarm for “Change Cold/Cooling water filter” (C.I. P/N #917202).
8. Verify proper operation of the safety enclosure doors.
9. Verify that machine operation is prevented when the Emergency Stop button has been pushed.
10. Confirm that Laser Ready cannot be turned on while the lower nozzle assembly is removed. Clean the Auto Focus cutting head.
11. Open the Maintenance | Statistics window and record the total X-axis travel. If the X-axis travel has increased by two million (2,000,000) feet (610 km) since the last semi-annual (2000 hours of operation) machine inspection, clean and re-lubricate the X1, X2, and Y-axis magnet tracks (see **SEMI-ANNUAL MACHINE INSPECTION**, Step 1 and 14).
12. Make note of any machine problems that might require additional attention. Contact CINCINNATI Laser Service for assistance in resolving those problems.

### **SEMI-ANNUAL (2000 HOURS) MACHINE INSPECTION**

Replace distilled water every 6 months on all machines.

Complete the steps in this procedure semi-annually, at 2,000,000 feet of X-axis travel, or at 2000 run-time hours, whichever comes first.

1. Lubricate the X, Y, and Z axes as described in DRIVES LUBRICATION, using these grease fittings:

<b>Component</b>	<b>Fittings</b>	<b>Figure</b>
<b>X-axis linear bearings</b>	12	9-1
<b>Y-axis linear bearings</b>	4	9-2
<b>Z-axis linear bearing</b>	2	9-10
<b>Z-axis ball screw</b>	1	9-4

2. Perform all service/inspection steps on the 2000 hour service inspection form. Contact CINCINNATI Laser Service for scheduling or proper training. The form includes service and inspection of the fiber laser.
3. Remove the cover below the fume exhaust fan, and clean the duct.
4. Remove scrap tray (*see Figure 1-6*) and remove excess accumulation of fine particulate. This task is most important if any materials that produce flammable residue (aluminum, plastics, fabrics, etc.) have been

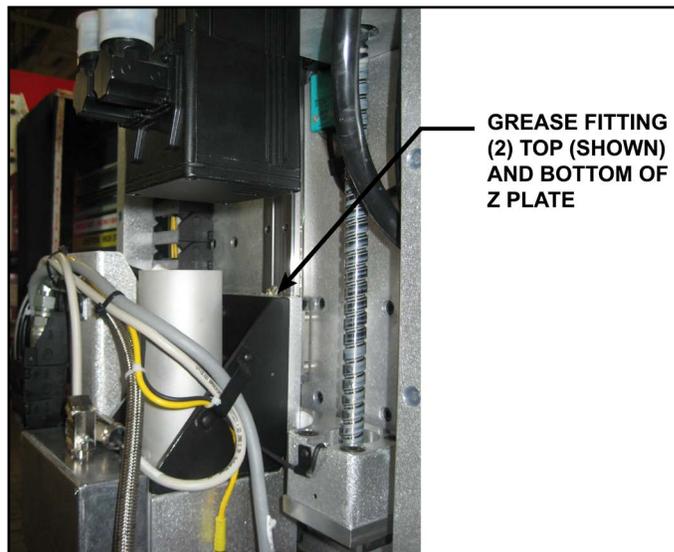
cut. This task is also important when the laser system alternates between processing aluminum and steel. Remove excess particulate from the fume plenum. Refer to **Associated Hazards** in **Section 3 - SAFETY** for additional information.

5. Manually lubricate the fume fan assembly, if applicable, as described in **FUME FAN LUBRICATION** in this section.



**Not all machines are equipped with a Fume Fan Assembly. Refer to the manual for the fume collection system (i.e. Torit or Camfil) if equipped.**

6. Inspect the X-axis and Y-axis linear bearings and the magnet track protective cover for indications of wear or contamination. Clean and lubricate the linear rails as required. Inspect the linear motor assemblies for cooling water leaks or indications of heat build-up. Inspect the area between the X-axis linear bearings and the encoders for debris and contamination – clean as necessary.
7. Lubricate the Z-axis linear bearings and ball screw as described in **DRIVES LUBRICATION**.



**Figure 9-18 Z-axis Linear Bearing Grease Fittings**  
*(Do not over-grease)*

8. Clean the chiller condenser.
9. Inspect the pallet drive chains and cables. Re-tension as necessary. Lubricate the pallet drive chains and gear reducers with SAE20 Non-detergent oil. Clean the pallet guide rails. Refer to **PALLET DRIVE MAINTENANCE** for details.
10. Inspect the machine for cooling water leaks and oil leaks. Correct as necessary.
11. Replace all missing or damaged safety signs.
12. Test chiller interlock and laser main voltage interlocks for proper operation.
13. Test all machine motion and safety interlocks for proper operation.
14. Remove the way covers to expose the magnet tracks of the X1 and X2 axis linear motors. Dampen a cloth with isopropyl alcohol and clean the tape that covers the magnet tracks. Re-lubricate the tape surface with a bonded dry Teflon spray (C.I. P/N #921916), then reinstall the bellows.
15. On the air dryer system, replace the carbon filter (*Item 6 in Figure 9-13*) cartridge. The replacement cartridge is C.I. P/N #922903.

16. Note any machine problems that might require additional attention. Contact CINCINNATI Laser Service for assistance in resolving those problems.

## **ANNUAL MACHINE INSPECTION**

Complete these steps after each year or 6000 hours, whichever comes first.

1. Replace the bulbs in the laser status indicators on top of the laser generating unit and the safety enclosure or as needed.
2. Replace assist gas filter cartridges (C.I. P/N #924856).
3. On the air dryer system, check the differential pressure indicator on the first stage coalescing filter (Item 2 in Figure 9-9). If the indicator is approaching the red zone or annually (whichever occurs first), change the cartridge in the pre-filters and the carbon filter (*Item 1,2,3 and 6 in Figure 9-13*). A filter kit that includes all of these cartridges is available as (C.I. P/N #923068).
4. On the air dryer system, check the moisture indicator (*Item 8 in Figure 9-13*). It should turn green within 30 minutes of turning on the dryer. If it does **not** turn green, change the moisture indicator cartridge with C.I. P/N #923067. If the new cartridge still does **not** turn green, contact CINCINNATI Laser Service for assistance.
5. For machines with a light source that was CDA or “Clean Air Dry” purge, replace the oil filter cartridge (C.I. P/N #917210).



## ORDERING REPAIR PARTS

When ordering repair parts, be sure to give this information:

1. Serial number of the Laser System. This is located on the machine's capacity plate and on the rear of the main frame, on top at the operator side.
2. Part number and part name, obtained from assembly drawings included on the CD that was shipped with this manual.
3. As complete a description of the part as possible.
4. Required delivery date.



*It is sometimes necessary to furnish subassemblies instead of single parts. In such cases, we reserve the right to ship and invoice accordingly.*

## RETURNING PARTS FOR CREDIT

1. No item is to be returned without prior authorization. Please write or call the factory for instructions and a Returned Goods Authorization number (RMA#).

CINCINNATI INCORPORATED  
7420 Kilby Road  
Harrison, OH 45030  
(513) 367-7408  
Email: Partsweb@e-ci.com

2. The Returned Goods Authorization number must be shown on the **outside** of the package. Unauthorized shipments will be returned to the sender freight collect.

## SERVICE

CINCINNATI INCORPORATED Service includes:

1. Established field service department with numerous local offices for prompt service assistance. Factory trained servicemen are available to assist with any service needs. This includes service ranging from minor repairs and adjustments to major reconditioning jobs.
2. Planned Maintenance Service. This program is designed to give comprehensive inspections and recommendations concerning the condition of the equipment. Planned Maintenance Service is specifically tailored to give timely inspections, qualified recommendations, and expert field assistance with repairs to equipment.

## TECHNICAL TRAINING

CINCINNATI INCORPORATED offers a variety of Operator and Maintenance Training Programs to assist our customers in obtaining maximum value from their investment in laser cutting systems. With today's sophisticated controls, operator knowledge and proficiency have a significant effect on overall productivity. These training programs cover the basics of laser cutting, use of the equipment and controls, as well as procedures performed by operating, maintenance, and service personnel.

The purchase of a new machine includes Operator Training for two customer employees, Programmer Class for two customer employees, and Frame Maintenance Training for one customer employee. Training for additional employees and consultation services for specific customer applications are available at additional cost. Please contact our customer Technical Training Department for further information.

## **CUSTOMER INFORMATION CENTER**

This service is provided on the CINCINNATI INCORPORATED Internet web site (<http://www.e-ci.com>). Customers can access the following information:

### **MACHINE INVENTORY AND DOCUMENTATION**

View a listing of your CINCINNATI INCORPORATED machines and available related documents such as manuals.

### **ORDER STATUS**

View parts orders placed within the last 90 days and track an order shipped by a specific carrier.

### **SOFTWARE**

View and download available software updates and files.





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