

OPERATION, SAFETY, AND MAINTENANCE MANUAL

CINCINNATI®

CL-900 SERIES LASER SYSTEM

(IPG FIBER LASER RESONATORS - 5x10, 6x12, 8x20 FRAME)



CINCINNATI®

CINCINNATI INCORPORATED
CINCINNATI, OHIO 45211

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OPERATION

FOR ADDITIONAL SETUP AND OPERATION INFORMATION FOR THIS MACHINE, REFER TO EM-551, SECTION 7 - OPERATION, A SUPPLEMENT TO THE OPERATION MANUAL FOR THE CL-900 LASER SYSTEM. 7-1

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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 from a stationary laser generating unit 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.

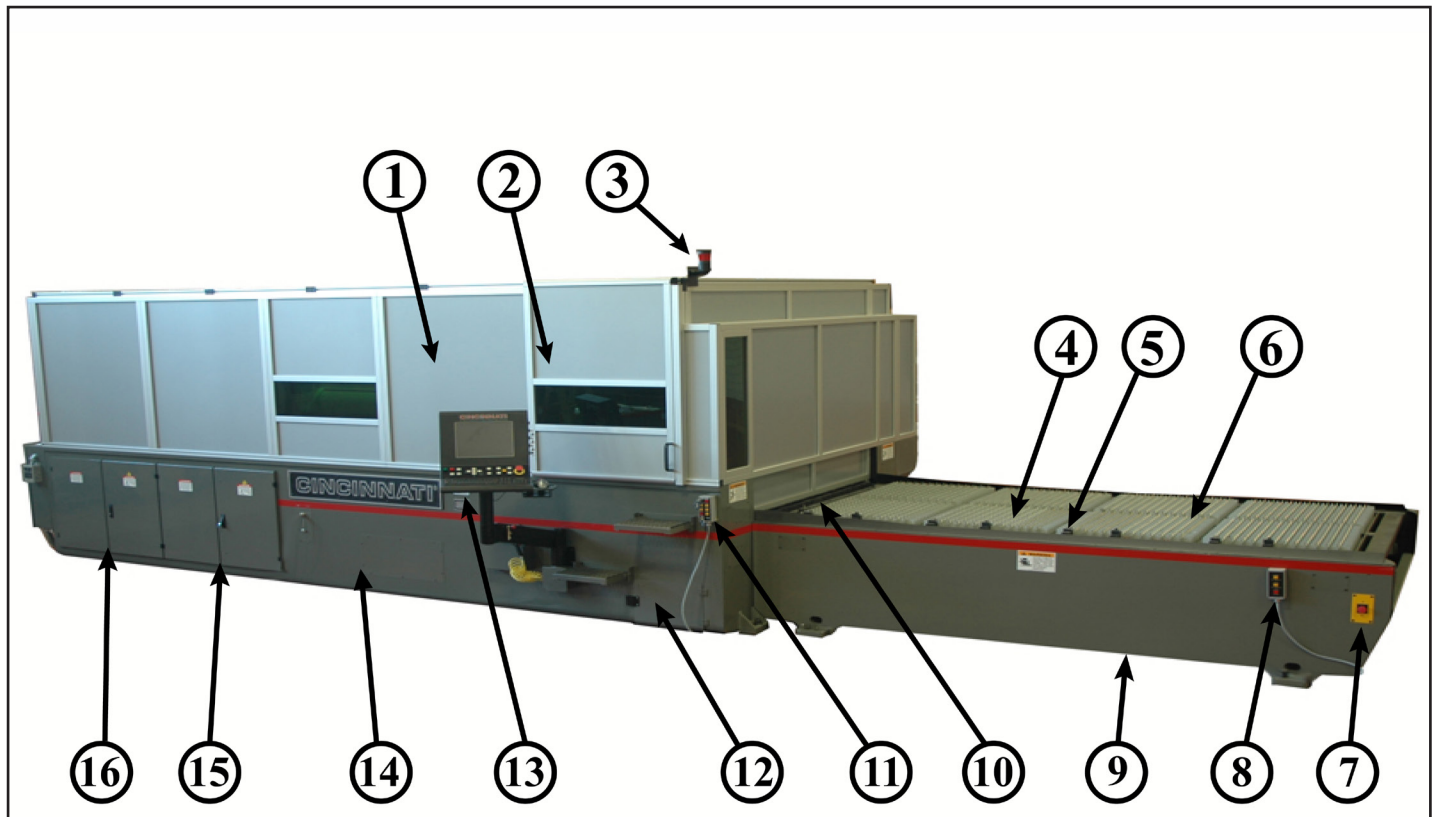
Part quality depends on the program to command the correct combination of laser power, assist gas, and feed rate for the material type and thickness being processed. Part accuracy depends on the program for proper use of kerf width compensation and for selection of feed rate within radius contouring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

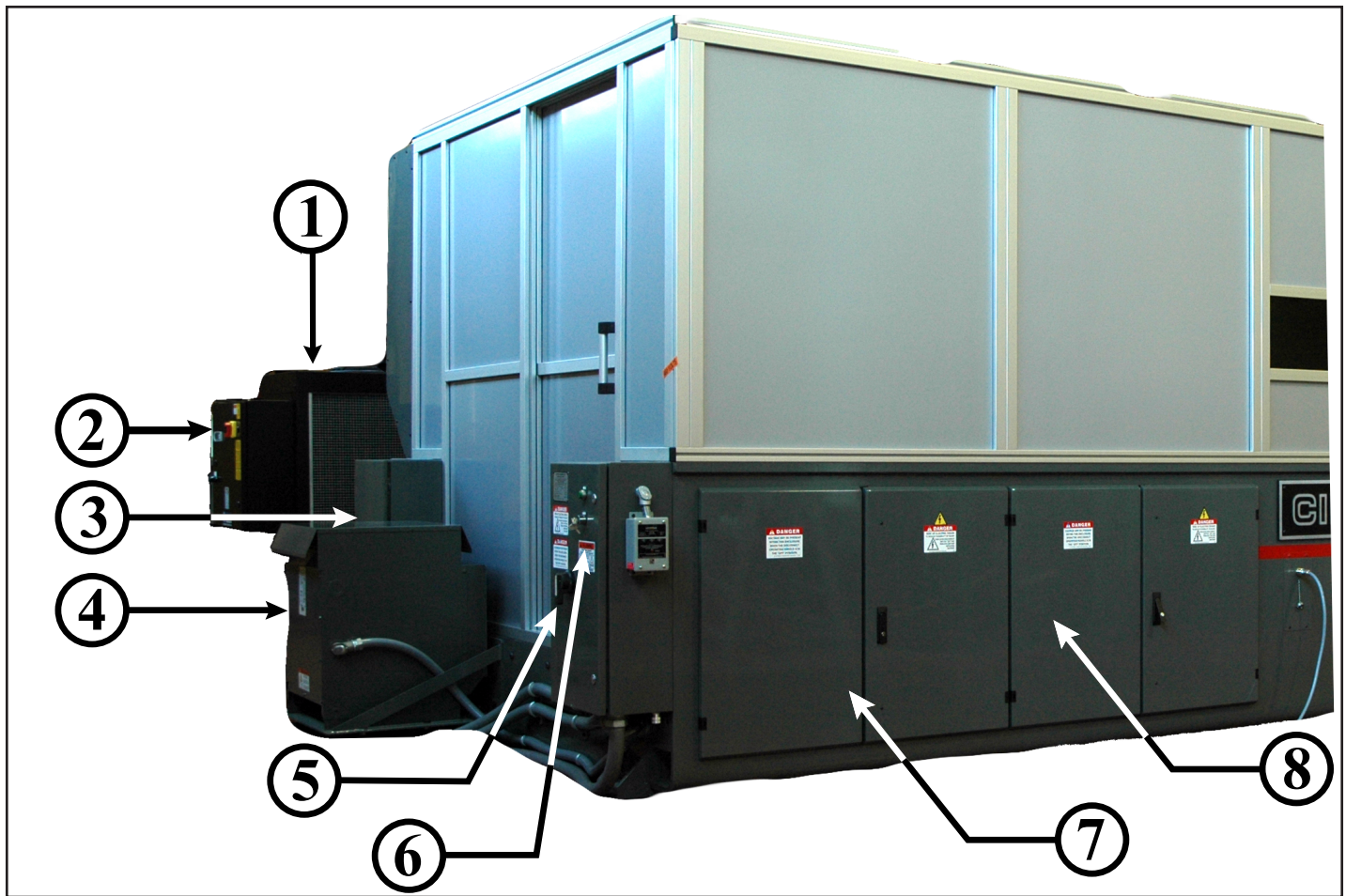
CINCINNATI CL-900 SERIES LASER SYSTEM - FIBER LASER



1. ENCLOSURE
2. OPERATOR DOOR
3. LASER STATUS INDICATOR LIGHT
4. MATERIAL SUPPORTS
5. MATERIAL CLAMPS
6. LOWER PALLET
7. E-STOP BUTTON
8. BALL TRANSFER REMOTE (OPT)

9. LOAD FRAME
10. PALLET DOOR
11. REMOTE STATION
12. SCRAP BIN ACCESS DOOR
13. OPERATOR CONTROL STATION
14. MAIN FRAME
15. CONTROL ENCLOSURE
16. POWER ENCLOSURE

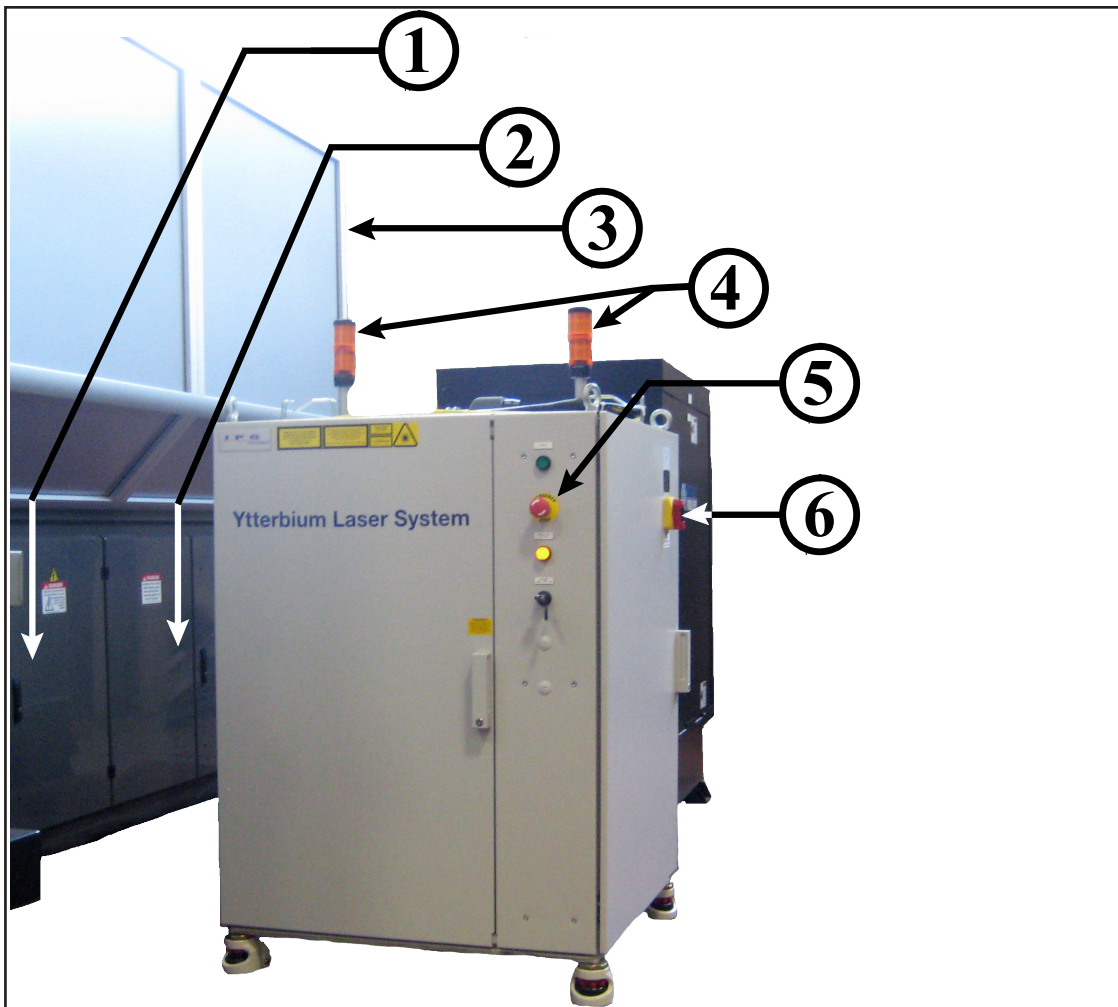
Figure 1-1 Front View



1. CHILLER
2. CHILLER MAIN DISCONNECT
3. GAS AND COOLANT CONNECTIONS
4. TRANSFORMER

5. MAIN DISCONNECT
6. MAIN BREAKER INTERLOCK BYPASS KEY
7. POWER ENCLOSURE
8. CONTROL ENCLOSURE

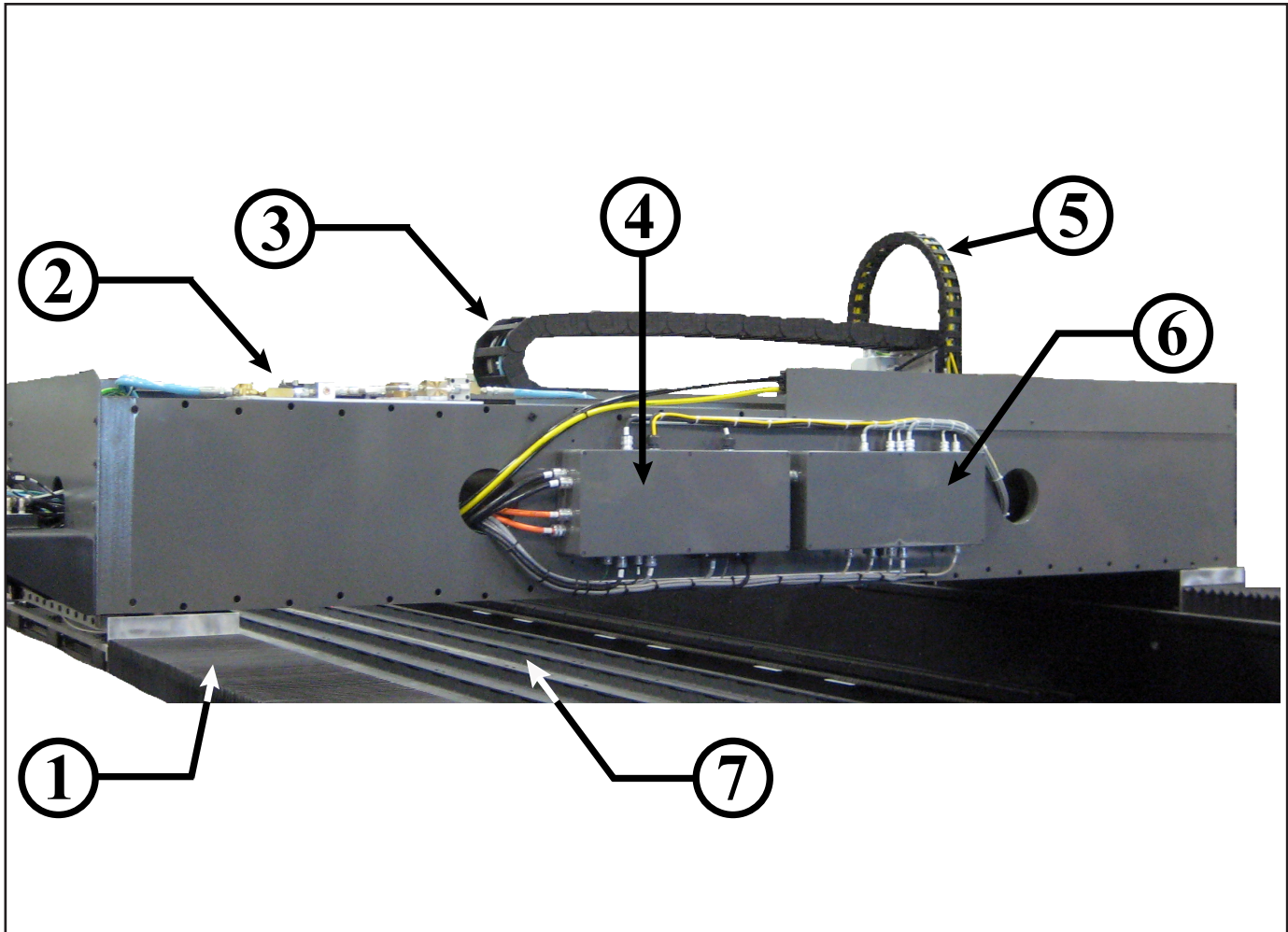
Figure 1-2 Rear View



- 1. I/O ENCLOSURE
- 2. DRIVE ENCLOSURE
- 3. ENCLOSURE

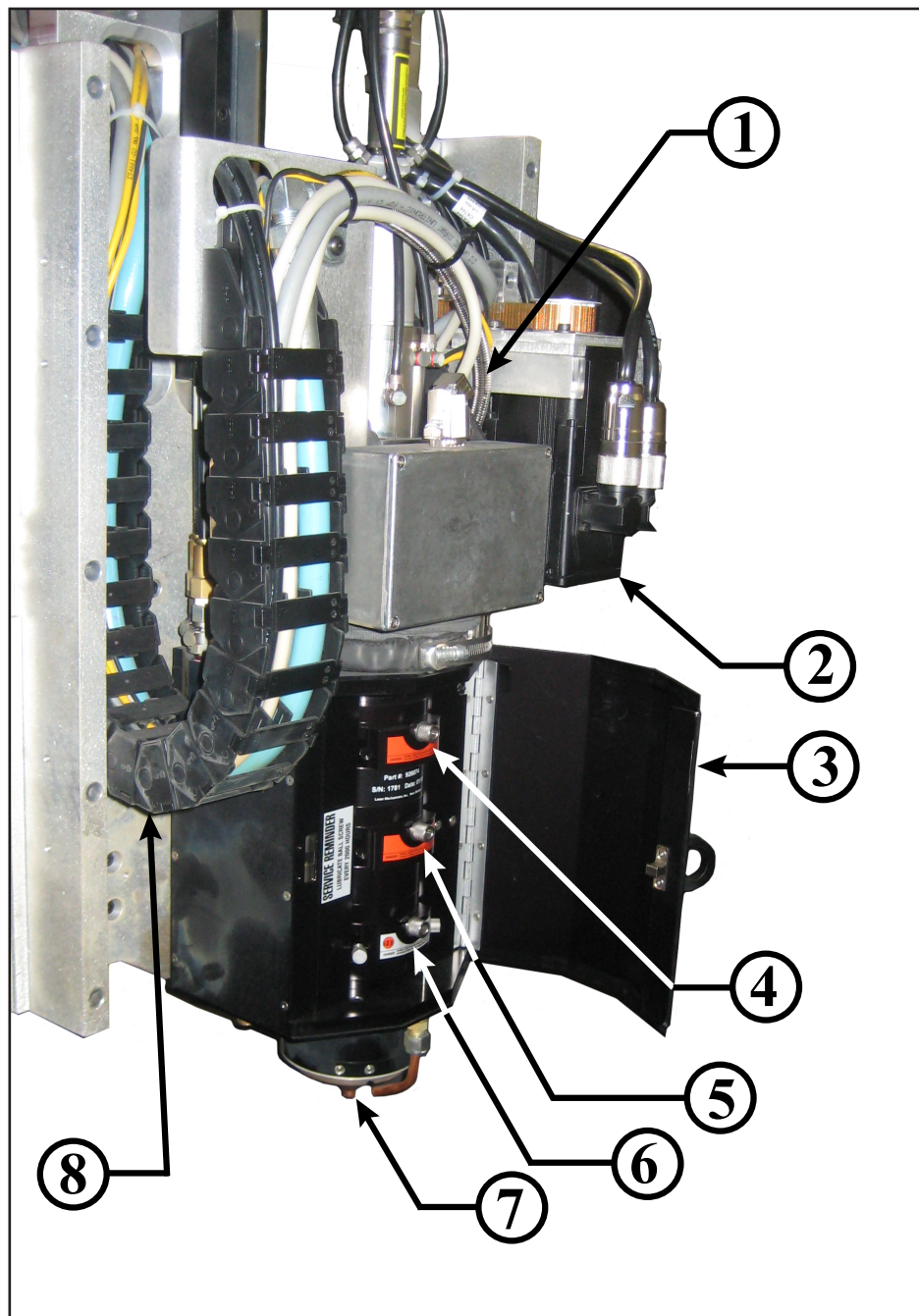
- 4. LASER STATUS INDICATOR LIGHTS
- 5. FIBER LASER E-STOP
- 6. FIBER LASER MAIN DISCONNECT

Figure 1-3 Rear View



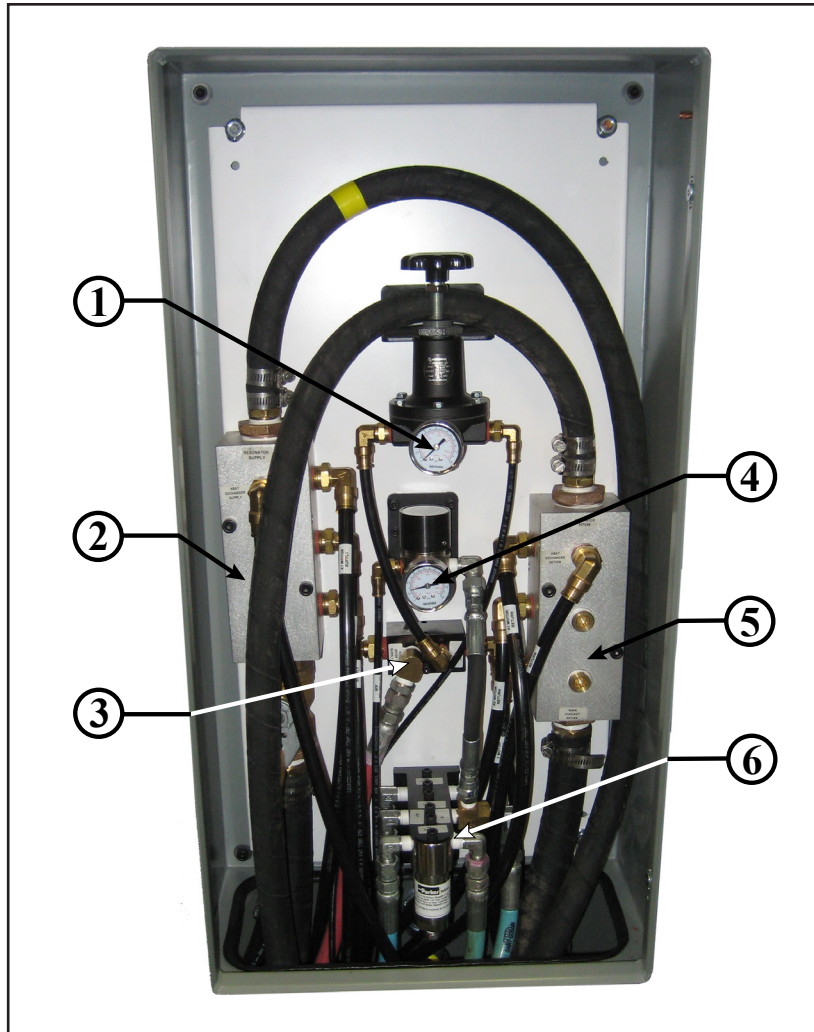
- | | |
|-----------------------------------|------------------------------------|
| 1. X-2 AXIS WAY COVER | 5. Z-AXIS FIBER CABLE CARRIER |
| 2. ASSIST GAS PROPORTIONAL VALVES | 6. RIGHT GANTRY ENCLOSURE |
| 3. Y-AXIS CABLE CARRIER | 7. SCRAP TRAYS AND SCRAP TRAY CAPS |
| 4. LEFT GANTRY ENCLOSURE |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

Figure 1-4 Rear View of the Gantry



- | | |
|--|---|
| 1. ASSIST GAS HOSE | 5. 7.5 INCH LENS DRAWER (EMPTY MANIFOLD SEAL) |
| 2. Z-AXIS MOTOR | 6. 5 INCH LENS DRAWER (INSTALLED) |
| 3. AUTO FOCUS HEAD DOOR | 7. LOWER TIP ASSEMBLY |
| 4. 10 INCH LENS DRAWER (EMPTY MANIFOLD SEAL) | 8. Z-AXIS CABLE CARRIER |

Figure 1-5 Y-Plate and Auto Focus Head Assembly



1. PALLET DOOR REGULATOR
2. SUPPLY MANIFOLD
3. AIR SUPPLY MANIFOLD

4. N₂ REGULATOR FOR OPERATION STATION
5. RETURN MANIFOLD
6. ASSIST GAS FILTERS

Figure 1-6 Pneumatic Enclosure

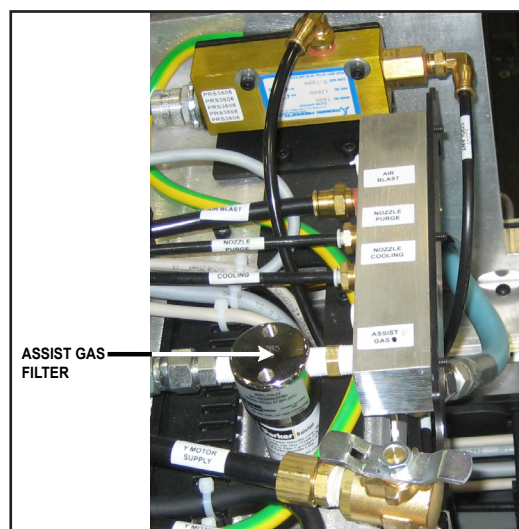


Figure 1-7 Y-Plate Assembly Rear View

SECTION 2

INSTALLATION

IMPORTANT: Before proceeding, contact CINCINNATI Laser Service for pre-installation instructions.

LIFTING AND MOVING

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

The main frame is lifted using four standard lifting clevises attached to four lifting links (C.I. Part # 920584) with spacers (C.I. Part # 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.

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 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.

IMPORTANT: 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.

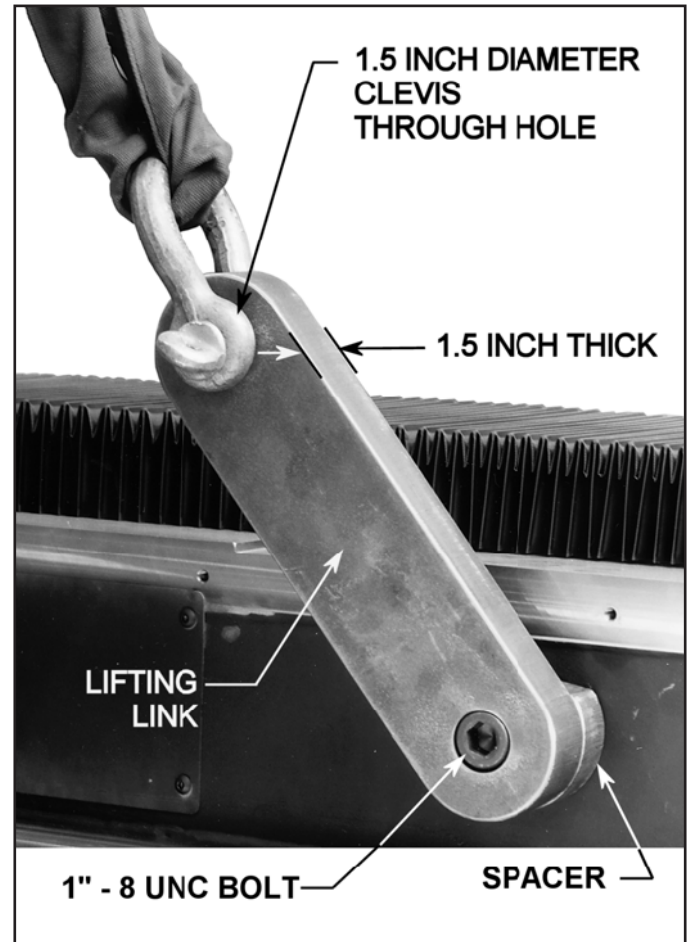


Figure 2-1 Lifting Main Frame



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 to be installed near shock inducing equipment such as punch presses, turret punches, etc., contact CINCINNATI INCORPORATED.

INSTALLATION OF MACHINE

After setting the machine on the anchor studs, place washers and nuts on studs, but do not tighten. Installation consists of the following steps:

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 coolant location mounted to the rear of the machine. Hoses are furnished to connect the chiller when located as shown on the Foundation Plan. Consult CINCINNATI INCORPORATED if an alternative chiller location is required. 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 pads are located on the outside surface of the main frame in the four corners.

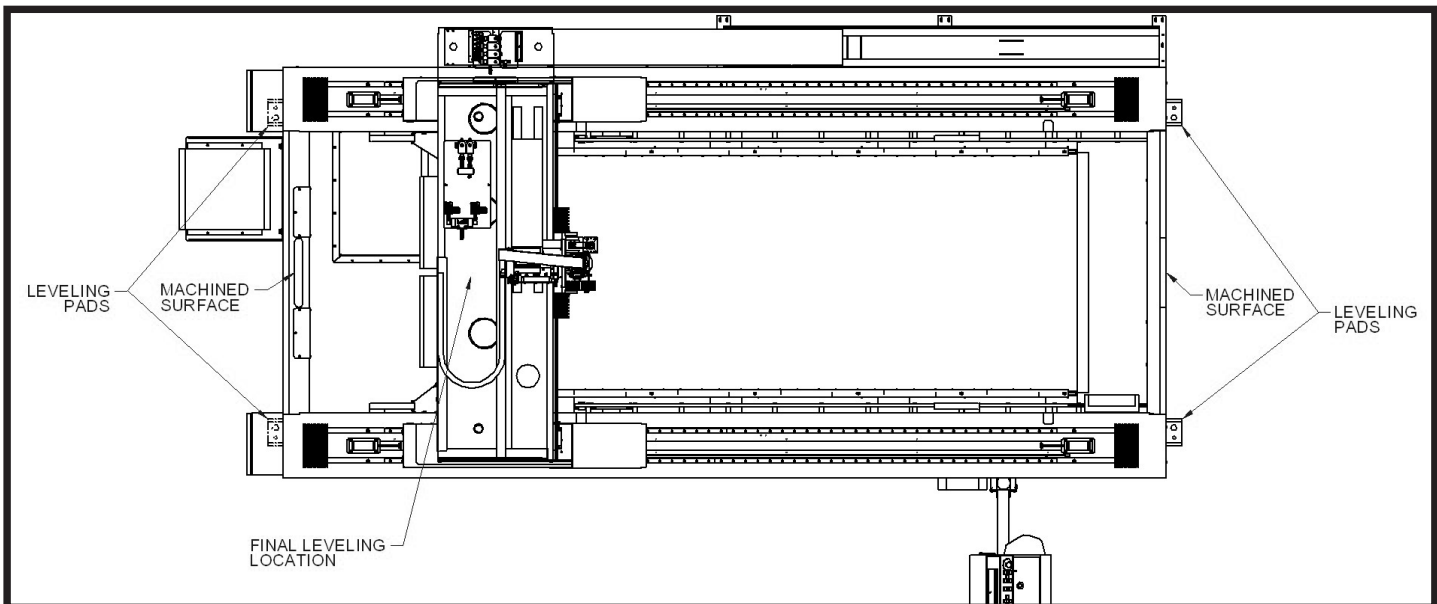


Figure 2-3 Main Frame Leveling Adjustments

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.

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

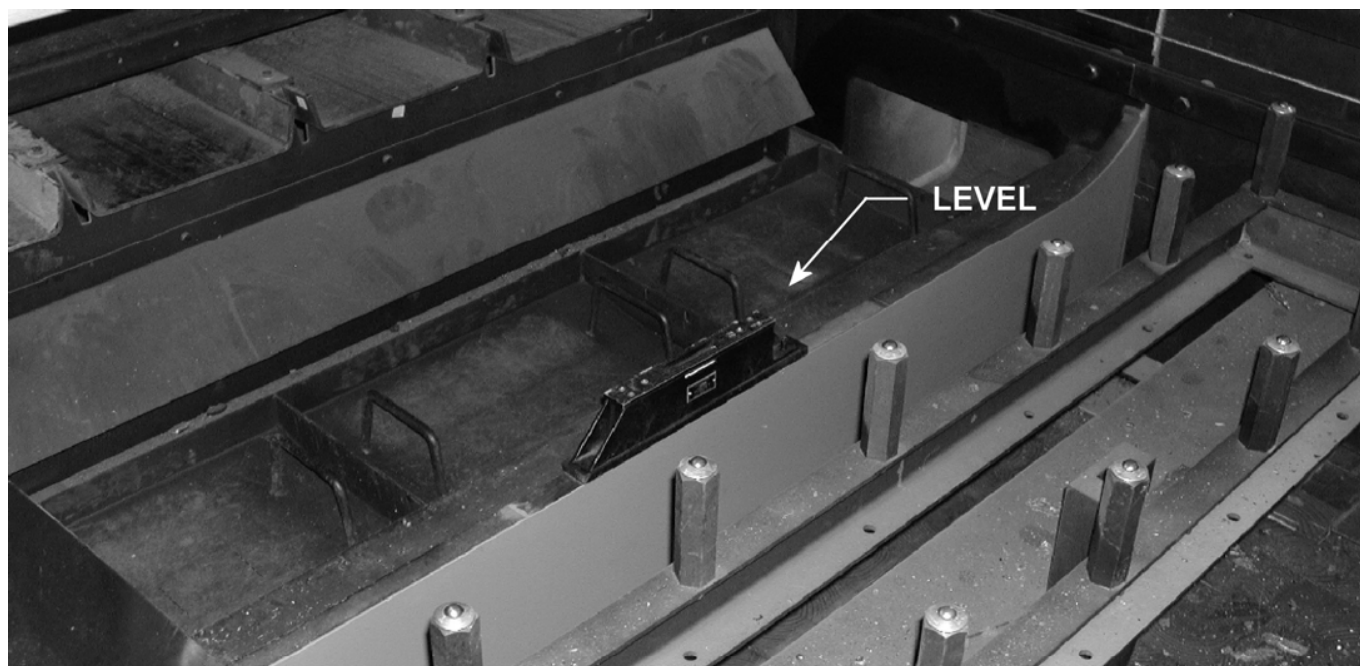
A very powerful magnetic field surrounds the magnet track. Keep all metal (steel) tools away from this track. Place a piece of wood (2x4) over the magnetic track to protect it and personnel.

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.

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.
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



Leveling pads are located at each end of main frame.

Figure 2-4 Cross Leveling (Preliminary)



Figure 2-5 Longitudinal Leveling

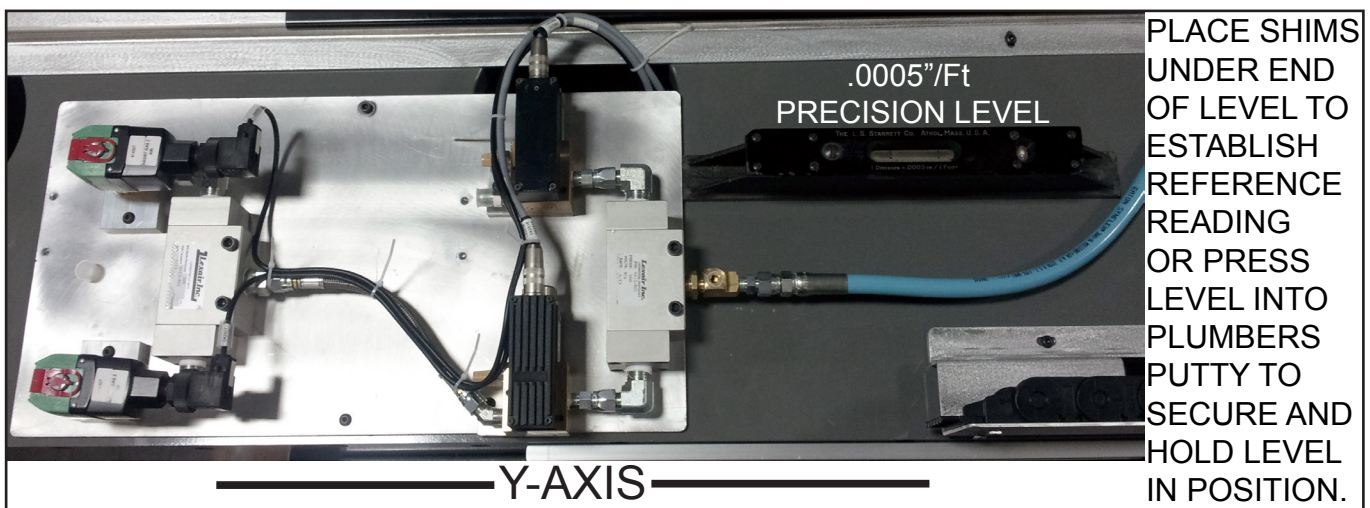


Figure 2-6 Final Leveling with Precision Level

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 +/-10%. The machine must be properly grounded

in accordance with the National Electric Code NFPA 70, 2002 edition, article 250, sections 50 through 70. CINCINNATI INCORPORATED recommends using an individual electrode per article 250.52 (5) to avoid interference from other equipment. Place ground electrode as indicated on Foundation Plan drawing. 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, 2098 Gaither Road, Rockville, Maryland 20850.

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:
 - a. National Safety Council, 1121 Spring Lake Drive, Itasca, Illinois 60143-3201.
 - b. The Laser Institute of America, Suite 128, 13501 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 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.

This brief introduction has been 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”.

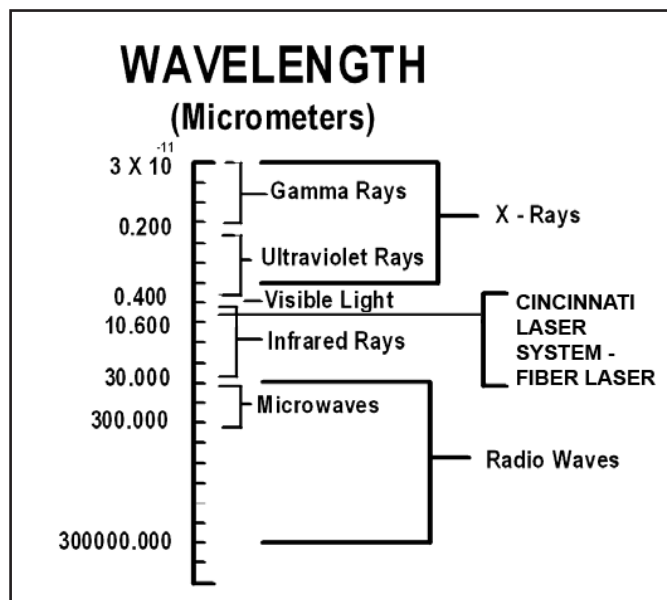


Figure 3-1 Electromagnetic Spectrum

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. 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. In these standards, the level of radiation accessible to persons is used to group lasers into one of four classes. The classes are Class 1, Class 2, Class 3, and Class 4. 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).

Of the standards and publications that apply to users of CINCINNATI Laser Systems, three will be most helpful:

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 Publication 8-1.7 “Guidelines for Laser Safety and Hazard Assessment”. This was developed for OSHA field personnel to help in their job of enforcing workplace safety standards.

LASER HAZARD CLASSIFICATION

As previously indicated, laser products are placed into one of four classes. These are:

Class 1 A Class 1 laser is considered safe based upon current medical knowledge. This class includes all lasers or laser systems which cannot emit levels of optical radiation above the exposure limits for the eye under any exposure conditions inherent in the design of the laser product.

Class 2 A Class 2 laser or laser system must emit a visible laser beam, whose natural brightness will limit exposure by making the eye turn away. Momentary viewing is not considered hazardous since the average radiant power limit on this type of device must not exceed 1 milliwatt (mW).

Class 3 A Class 3 laser or laser system can emit any wavelength, visible or non-visible. The Class 3 laser is divided into two subclasses, Class 3a and Class 3b. These lasers and laser systems are not considered a fire hazard or a serious skin hazard. Any CW (continuous wave) laser that is not a Class 1 or Class 2 is a Class 3 device if its output power is 0.5 watts or less. Since the output beam of such a laser is definitely hazardous when the beam is allowed to directly enter the eye, control measures for the Class 3 lasers and laser systems center on eliminating this possibility.

Class 4 A Class 4 laser or laser system is any that exceeds the output limits (Accessible Emission Limits, AEL's) of a Class 3 device. As would be expected, these lasers may be a fire and skin hazard, a diffuse reflection hazard, or both. Very stringent control measures are required for a Class 4 laser or laser system.

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 with specific responsibilities spelled out for all workers involved. The plan has four worker categories. The Laser Safety Officer (LSO) is one category and the other 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, called stimulated emission, 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, and 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.

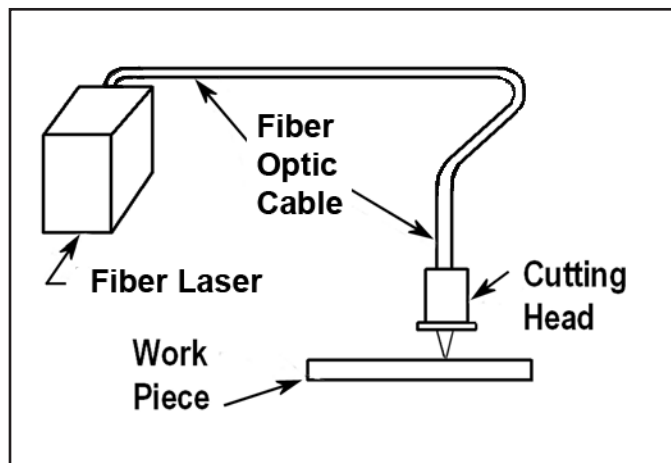


Figure 3-2 Fiber Optic Cable

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 ²
100 watt light bulb surface	1.0 w/cm ²
Soldering Iron Tip	100 w/cm ²
4000-watt laser beam, 1.00 inch (25.4 mm) diameter.	800 w/cm ²
4000-watt laser beam, 0.010 inch (0.254 mm) focus spot diameter.	8 million w/cm ²
Steel Threshold	2 million w/cm ²

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.

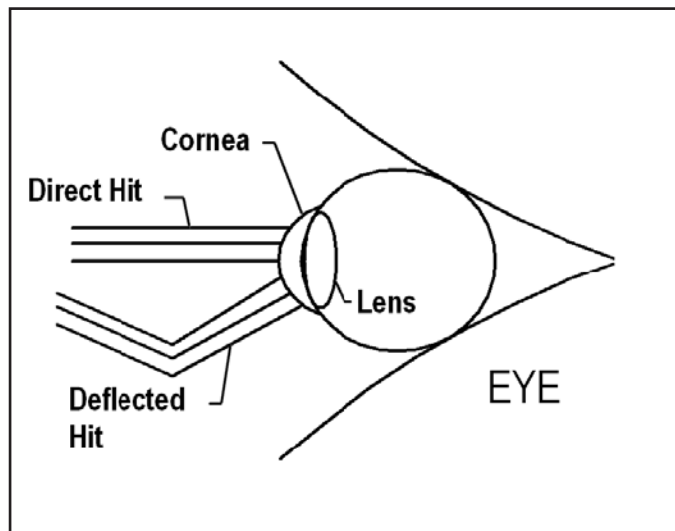


Figure 3-3 The Eye

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

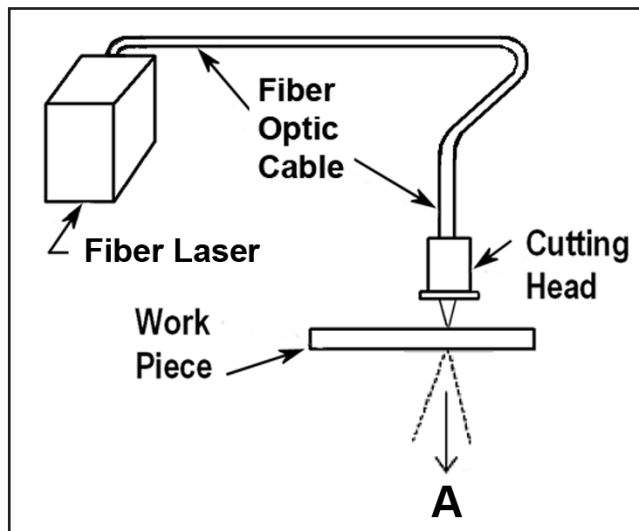
Safety standards define a laser's Nominal Hazard Zone (NHZ) as "the space within which the level of the direct, reflected, or scattered radiation during operation exceeds the applicable Maximum Permissible Exposure (MPE)". When considering a CINCINNATI Laser System - Fiber Laser, the radiation hazard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

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.

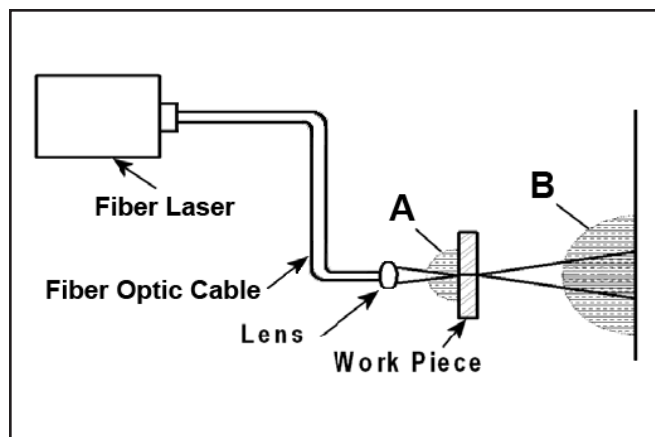


Figure 3-5 Diffuse Reflection

"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

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:

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

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 CM². For Ytterbium laser beam exposure lasting more than 10 seconds, the MPE is 0.005 watts per CM².

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 materials, for example: plastics, aluminum, fabrics, etc., can create a fire hazard if allowed to accumulate in significant quantities. Good housekeeping practices should 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.

Eliminate this hazard by avoiding accumulations of aluminum particles with iron oxide particles. (Note: 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 trays to expose one half of the box. After cleaning this half, the trays 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.

DANGER

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.

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 the purpose of such equipment should be understood by operating personnel. Follow basic fire fighting procedures.

FUMES AND DUST

DANGER

**Poisonous fumes may be formed by laser cutting.
Do not breathe fumes.**

Use the Laser System only with 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 above, 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, for example: 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 are 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 discussion below will

address safety consideration when storing and handling compressed gas cylinders. Later in this section 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 shall 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 as such to avoid confusion. Empty cylinders that held the same type of material should be grouped together.

USING

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 handwheel 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 shall 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 should 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°F (-150°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°F or -194°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 the gate ensures that all motion, except Z-axis and auto focus lens assembly, is disabled.
- 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.

Note: 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 system has several lights that provide notice to personnel regarding the status of the laser beam and laser generating unit.

There is 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 machine 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.

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. 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 on the operator’s side. 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, opening any Cut Area Enclosure door will remove power from all axes and pallets, and disable the laser. The MAIN DRIVES light will turn off, indicating that drive power is off. The laser is disabled, preventing the delivery of the laser beam. This ensures protection for the operators and maintenance personnel who must enter the cutting area temporarily to perform adjustments, retrieve parts, or make repairs. 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

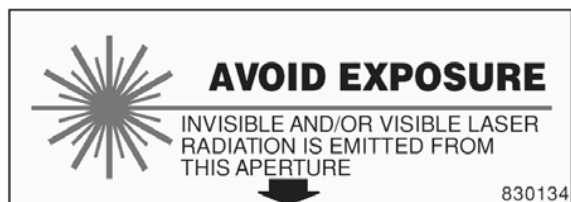
To warn laser operators and maintenance personnel of certain potential hazards that may exist, unless specified procedures are followed, a number of warning signs are attached to CINCINNATI Laser Systems. Warning signs are not intended to be a substitute for reading and understanding this section and the machine **Section 7 - Operation Supplement Manual, EM-551**.

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 figures illustrate warning signs commonly used on the laser system. Other signs may be furnished to cover possible hazards due to special equipment or machine features. 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.

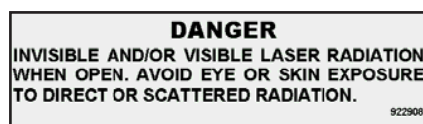
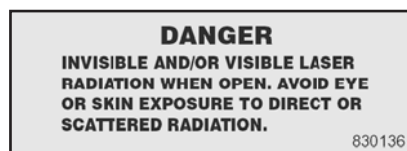
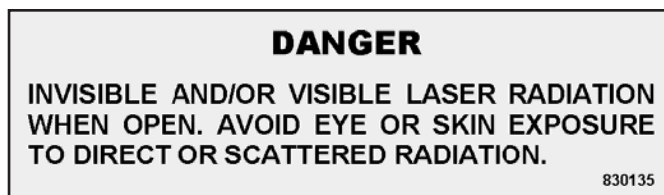
AVOID EXPOSURE - APERTURE (830134)

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.



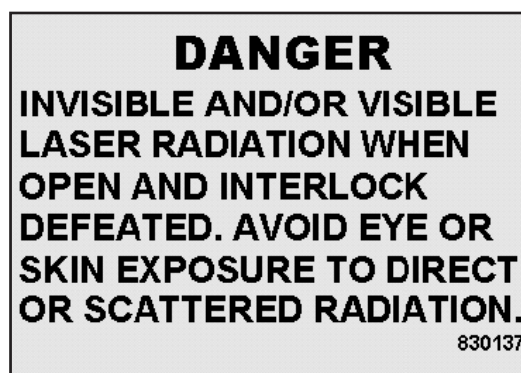
DANGER - LASER RADIATION (830135, 830136, and 922908)

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.



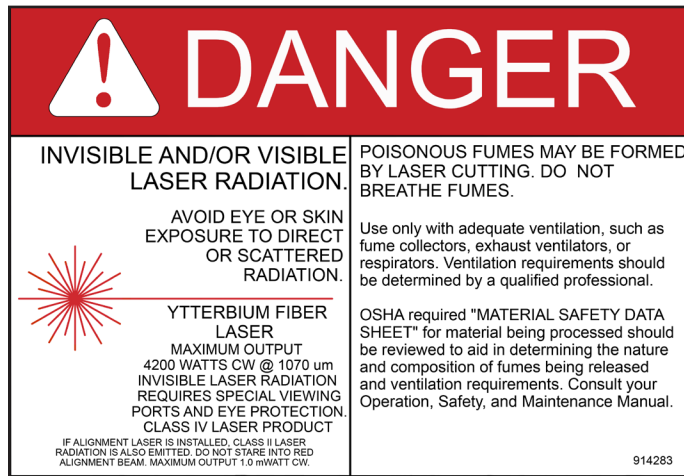
HIGH STRENGTH MAGNETIC FIELD (921533)

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)

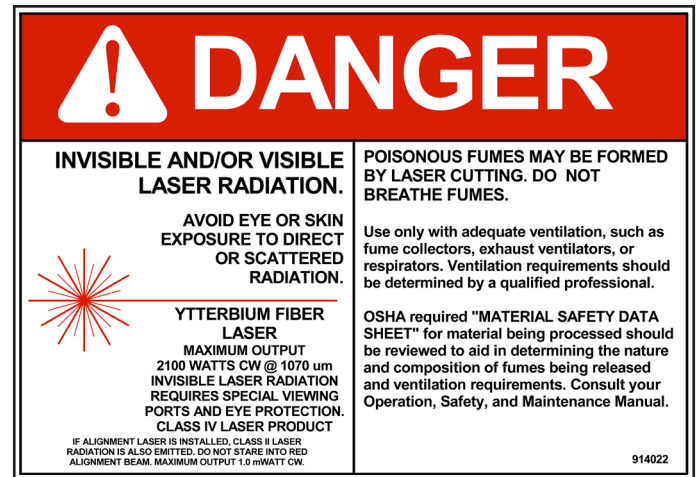
This sign is mounted on the sides and rear of the cut area enclosure. It warns against the dangers of climbing on the material support grids or machine frame and defeating the safety mat. It instructs operators to wear safety glasses, and instructs all personnel to read and understand this manual before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



DANGER - LASER SPECIFICATIONS / POISONOUS FUMES (914022, 914283)

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)			
MAIN FRAME	5 X 10	125	183	268	97	23,200
	(1.5 X 3.0 m)	(3175)	(4648)	(6808)	(2464)	(10524)
	6 X 12	144	202	268	97	27,200
	(2.0 X 4.0 m)	(3658)	(4648)	(6807)	(2464)	(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)	33		52	66	900
		(839)		(1321)	(1677)	(409)
	CL-940 (60 Hz)	42		52	64	1200
		(1067)		(1321)	(1626)	(544)

SPECIFICATIONS

LASER	RATED POWER	TYPICAL RANGE
YLS-2000	2000 W	200-2000 W
YLS-4000	4000 W	400-4000 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)

Note: 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 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.

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.

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)	

ACCURACIES:

- ◆ Absolute Positioning (X and Y-axis): ± 0.001 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 (5.1 m/min.)
Z-axis: 1700 IPM (0.7 m/sec.)
- ◆ Accelerations
X and Y-axis: 5 X 10: 1.65 G (16.2 m/sec²)
X and Y-axis: 6 X 12: 1.50 G (14.7 m/sec²)
Z-axis: 2.00 G (19.6 m/sec²)

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:

5-200 PSIG (34 to 1379 kPa) for Oxygen and 5-500 PSIG (34 to 3447 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 a solution of distilled water and 30% to 35% Dowtherm SR-1 or 35% to 40% Dowfrost HD by volume.

CAUTION

The minimum specification for heat transfer fluid (30% Dowtherm SR1 or 35% Dowfrost HD) is required to provide corrosion protection. Maintain the minimum concentration according to the Preventative Maintenance instructions in Section 9. If these additives are not available, consult CINCINNATI INCORPORATED for approval of a comparable product from another supplier.

Tap water must meet the following quality requirements to be used in place of distilled water in circuit #2:

Maximum Hardness: 200 mg CaCO₃/liter
Maximum Cl Concentration: 50 mg/liter
pH Range with additive: 6.5 to 8.0
Maximum Conductivity: 1000 μ S /cm

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 ³ /min.)	0.75 in. (19 mm)
8 X 20	6500 SFCM (184 m ³ /min.)	4.0 in. (102 mm)

Notes: 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 m³/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 to aid in determining the nature and composition of fumes being released. See **Section 3 - SAFETY** of this manual for more information.

PIPING CONNECTIONS

ASSIST GASES: 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.

EXTERNAL 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.

FOCUS LENS: The standard cutting head uses a focus lens with a 10.0, 7.5, or 5.0 inch working distance. The cutting head has three lens locations. Install the required focus lens in one location and an “empty manifold seal” (EMS) in the other two locations.

LENS LOCATION	WORKING (MOUNTING) DISTANCE	EFFECTIVE FOCAL LENGTH (EFL)
5 inch (Lower)	5 inch (127 mm)	(4.85 inch (123.4 mm))
7.5 inch (Middle)	7.5 inch (191 mm)	7.63 inch (194 mm)
		7.87 inch (200 mm) 4,000 W only
10 inch (Upper)	10.0 inch (254 mm)	10.12 inch (257 mm)

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.

1. **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 five to 200 PSI (34 to 1379 kPa) and the nitrogen and air has a pressure range from five to 500 PSI (34 to 3447 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

GAS USE	GAS TYPE	MANIFOLD LABEL	GAS PURITY	TYPICAL PRESSURE	REGULATOR SPECIFICATION	APPROXIMATE GAS USAGE
ASSIST GAS #1	Oxygen (O ₂)	Assist Gas #1	99.80 %	See TABLE 4-2	10 to 650 PSI O ₂ Compatible CGA 540	See TABLE 4-2
ASSIST GAS #2	Nitrogen (N ₂)	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 ₂	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	125 SCFH *

* This table specifies purge and nozzle cooling gas requirements for the laser system. The air dryer also requires 350 SCFH of “self purge” air. See the foundation print for total air flow requirements at machine inlet.

TABLE 4-1 Gas Requirements

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 must not exceed 550 PSI (3792 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).

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

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.	.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

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.

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	287	325	363	397
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

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:

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

TABLE 4-5 Air Assist Gas Purity Specifications

IMPORTANT: Regulated assist gas supply pressure must not exceed 550 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.

2. **Rapid Pierce:** Clean, dry, compressed air is required for the air-blast system used with rapid pierce.
3. **Air Dryer Supply:** The air dryer requires up to 478 SCFH (14 cubic meter/hour), 90 PSI minimum (620 kPa). The air supplied to the dryer must be less than 100°F (38°C) and free of oil and/or water mist. Excessive wet or oily air could overwhelm and contaminate the instrument grade air dryer, the laser system piping, and the beam delivery optics. This damage is not covered by warranty. If incoming air is hot, a refrigerant dryer prior to the instrument grade dryer may be required.

Air piping to the dryer must include a drip leg with auto-drain. If large amounts of condensed water are expected during humid summer months, a water-separating filter is required. Likewise, if large amounts of oil are expected, a coalescing filter is required. In the supply air, combined oil and water must be less than .01 oz./hr (280 mg/hr).

Figure 4-1 illustrates a compressed air supply system with various stages of supply air pretreatment.

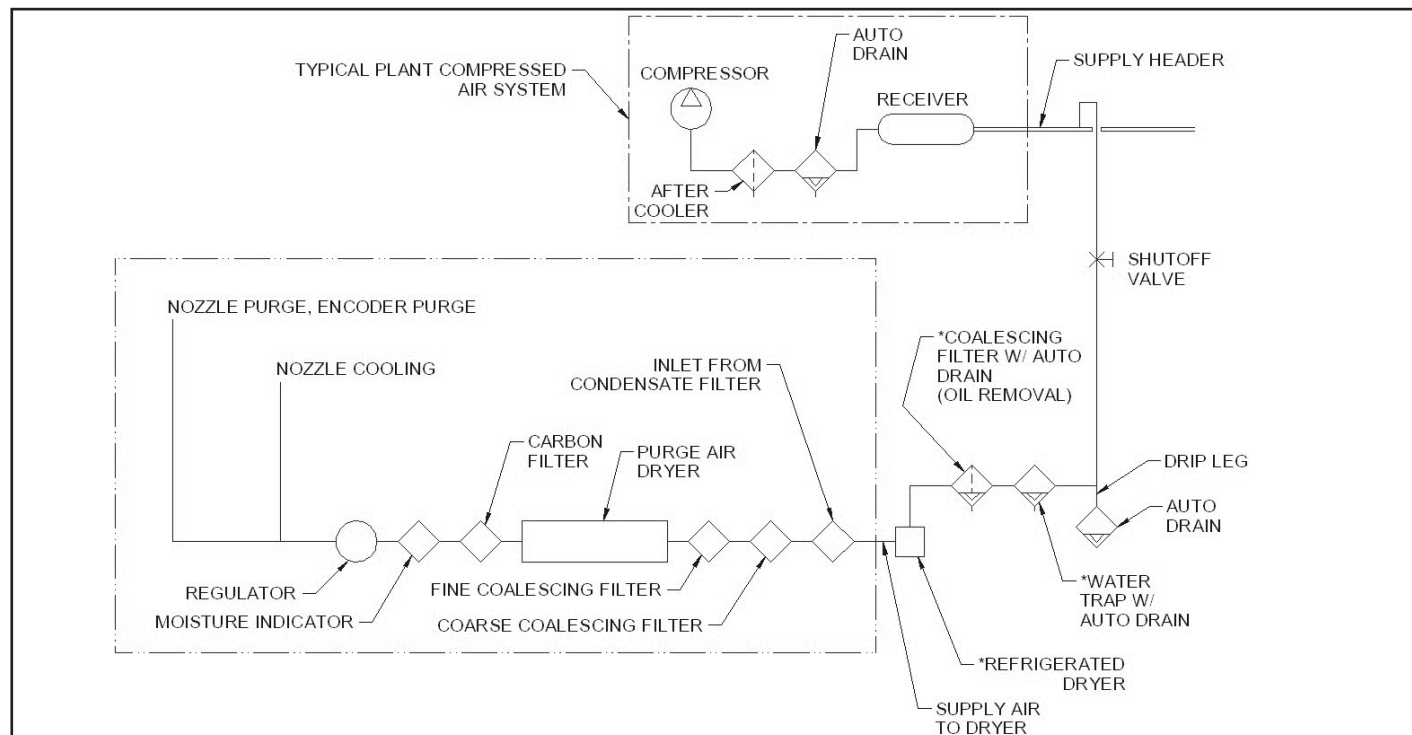


Figure 4-1 Schematic of compressed air supply system for purge requirements. "Basic" system components and recommended pretreatment (*) components to comply with air dryer inlet specifications.

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 feed rate 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:

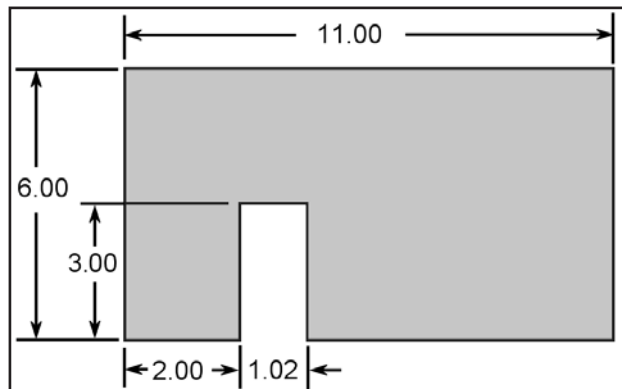
- LASER SETUP, ELECTRICAL (by CINCINNATI Laser Service) specifically setting of Y-axis Home Offset.
- LENS CENTERING
- LENS FOCAL POINT LOCATION
- MACHINE STARTUP

MATERIAL REQUIRED

- **Y-Stops:** C.I. #910257 - four stops per pallet.
- One piece of mild steel with the same thickness as the Y-stops. C.I. #910257 stops are .18 inch (4.5 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\ FactorySetup” 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:



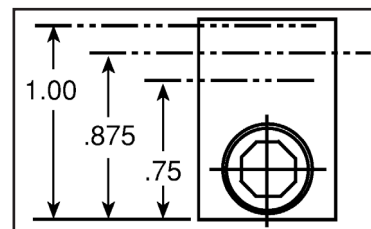
2. Move the material clamps away from the Y-stops on both pallets.
3. Perform the AXIS HOME procedure as described in **Section 7 - OPERATION, EM-551, START-UP AND SHUT-DOWN**. Confirm the AXIS HOME operation by checking that the machine coordinates are zero on the Axes Position window.
4. The Y = zero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

Note: *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.

Note: *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.

Note: *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 $X = \text{zero}$ in the machine coordinate system of the control. The gantry moves to the machine $X = \text{zero}$ position when the AXIS HOME operation is done (see **Section 7 - OPERATION, EM-551, 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 $X = \text{zero}$.

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 $X = \text{zero}$ 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

Note: 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.

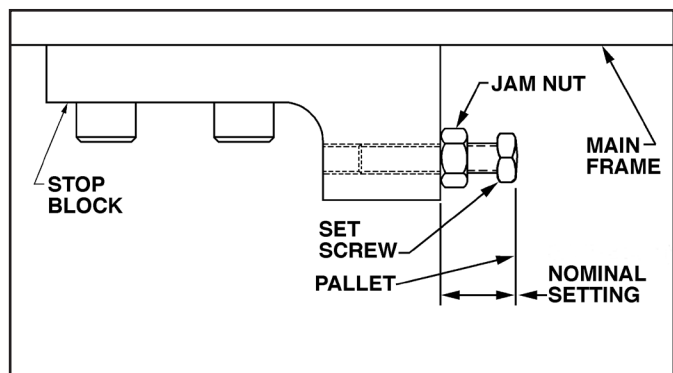


Figure 5-1 Pallet Stop Block

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.

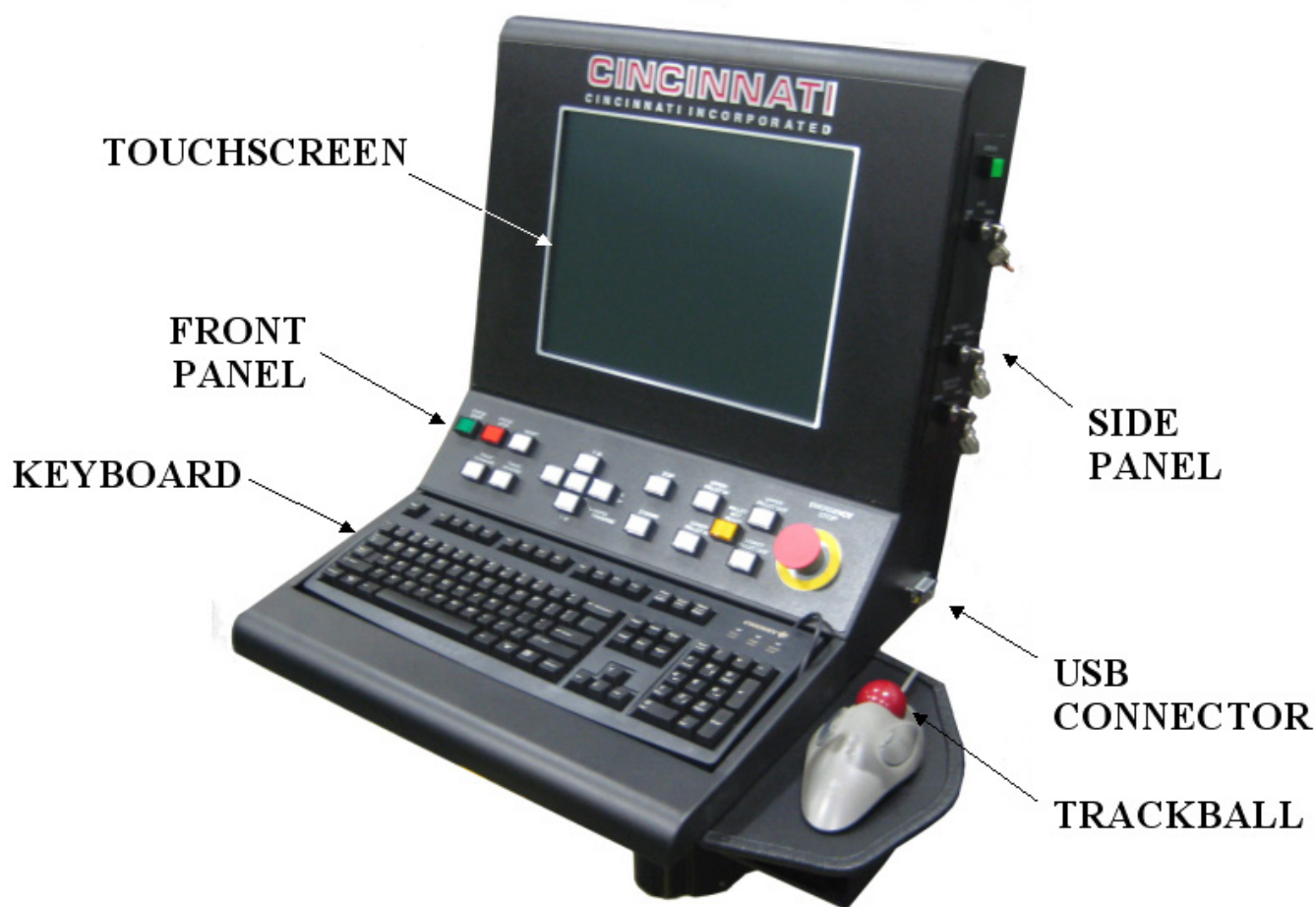


Figure 6-1 Operator Control Station

OPERATOR CONTROL STATION

This section describes the individual controls located on the Operator Control Station. Refer to Figures 6-1, 6-2, and 6-3 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 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.

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.

Side Panel Controls: On the side of the Operator Control Station is a panel with three keyswitches and one pushbutton/indicator. These controls are described in detail in this section.

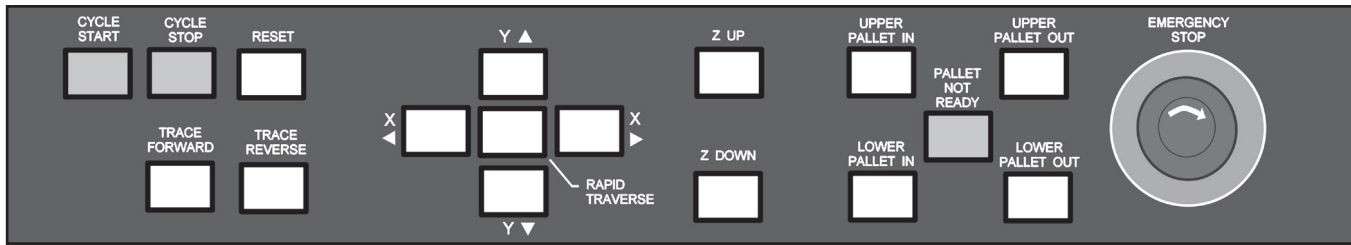


Figure 6-2 Front Panel Controls

USB Connector: On the side of the Operator Control Station is a USB (Universal Serial Bus) connector. 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.

MACHINE OPERATOR PANELS

The Operator Control Station has a front panel with several pushbuttons and indicators, and a side panel with one pushbutton/indicator 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

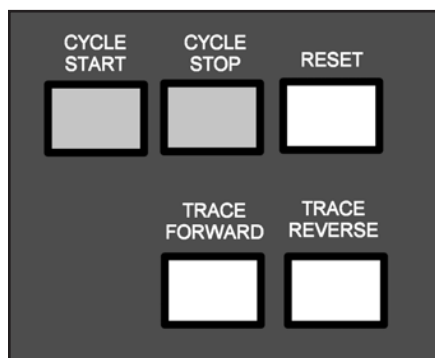


Figure 6-3 Front Panel - Program Controls

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-551.**)

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-551**, for more details.)

AXIS MOTION CONTROLS

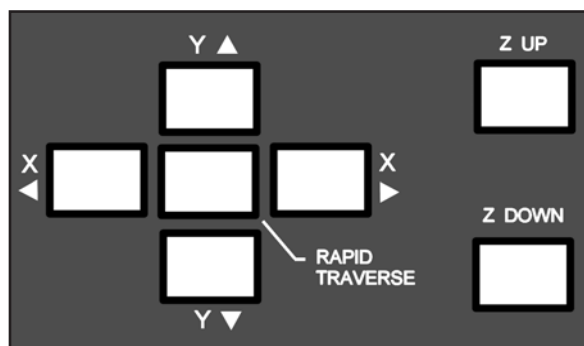


Figure 6-4 Front Panel - Axis Motion Controls

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.

Note: 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

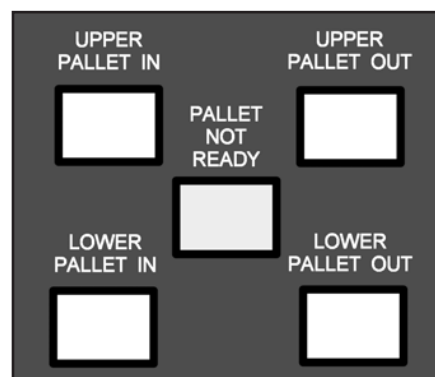


Figure 6-5 Front Panel - Pallet Controls

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-551**.

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.

NOTE: When using the optional Modular Material Handling System (MMHS), pressing either Emergency Stop pushbutton on the CL-900 will stop both the laser and the MMHS. However, pressing the Emergency Stop pushbutton on the MMHS will **only** stop the MMHS and **not** the laser.

SIDE PANEL CONTROLS

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.

WARNING

Make sure everyone is clear of pallets and gantry before enabling drives. DO NOT position any part of the body where it may be struck by machine movement.

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.

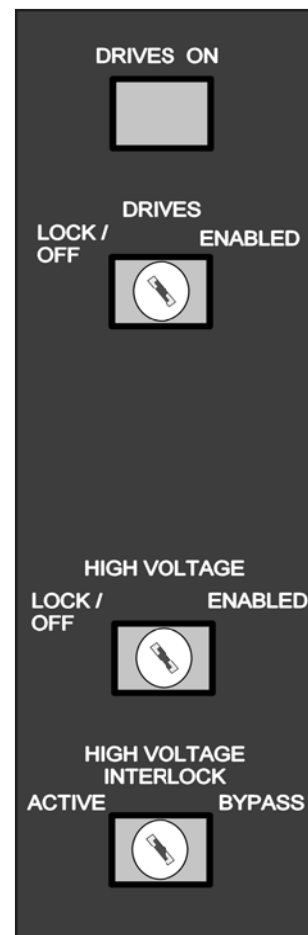


Figure 6-6 Side Panel Controls

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.

Note: *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.

NOTE: *THE HIGH VOLTAGE INTERLOCK KEYSWITCH IS INTENDED FOR USE ONLY BY CINCINNATI OR IPG SERVICE TECHNICIANS.*

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.

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.



Figure 6-7 Remote Station

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-551**). 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-551, 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-551, 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.



Figure 8-1 Ball Transfer Load Station Pendant

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**.

MODULAR MATERIAL HANDLING SYSTEM (MMHS)

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. Options for the material location are: a pallet on the floor, a set of power over/under carts, or a transfer cart that accompanies an option material storage tower. The MMHS control system is PC based and includes a web-based user interface that can be monitored from the laser system control or from a remote computer.

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.

Note: 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.

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, whichever is greater. 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 9-3 shows the Z-axis fitting on one of the two truck bearings. Top bearing truck shown.

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
- ◆ Calcium Base Grease
- ◆ NLGI #2, worked penetration of 280 mm.
- ◆ 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.

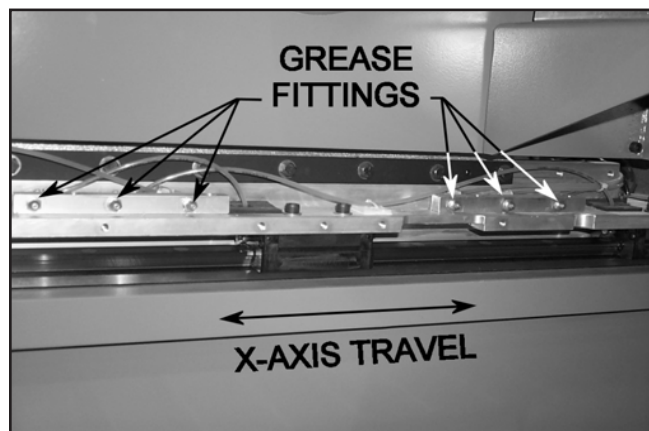


Figure 9-1 X-axis Linear Bearing Grease Manifolds, Operator and Beam Side (Do not over-grease.)

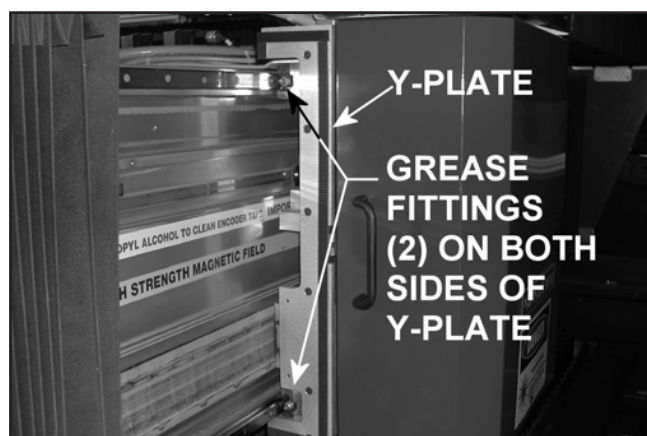


Figure 9-2 Y-axis Linear Bearing Grease Fittings (Do not over-grease.)

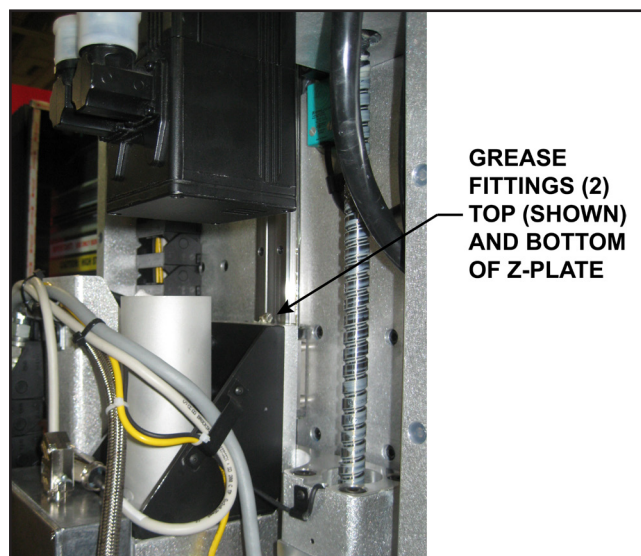


Figure 9-3 Z-axis Linear Bearing Grease Fittings, Top Bearing Shown. (Do not over-grease.)

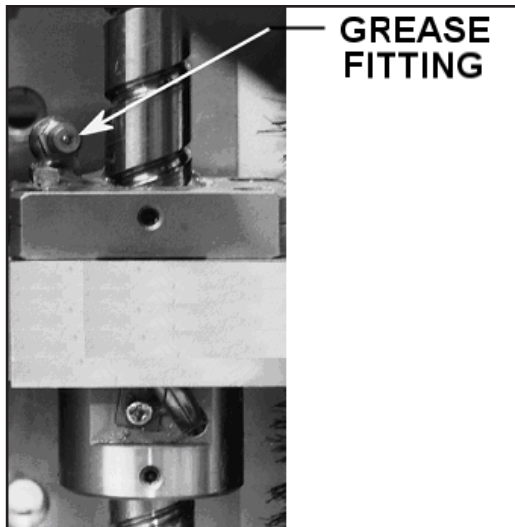


Figure 9-4 Ball Screw Lube Point

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.

MAGNETIC TRACK MAINTENANCE

WARNING

A very powerful magnetic field surrounds the magnet track. Keep all metal (steel) tools away from this track.

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. 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 (C.I. #921916) can be applied to the magnet track.

PALLET DRIVE MAINTENANCE

GEAR REDUCER

The gear reducer manufacturer recommends an initial oil change after the first 100 hours of operation. However, since pallet drives run only a small percentage of the time, CINCINNATI INCORPORATED recommends an initial oil change after six months of machine operation. At that time, flush the gearbox with a non-flammable, nontoxic solvent (Whitmore's flushing oil or similar product). After the initial oil change, check the oil level once a year under normal conditions. Refer to gearbox manufacturer's bulletin for information on checking level. Recommended gear reducer lubricant for ambient temperature above 50°F (10°C) is medium-heavy EP gear oil, CINCINNATI INCORPORATED Code G-850. For ambient temperatures consistently below 60°F (15.6°C), use medium gear oil, C.I. Code G-315.

CHAIN DRIVE TENSION ADJUSTMENT

Check chain drive tension periodically and adjust if necessary. Use 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 (4) 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 (4) motor mount assembly bolts on the inside of the main frame.

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 trays 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.

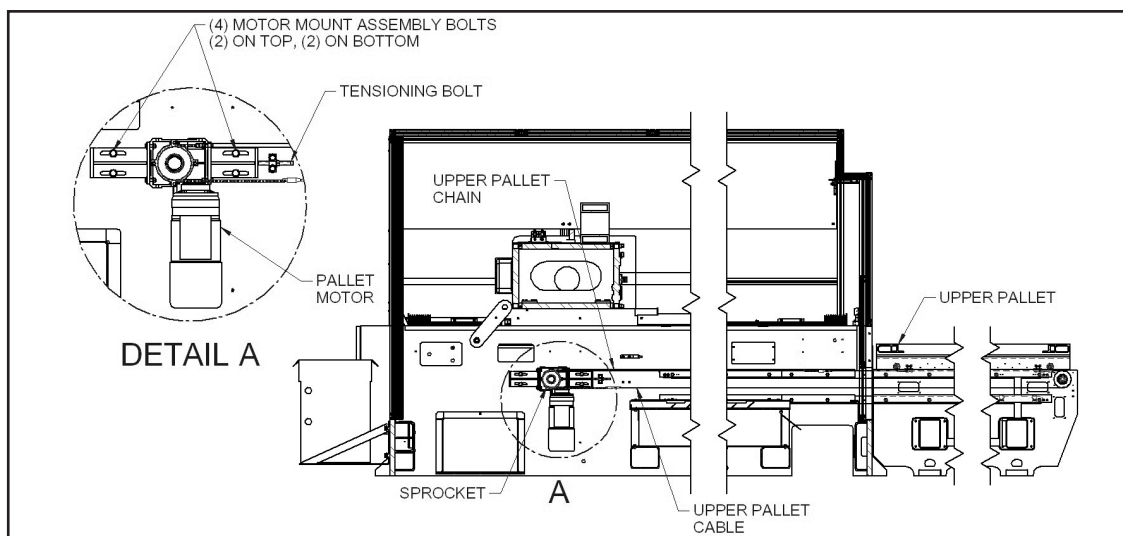


Figure 9-5 Adjusting Pallet Cable Tension

ENCODER MAINTENANCE

The laser system X and Y-axes have “open style” linear encoders 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. If using a Renishaw X-Axis Read Head, clean the scale if the X-axis encoder signal indicator changes color from green to red. If using an AMO encoder, no indicators will be present. Clean the scale if the axis motion is unstable or is dirty.

Note: *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.

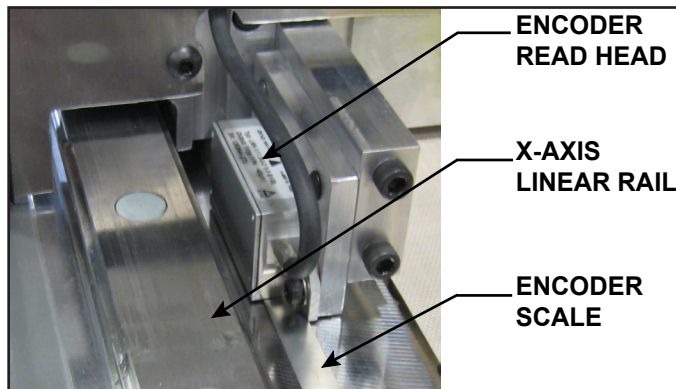


Figure 9-6 X-axis Encoder Read Head with Air Nozzle Scale Purge

Note: *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.

Note: *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 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 property 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 collimator. Any time the fiber coupler is connected to a collimator, it is to be inspected for dust, dirt, or damage. Refer to the IPG manual for proper inspection and cleaning procedure.

To extend the life of the focusing lens, periodic cleaning is recommended. Follow procedure for lens cleaning outlined in this manual.

⚠ WARNING

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.

CLEANING SUPPLIES

- Acetone (ACS grade or better)
- Acetic acid (distilled white vinegar)
- Surgical quality cotton balls
- Surgical quality cotton swabs
- Air bulb or clean, dry filtered air supply
- Lens tissue (C.I. #909948 or equivalent. Common lens tissues for eyeglasses or camera lenses will damage laser optics.)

CAUTION

Follow manufacturer's recommendations regarding safe storage and use of acetone.

HANDLING

1. Access to optics should be restricted to trained personnel.
2. Clean 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 recommended.
3. Handle and clean the optics one at a time and avoid unnecessary handling. Leave the optics in their mounts until ready for cleaning and replace them immediately after cleaning. Always handle the optic by the edge only, and avoid sliding the optic on its polished surface.

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

LENS INSTALLATION AND REMOVAL

1. The focus lens is in a drawer in the cutting head assembly (see Figure 1-5). To remove the lens and lens holder, loosen the locking screw and slide the lens holder out of the cutting head.

To remove the lens cover and lens from the lens holder, remove the lens cover and lens retaining nuts using the tool provided (C.I. #925250). Gently push the lens out of the holder with lens tissue between your fingers and the lens. If the indium ring under the lens is removed, be sure to reinstall it before reinstalling the lens.

To replace the lens and lens cover after cleaning, gently push the lens into the lens holder with lens tissue between your fingers and the lens. Be sure the curved side of the lens faces up. To identify the curved side, notice that reflected images from the curved side (convex) appear smaller than reflected images from the flat side. Replace the lens retaining nut, lens cover, and lens cover retaining nut.

***Note:** Removal and installation of the lens in the lens holder is much easier if the O-ring in the holder is lubricated with one drop of halocarbon oil (C.I. #922822) on a cotton swab. Remove any excess oil before installing the O-ring. Excess oil can migrate to the lens and damage the optic. Do NOT use any other lubricant on this O-ring.*

2. Storage: Spare optics should be wrapped in lens tissue and kept closed in their shipping container to prevent exposure to contaminants. Store optics in a cool, dry environment.

LENS CLEANING

Perform only as many steps of this procedure as are required to get the lens clean. Use these procedures for both sides of the lens. For routine cleaning, Steps 1 and 2 are often sufficient.

1. Use an air bulb or clean, dry, filtered air to blow away any loose particles on the surface of the lens. Do not breathe on the lens to remove loose particles. The moisture in the breath may damage the lens.
2. A slightly contaminated lens can be cleaned while it is in the lens holder. Gently wipe the lens with a cotton swab moistened with solvent. Roll the cotton swab when wiping so particles on the lens are picked up rather than dragged across the lens surface. Use a new swab after every one or two wipes.

CAUTION

DO NOT pour solvent onto the lens while it is in the lens holder. Some of the acetone will seep under the locknut and evaporate slowly. The resulting vapor can interfere with the cutting process. The solvent may also damage the O-ring.

3. For thorough cleaning, remove the lens from its holder. Again, gently wipe the lens with a cotton swab moistened with acetone. Roll the cotton swab as you wipe so particles on the lens are picked up rather than dragged across the lens surface. Use a new swab after every one or two wipes.

Place a piece of lens tissue over the lens. Moisten the tissue with acetone and gently drag it across the surface so the acetone just evaporates behind the tissue. Repeat with a clean tissue after each pass until the lens is clean.

4. If contaminants are still visible, repeat Step 3.
5. Cutting thin mild steel or stainless steel with nitrogen assist gas can deposit invisible contamination on the bottom surface of the lens. When this contamination occurs, the lens absorption increases and the cutting performance degrades (gradual increase in dross, eventual loss of cut).

If this form of contamination is suspected, clean the lens with acetic acid (distilled white vinegar) by dampening a cotton ball and gently wiping the surface. Do not rub hard.

Immediately after cleaning with acetic acid, repeat Step 3 using acetone to remove acetic acid residue. If any acetic acid residue is allowed to dry on the lens, repeat this step. Acetic acid will damage the optic coating if not removed.

6. If the above steps do not satisfactorily clean the lens, replacement may be necessary.

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.

The lens coolant is a mixture of water and Dowtherm additive. Some coolant may leak when connecting the lens coolant lines. This conductive solution can contaminate the Auto Focus outer cone and tip retaining nut. After installing the auto focus head, clean the nozzle tip, remove any coolant. 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. #843254) effectively removes residue from most cutting applications.
- Electro contact cleaner (C.I. #843512) effectively removes residue produced when cutting some galvanized materials.

- Cleaning rags must be free of dirt, oil, grease and lens coolant. 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 black anodized coating from the Outer Cone (see Figure 9-7)

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.

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 the Height Sensor. (Jog the cutting head over material, open Standoff Calibration window, select Recalibrate, and press CYCLE START.)

DRIVE MAINTENANCE

To keep the Auto Focus head operating properly with minimum wear, periodic maintenance of the drive mechanism is necessary. Access to the drive mechanism requires partial disassembly of the head.

Drive Mechanism

1. Remove cover by removing the screws on the side cover (see Figure 9-8).
2. Adjust the lens carriage all the way to the bottom of travel by turning the focus adjust knob clockwise as viewed from the bottom of the head.

3. Clean any debris on the ball screw shaft with a soft, clean, lint-free cloth or soft brush. Move the lens carriage to the top of travel and clean any debris on the ball screw shaft again.
4. Make sure the upper and lower ball screw support bearings are free of debris. Clean if necessary with lint-free cloth or brush.
5. Apply (4) drops of Mobil Vactra #4 oil (C.I. #913071) or equivalent (ISO viscosity grade 220) directly into the top of the ball nut. Also add one drop to the ball screw shaft on either side of the ball screw.
6. Inspect supports bearings for lubrication. If dry apply (2) drops of oil (same type as step 5).
7. Reinstall the head side cover.

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 SYSTEM ALARMS

Auto Focus Amp Fault

If the Auto Focus drive indicates a fault, the control displays this System Alarm and interrupts any executing program. The drive LED code indicates the specific fault condition (see table). The Auto focus amp is located in the Gantry Right Enclosure which is on the rear of the gantry.

FAULT CODE	DESCRIPTION
2 Blinks	Overload
3 Blinks	Over Voltage
4 Blinks	Speed Error
6 Blinks	Over Speed
7 Blinks	EEPROM Data Error
8 Blinks	Motor Cable not Connected
ON Continuous	Fatal Drive Error

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 Door Open

If the Auto Focus head access door is left open (or opens on its own), the control displays this System Alarm and interrupts any executing program. This interlock helps to prevent cutting debris from contaminating the internal mechanism and electronics.

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.

Note: *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.*

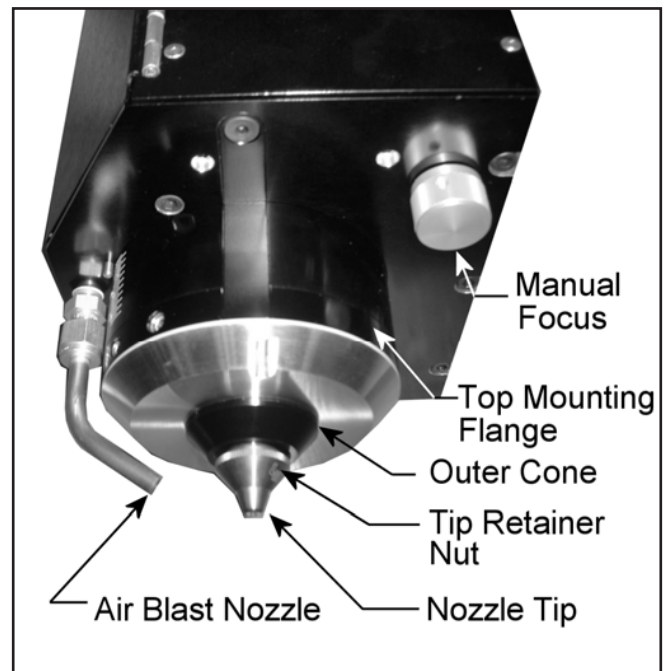


FIGURE 9-7 Auto Focus Lower Tip

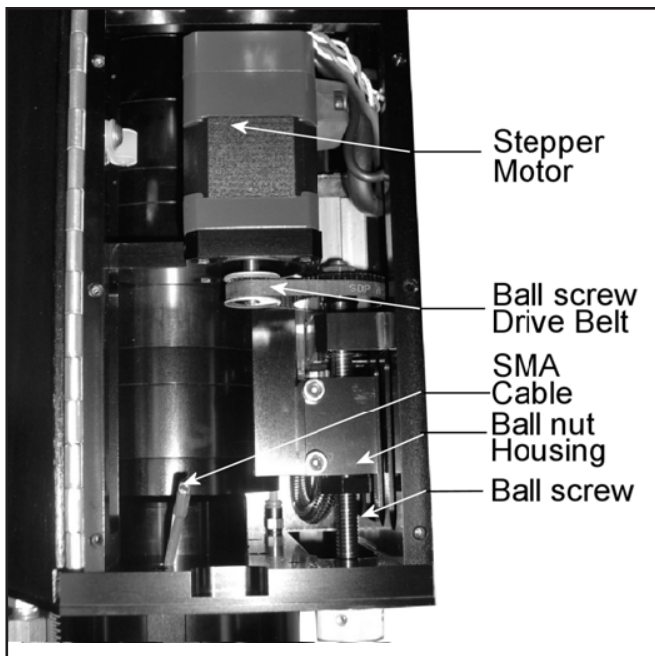


Figure 9-8 Auto Focus Drive Mechanism

AIR DRYER

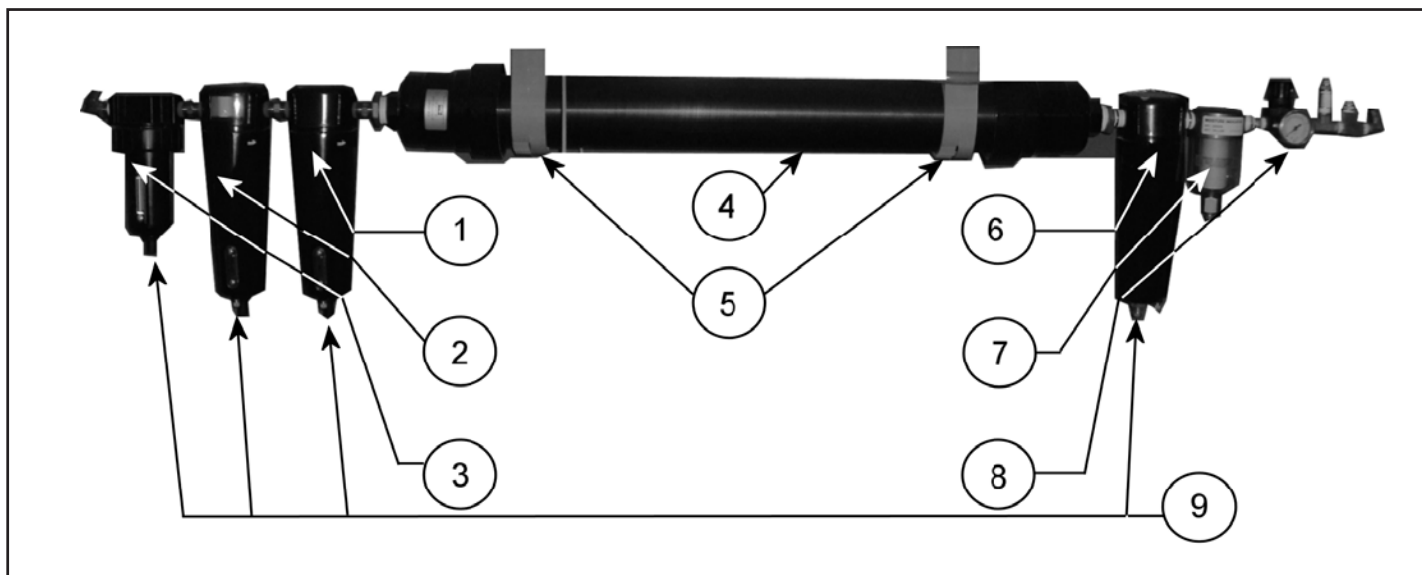
The laser system is equipped with a compressed air dryer. See Figure 9-9. This dryer supplies treated, clean, dry air for beam delivery purge requirements. The purge air applies a slight positive pressure within the cutting head and on the X-axis encoder scales. This purge flow minimizes contamination of these sensitive areas.

⚠ WARNING

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

Near the dryer entry, there are two coalescing pre-filters. Each filter has a differential pressure indicator, which monitors the pressure drop across the pre-filter. The cartridge should be changed when the indicator approaches the red zone (or annually, whichever is earlier). A filter kit is available; see assembly drawing C.I. #914072.

The second stage filter is a coalescing type also, but contains a finer cartridge element.



1. SECOND STAGE COALESCING PRE-FILTER
2. FIRST STAGE COALESCING PRE-FILTER
3. SEPARATOR FILTER
4. MEMBRANE DRYER
5. MOUNTS TO MAIN FRAME
6. CARBON FILTER

7. MOISTURE INDICATOR:
GREEN: CORRECT OPERATION
YELLOW: NEEDS SERVICE
8. PRESSURE REGULATOR
9. AUTO DRAINS

Figure 9-9 Air Dryer System

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.

INPUT AIR REQUIREMENTS

- 478 SCFH (14 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 trays 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-551**.
6. To clean the touchscreen surface, spray a soft cloth with isopropyl alcohol or a non-abrasive cleaning solution and then wipe the screen.

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 one scrap tray (See Figure 1-4) 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 if necessary. If fluid loss is due to normal evaporation, add distilled water only. If fluid loss is due to a leak, add chiller fluid as specified in **Section 4 - SPECIFICATIONS**. The concentration can be checked with an automotive radiator tester. For dual circuit chillers, ensure that only distilled water is added to the IPG resonator cooling on circuit #1.
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 cutting head is removed and the High Voltage Interlock switch is in active.
11. Clean the Auto Focus cutting head.
12. 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 machine inspection, clean and re-lubricate the X1, X2, and Y-axis magnet tracks (See **SEMI-ANNUAL MACHINE INSPECTION**, Step 14).
13. Note any machine problems that might require additional attention. Contact CINCINNATI Laser Service for assistance in resolving those problems.

SEMI-ANNUAL (2000 HOURS) MACHINE INSPECTION

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. 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.
2. Remove the cover below the fume exhaust fan, and clean the duct.
3. Remove all scrap trays (see Figure 1-4) 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.
4. Manually lubricate the fume fan assembly as described in **FUME FAN LUBRICATION** in this section.
5. 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 coolant 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.

6. Lubricate the Z-axis linear bearings and ball screw as described in **DRIVES LUBRICATION**.
7. Replace the filter elements (C.I. #914083) for the chiller water input.
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. Clean the pallet guide rails. Refer to **PALLET DRIVE MAINTENANCE** for details.
10. Inspect the machine for coolant leaks and oil leaks. Correct as necessary.
11. Replace all missing or damaged safety signs.
12. Test all coolant 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. #921916), then reinstall the bellows.
15. 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. Lubricate the X, Y, and Z-axes as described in **DRIVES LUBRICATION**, using these grease fittings:

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

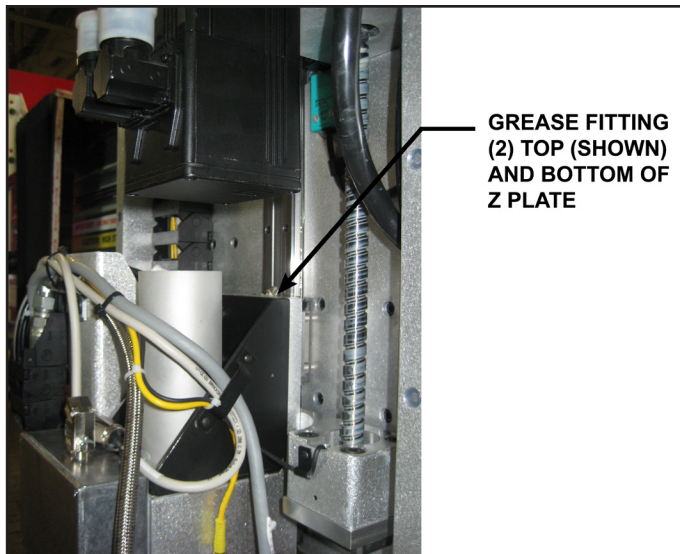


Figure 9-10 Z-axis Linear Bearing Grease Fittings
(Do not over-grease)

2. Replace the bulbs in the laser status indicators on top of the laser generating unit and the safety enclosure.
3. Check the concentration of the chiller fluid additives. If concentration is below the minimum specified in **Section 4 - SPECIFICATIONS**, drain the chiller fluid, refill with distilled water, flush the system for 30 minutes, drain the water, replace the water filter element and then refill with new chiller fluid.
4. Replace assist gas filter cartridges (C.I. #924856).

SECTION 10

SERVICE AND PARTS

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.

Note: *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:

CINCINNATI INCORPORATED
7420 Kilby Road
Harrison, OH 45030
(513) 367-7408

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 once a login has been established:

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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