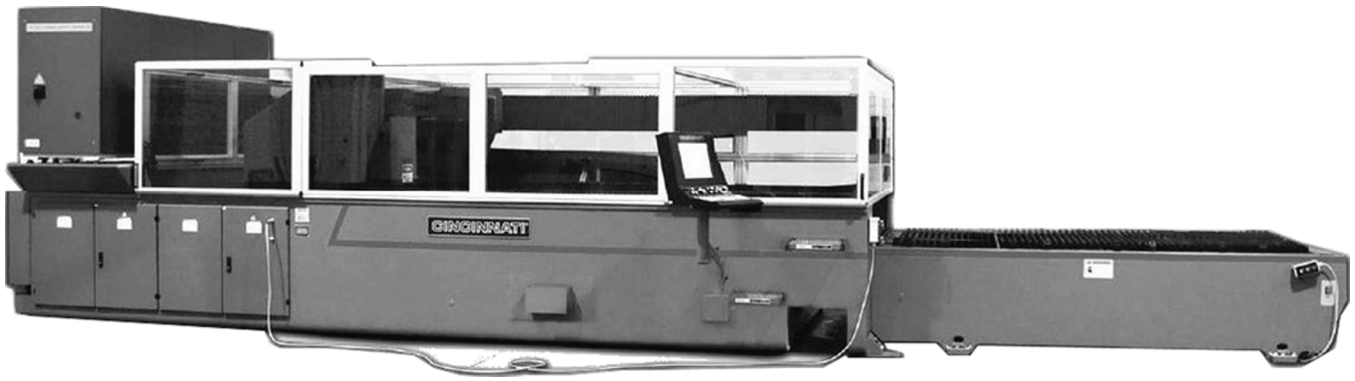
OPERATION, SAFETY, AND MAINTENANCE MANUAL

CINCINNATI®

CL-800 SERIES LASER SYSTEM

(GE FANUC RESONATORS – 5x10, 6x12 Frame)



CINCINNATI®

CINCINNATI INCORPORATED
CINCINNATI, OHIO 45211

EM-534 (R-03/10)

INTRODUCTION

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SECTION 2 INSTALLATION

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SECTION 4 SPECIFICATIONS

SECTION 5 SETUP AND USE

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SECTION 7 OPERATION

FOR ADDITIONAL SETUP AND OPERATION INFORMATION FOR THIS MACHINE, REFER TO EITHER THE ONLINE HELP INFORMATION IN THE MACHINE SOFTWARE OR TO EM-544, “SECTION 7 OPERATION – A SUPPLEMENT TO THE OPERATION MANUAL FOR THE CL-800 LASER SYSTEM”, INCLUDED WITH THIS MANUAL.

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INTRODUCTION

CINCINNATI CL-800 SERIES LASER SYSTEM

The 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 resonator is directed to a moving lens by two mirrors mounted on 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 mirrors and lens are positioned by the gantry to produce the programmed workpiece geometry. A DSP (Digital Signal Processor) motion controller commands servo drives to control the gantry motion. The program is provided by the user and includes commands to specify feedrate, 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.

PART QUALITY

The following factors affect part quality:

- Machine condition
- Operator ability
- Set-up 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.

Uniform beam quality and power level are most influenced by the alignment and cleanliness of the optical elements (internal resonator mirrors, external beam delivery mirrors and the focusing lens).

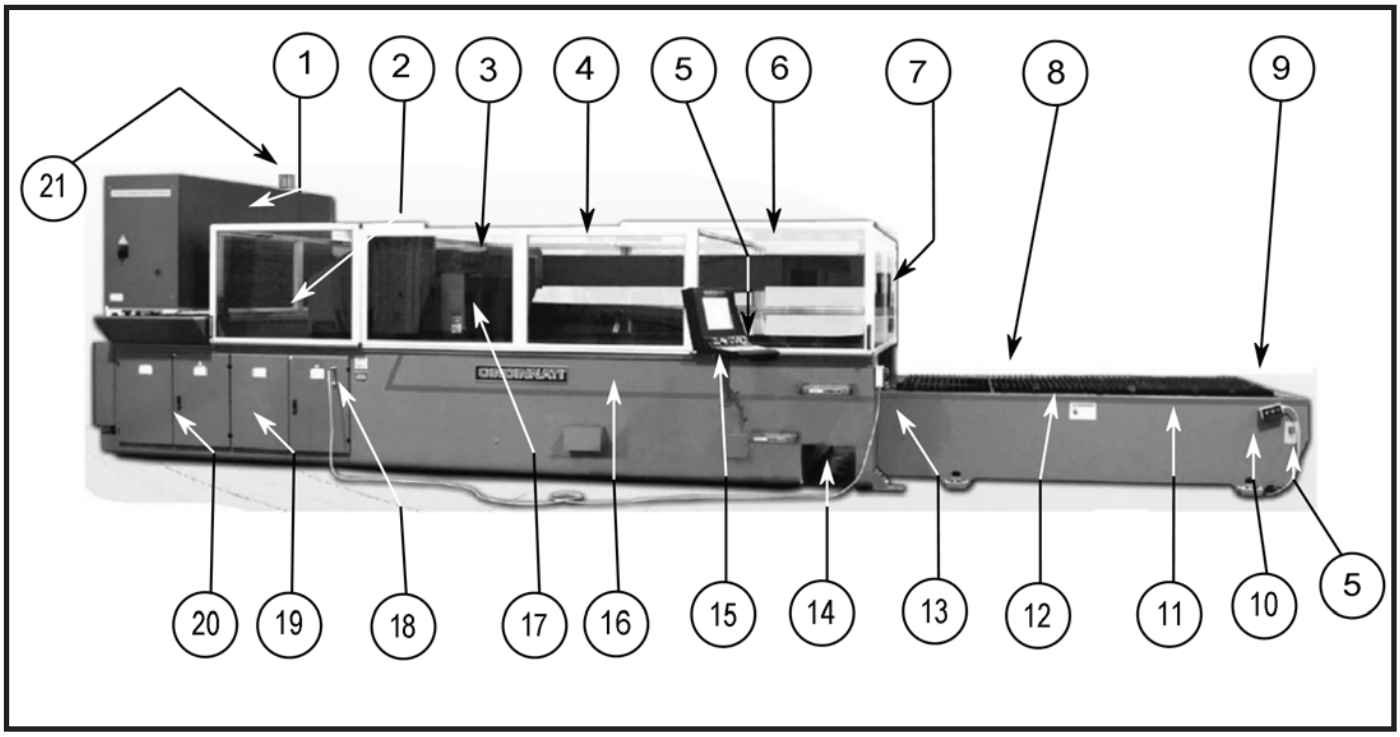
Critical manual adjustments are: Lens focal point location and lens-to-nozzle centering. The Auto Focus Cutting Head eliminates manual focal point adjustment.

Part quality depends on the program to command the correct combination of laser power, assist gas, and feedrate 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 feedrate 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.

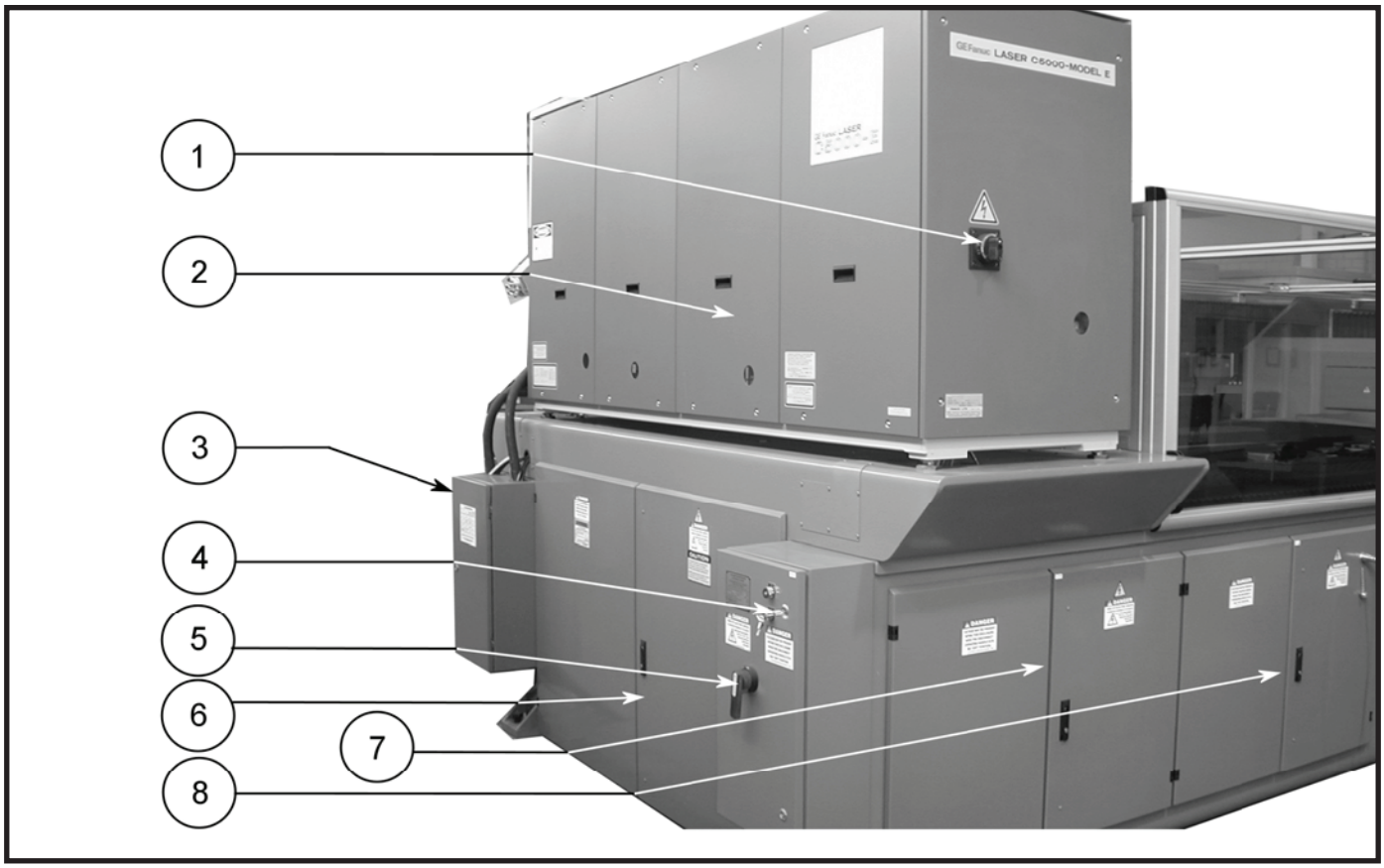
SECTION 1 IDENTIFICATION

CL-800 SERIES LASER SYSTEM



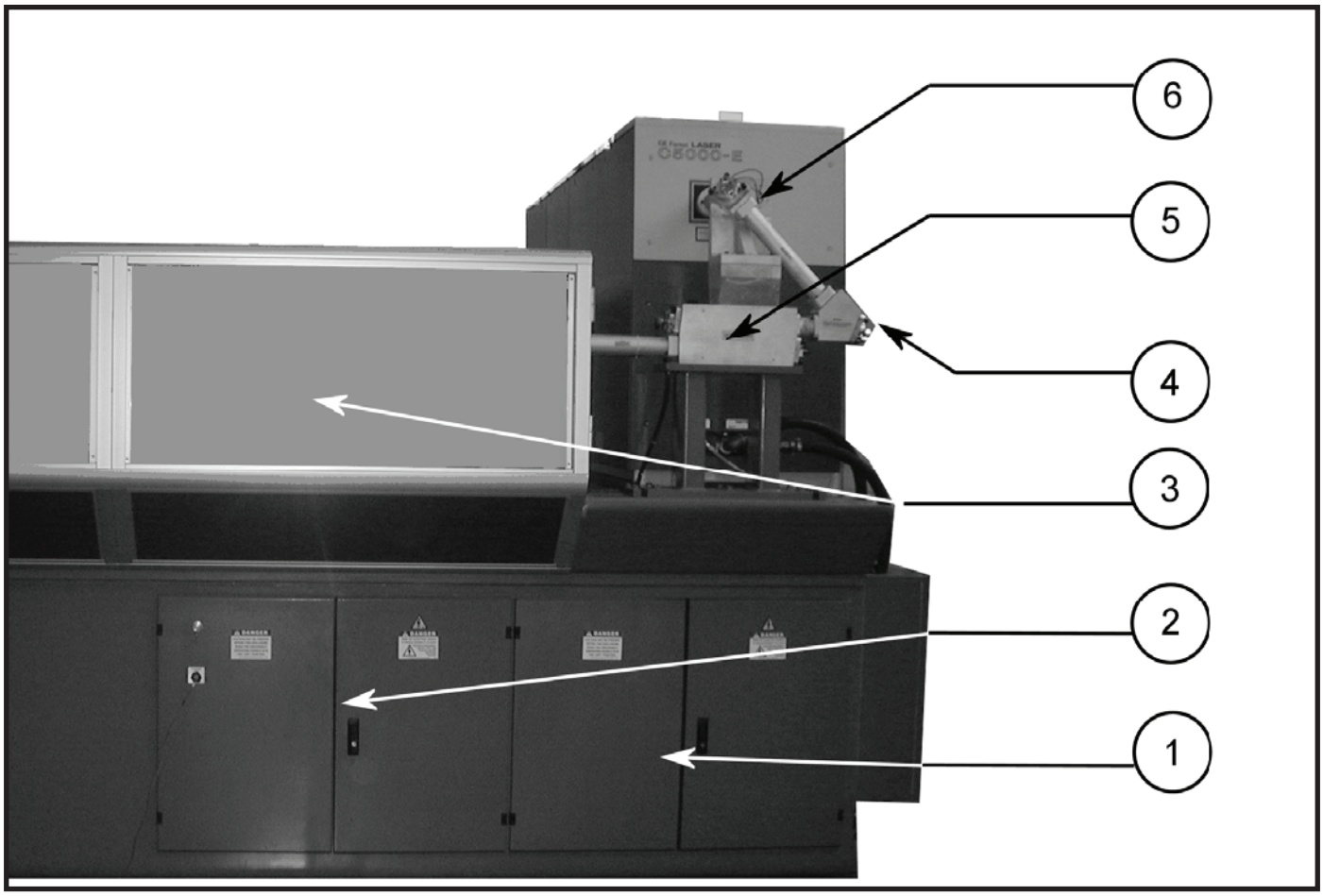
1. RESONATOR
2. RESONATOR SAFETY DOOR
3. X-BEAM DELIVERY MIRROR BOX
4. X-AXIS BEAM TUBE
5. E-STOPS
6. OPERATOR SAFETY DOOR
7. SAFETY ENCLOSURE
8. LOWER PALLET
9. LOAD FRAME
10. BALL TRANSFER REMOTE (OPT)
11. MATERIAL SUPPORTS
12. MATERIAL CLAMPS
13. REMOTE STATION
14. SCRAP BIN
15. OPERATOR CONTROL STATION
16. MAIN FRAME
17. Y-PLATE
18. REMOTE STATION CONNECTION
19. CONTROL ENCLOSURE
20. POWER ENCLOSURE
21. RESONATOR HIGH VOLTAGE LIGHT

FIGURE 1-1 Front View



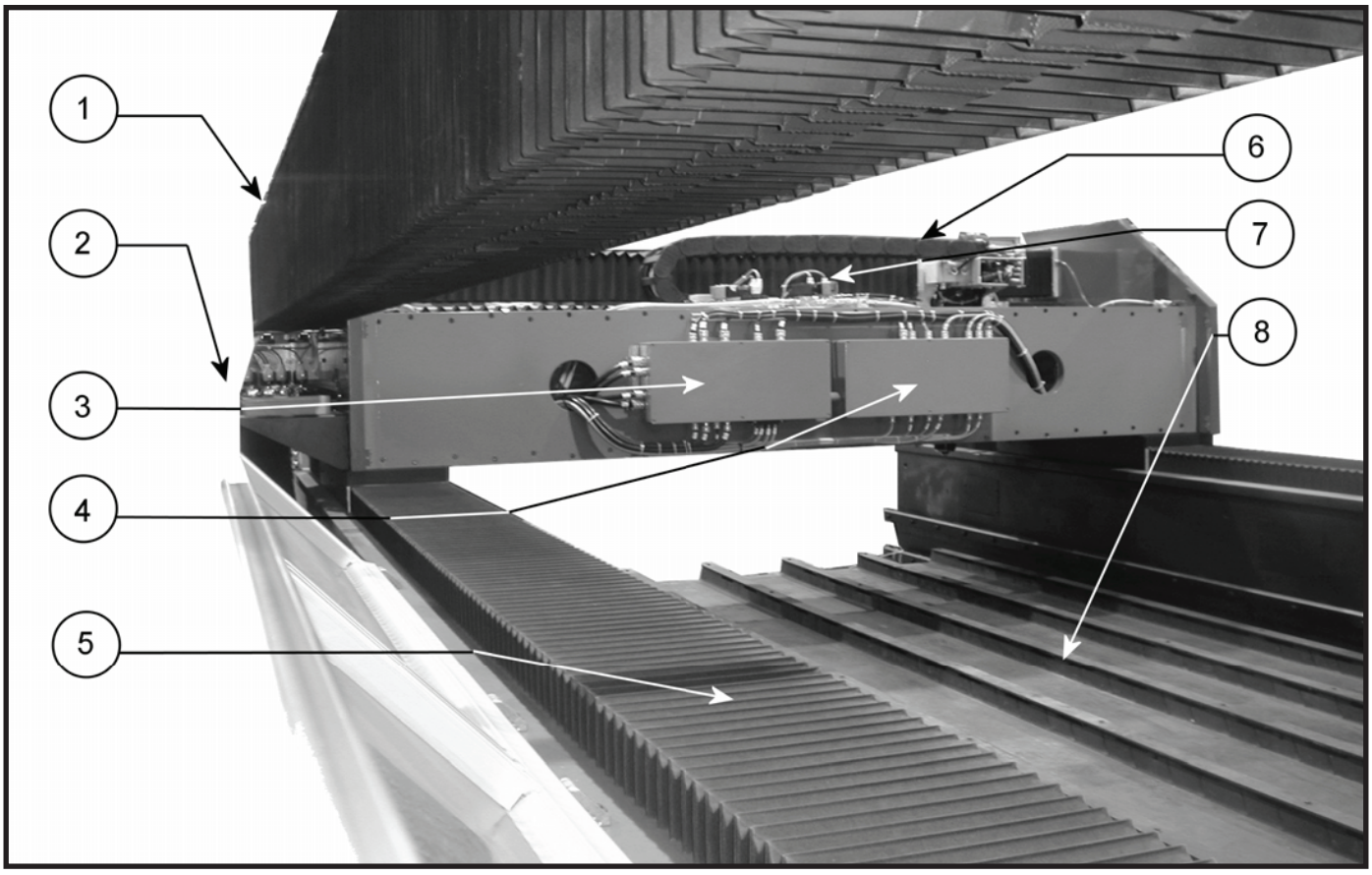
1. RESONATOR MAIN DISCONNECT
2. RESONATOR
3. GAS AND COOLANT CONNECTION
4. MAIN BREAKER INTERLOCK BYPASS KEY
5. MAIN DISCONNECT
6. MAIN ENCLOSURE
7. POWER ENCLOSURE
8. CONTROL ENCLOSURE

FIGURE 1-2 Rear View



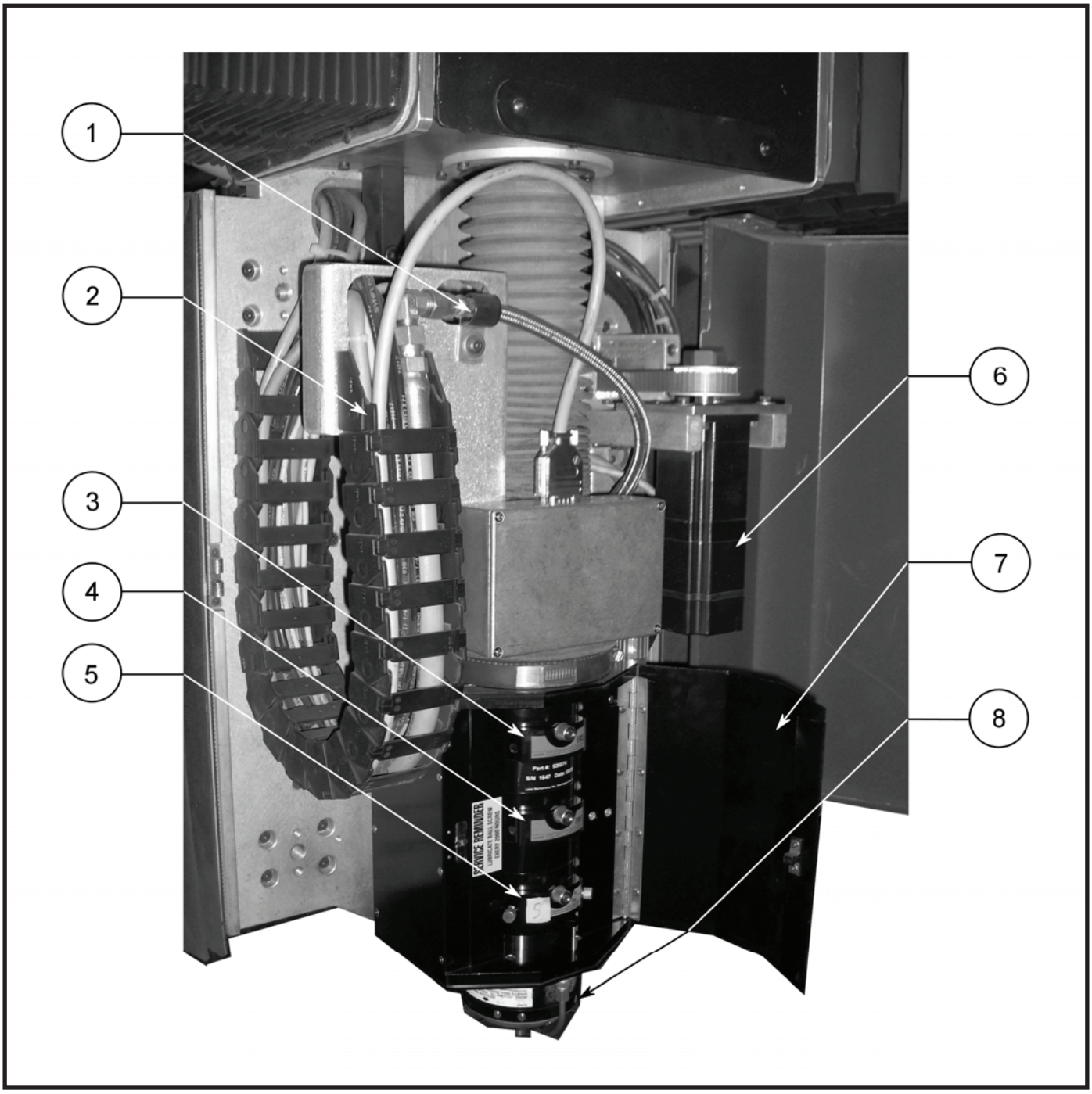
1. DRIVE ENCLOSURE
2. I/O ENCLOSURE
3. SAFETY ENCLOSURE
4. SECOND EXTERNAL MIRROR (BEAM BENDER
5. COLLIMATOR
6. FIRST EXTERNAL

FIGURE 1-2a Rear View



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

FIGURE 1-2b Rear View



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

FIGURE 1-3 Y-Plate and Auto Focus Head Assembly

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

LIFTING AND MOVING

Machine weights are provided in SECTION 4.

The main frame is lifted using four standard lifting clevises attached to four lifting links (C.I. #920584) with spacers (C.I. #920585). 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. #920585) 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 RESONATOR.

IMPORTANT: Extreme care must be taken not to subject the machine to shock loads. The machine must be lifted and set down gently. Do not allow any weight to rest on resonator enclosure. Set the machine on its feet without letting the enclosure “touch down” first.

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

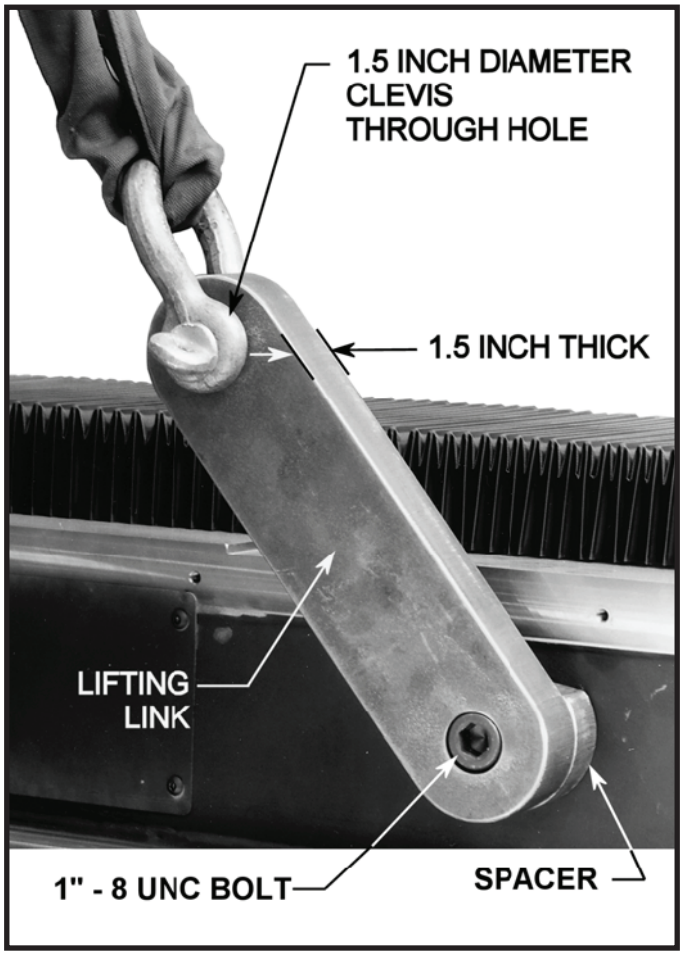


FIGURE 2-1 Lifting Main Frame

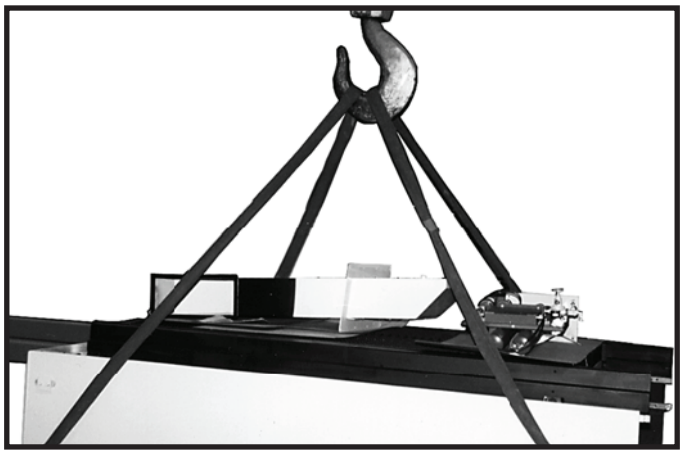


FIGURE 2-2 Lifting Load Frame

FOUNDATION

A Certified Foundation Plan drawing is provided when 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

Remove neoprene shipping feet before setting machine on the anchor studs.

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. Install safety mats, using instructions provided with the machine.
7. CINCINNATI Service will install the operator control station and complete final electrical connections to the control.
8. 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 at a central location on the beam delivery side. Hoses are furnished to connect the chiller when located as shown on foundation plan. Consult CINCINNATI INCORPORATED if an alternative chiller location is required. See SECTION 4 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.

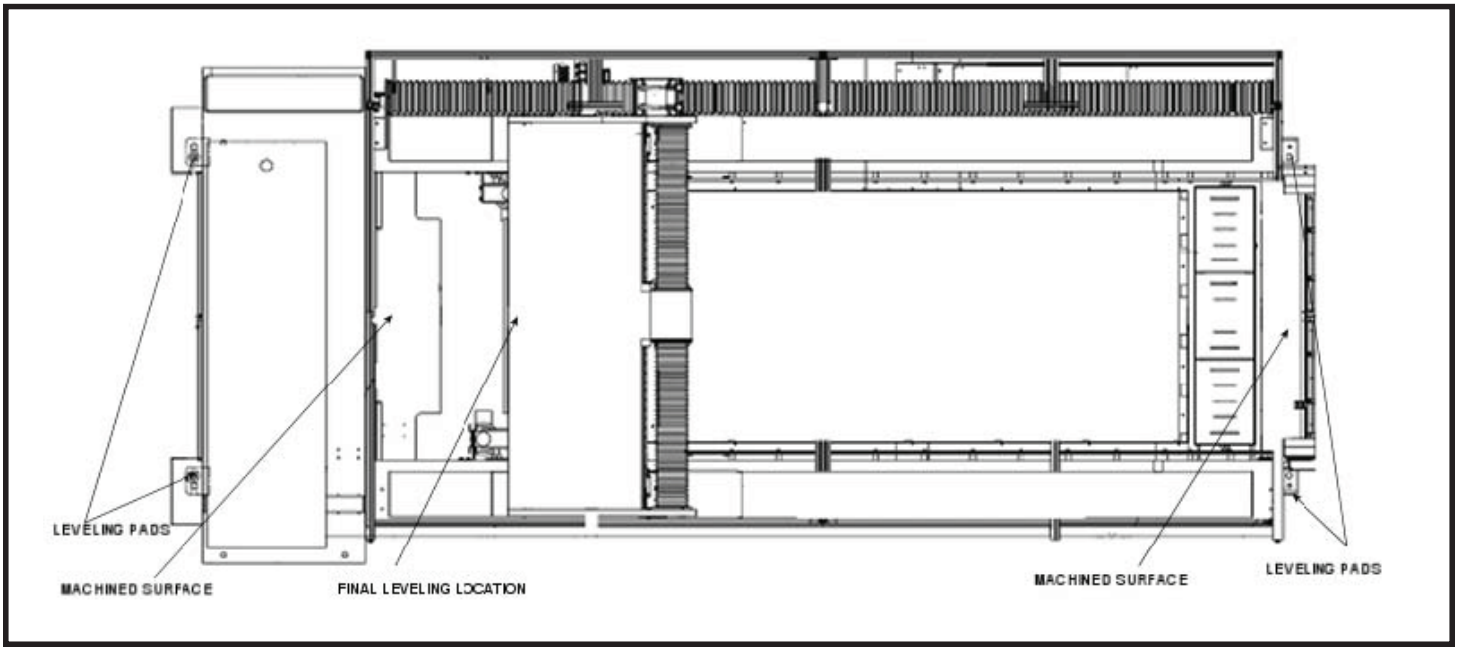


FIGURE 2-3 Main Frame Leveling Adjustments

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 main frame. For preliminary leveling, a level with .004”/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 (2 X 4) OVER THE MAGNETIC TRACK TO PROTECT IT AND YOURSELF.

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” (380 mm) precision spirit level with a sensitivity of .0005”/ft. (0.04 mm per meter).

2. Place the level on the top of the gantry and position the gantry at X = 0. See Figure 2-6. The gantry may be moved by manually pushing it when drives are off, or by using JOG mode when drives on.

3. The top of the gantry is not machined. Therefore, it will be necessary to shim one or both ends of the level to establish a reference reading and make the level sit solidly in place. Paper shims can be used for this purpose.

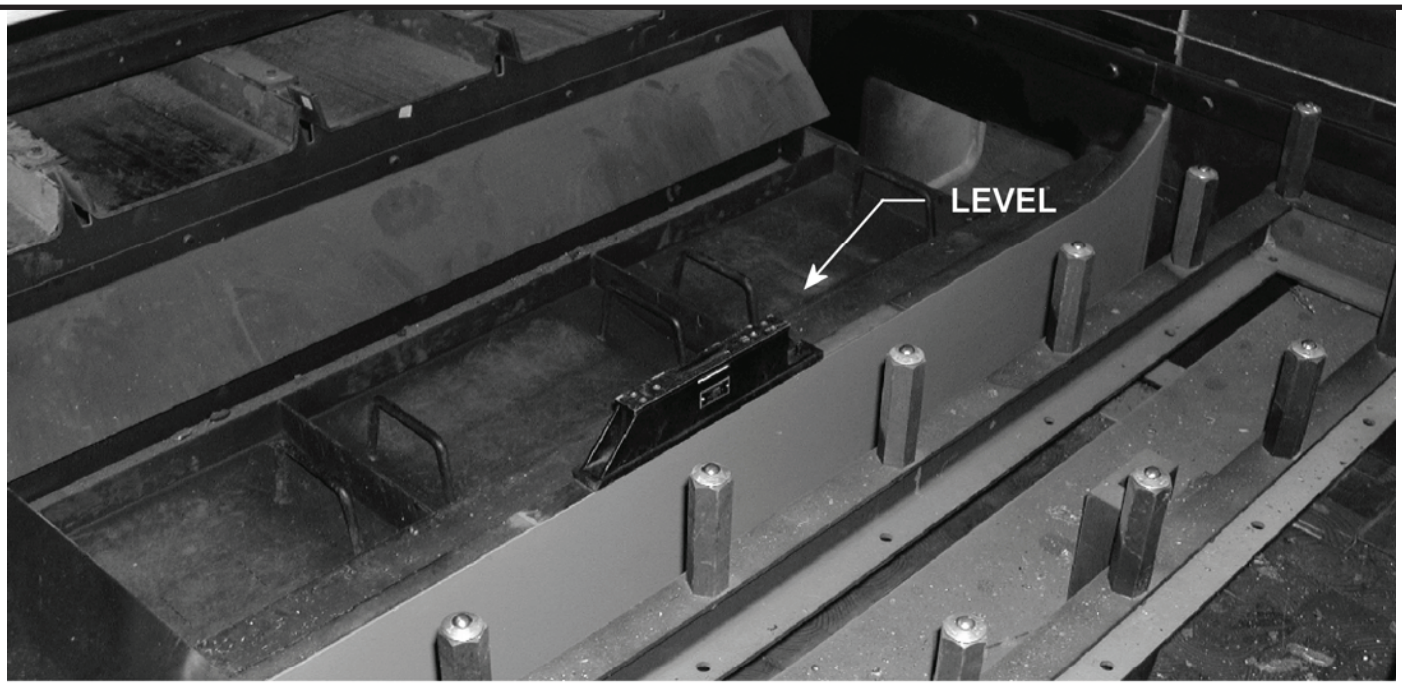


FIGURE 2-4 Cross leveling (Preliminary)

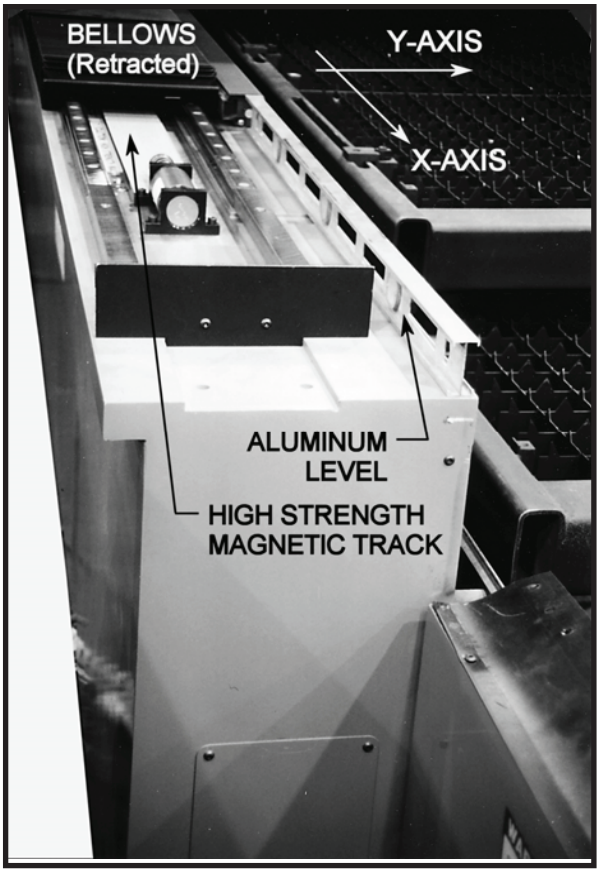


FIGURE 2-5 Longitudinal leveling

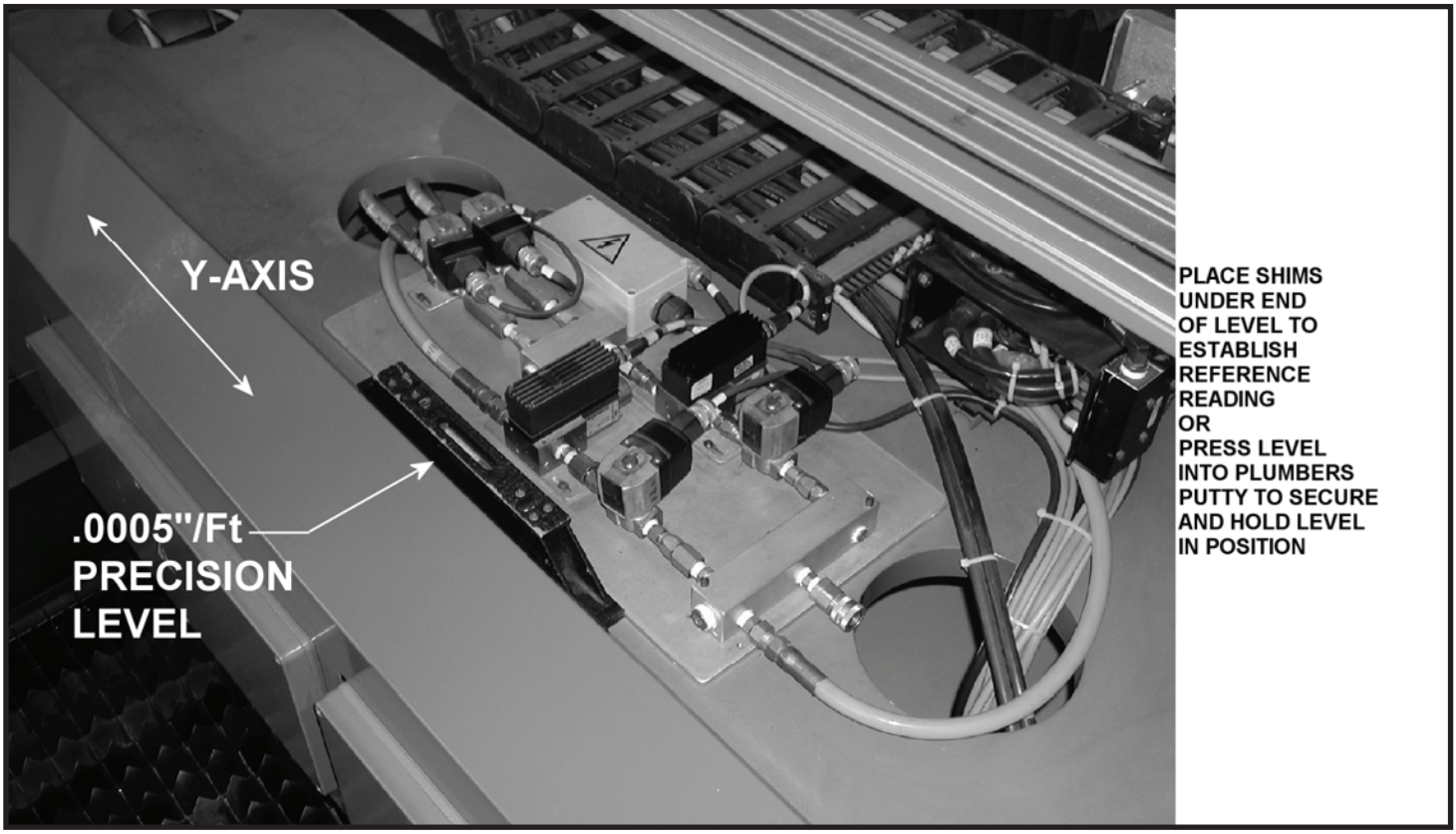


FIGURE 2-6 Final leveling with precision level

4. Observe the position of the bubble while moving the gantry from X = 0 to X = Maximum travel. The maximum acceptable deviation is one division of the level (.0005"/ ft. or 0.04 mm per meter) as the gantry moves from end-to-end. This ensures that the frame is not in a twist. Adjust as described above, using jackscrews to add or remove shims under mounting feet.

5. When Step 4 is complete, lightly tighten anchor nuts and recheck level as specified in Step 4. Verify that jacking screws are backed off and not supporting the machine.

6. Tighten the anchor nuts.

7. Repeat Step 4 as a final level check.

ELECTRICAL CONNECTION

Each Laser System customer is supplied a complete set of Foundation Plan drawings prior to machine shipment. The electrical load requirements and connection points are called out on these drawings. Be certain that a suitably sized wire is brought to the main disconnect and the proper voltage is supplied.

The standard electrical input is 460 volt, 3 phase and 50/60 hertz. 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 the SAFETY section 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 MACHINE UNTIL YOU HAVE THOROUGHLY READ THE SAFETY SECTION OF THIS MANUAL AND A CINCINNATI INCORPORATED SERVICE REPRESENTATIVE IS PRESENT.

SECTION 3 SAFETY

SAFETY IS EVERYONE'S JOB

The CINCINNATI Laser System 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, we recommend you:

1. Obtain 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. Determine your responsibilities under your state and local safety codes.
3. Request assistance from the loss prevention department of your workmen's compensation carrier.

Personnel responsible for your 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 they thoroughly understand it and know how to do their 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 are made 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 your electric company (i.e. 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 Systems **do not use "ionizing" radiation.**

Radiation that lacks the energy to deform atoms is called "non-ionizing" radiation. This is the type used in a CINCINNATI LASER SYSTEM. The source used to generate the laser beam is carbon dioxide gas (CO_2). The laser beam is emitted in a continuous wave (CW) at a fixed wavelength of 10.6 micrometers. This wavelength is in the far-infrared region of the electromagnetic spectrum. The beam is invisible 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 the burn you can get from a bonfire by standing too close for too long or the burn you can get 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 your 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 (CO_2) LASER SYSTEM operates at a wavelength of 10.6 micrometers. As you can see from the chart, this wavelength is in the infrared range. Breaking the infrared range down further, the radiation generated from a carbon dioxide gas laser is considered to be in the far-infrared range.

This brief introduction has been prepared to alleviate any unwarranted worries 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".

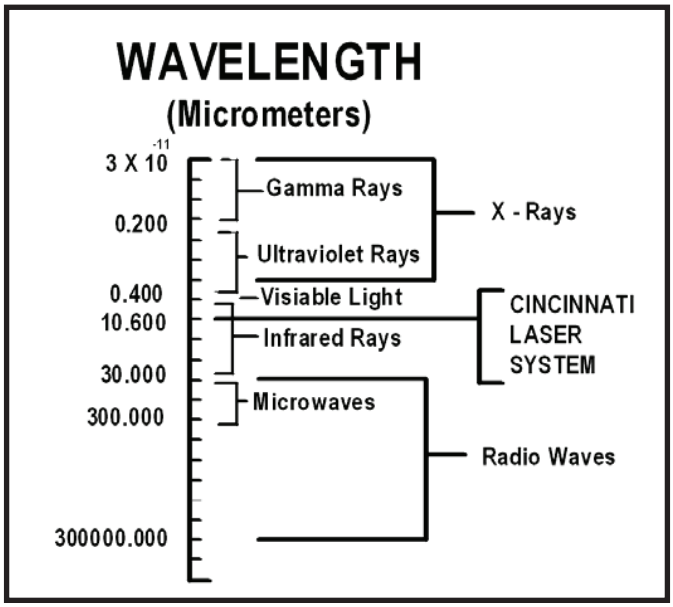


FIGURE 3-1 Electromagnetic Spectrum

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 (i.e. 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 or 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 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 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 (4) 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 Office (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 fulltime 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 while the laser beam is active. 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 such as Mode Burns, Tape Shots and Mirror Alignments. During these tasks, the laser beam needs to be available and therefore exposure to the hazards of the beam is possible. To get to the mirrors and beam locations, the service level worker often must override or defeat the protection provided. 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. Additional information concerning this topic can be located in the American National Standard B11.21 & 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 Systems use gas type lasers to generate the cutting beam and gas and semi-conductor lasers to generate the positioning beam when that feature is supplied. In all cases (i.e. for cutting or positioning), the actual laser-generating unit is located at one end of the CINCINNATI Laser System and the beam is directed to the cutting head through an enclosed beam tube. See Figure 3-2.

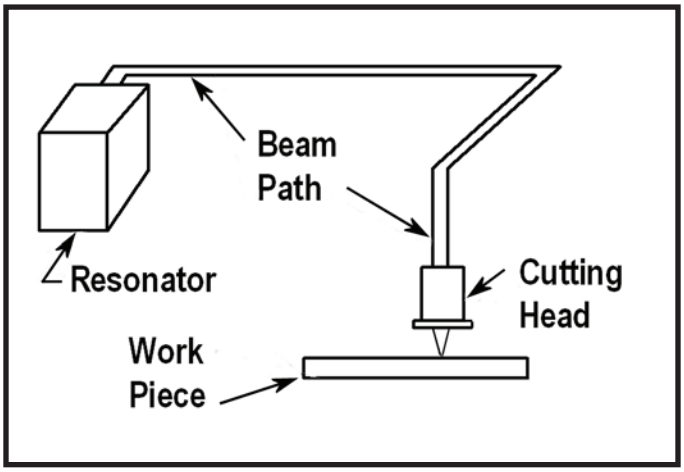


FIGURE 3-2 Beam Path

The enclosure at one end of the CINCINNATI Laser System is the laser resonator where the laser beam is created. An electronically actuated shutter system is used to allow the beam to exit the resonator and enter the beam tube. At this point, the beam is approximately 1.0" (25 mm) in diameter. The beam is then directed to the laser cutting head by a series of special mirrors. After the beam enters the cutting head, the lens will focus it down to a point as the beam travels out of the nozzle and onto the work piece.

In order to cut (vaporize) steel you need to generate a power density of over 2 million watts per square centimeter. 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" (25.4 mm) diameter.	800 w/cm^2
4000-watt laser beam, 0.010" (0.254 mm) focus spot diameter.	8 million w/cm^2
Steel Threshold	2 million w/cm^2

TABLE 3-1 Power Density Comparisons

Gas lasers have several power sources, including chemical reactions, electric current, electron beams, ultraviolet rays and radio frequency excitation. Most gas lasers produce a continuous beam of light. Gas lasers can produce beams of higher average power than solid lasers because the gas cools the laser as it flows through the tube. Light from a gas laser has a narrower frequency range than light from a solid laser.

The CINCINNATI Laser System can be provided with a second laser used for positioning. The positioning laser is a diode laser with very low power. It is located in the resonator cabinet and produces a visible red beam when turned on. Due to the visible nature of this beam and its power level, the positioning laser is designated as a Class 2 or Class 3a laser product depending on the type of laser furnished. Since Class 2 and Class 3a laser beams are considered a chronic viewing hazard, the laser system includes signs warning personnel not to stare into the red beam.

HAZARDS - CINCINNATI LASER SYSTEMS

EYE HAZARDS

The beam of a CINCINNATI Laser System 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 far-infrared region will be absorbed in the front surface of the eye. Thus, if the eye is not protected, it may receive damage to the cornea and lens from direct or reflected laser beam exposure. **Therefore, all operation, maintenance and service personnel working at the CINCINNATI Laser System must wear eye protection.**

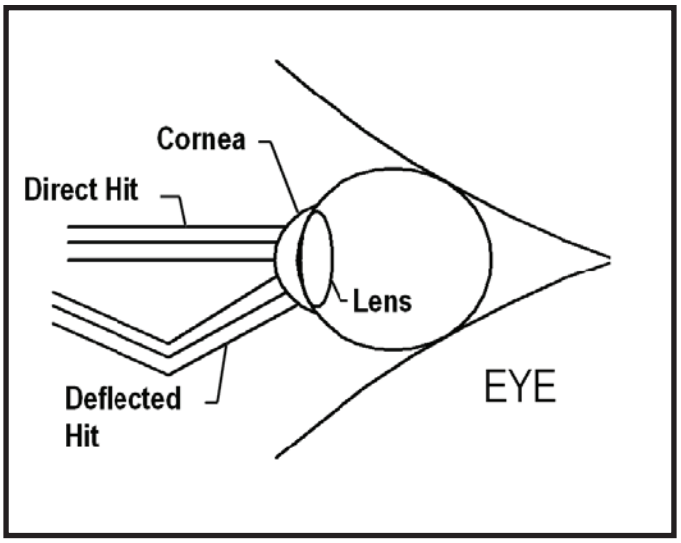


FIGURE 3-3 The Eye

The type and style of eye protection to use should be worked out with the supplier of your shop eye protection. In general, the normal polycarbonate safety glasses with side shields used in metal working shops and meeting the ANSI Z87 Standard will provide all the protection necessary from reflected beams for operating and maintenance personnel. Their work should not expose them to the possibility of direct beam exposure. The procedures established for service personnel are designed to protect them from direct beam exposure. However, it is recommended that their safety glasses have a protective optical density of 4.

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 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 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

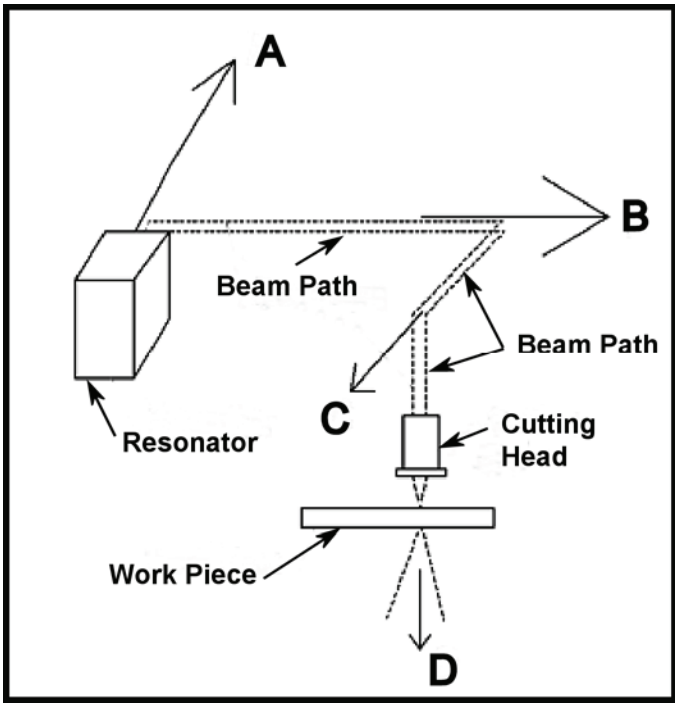
Safety standards define a laser's Nominal Hazard Zone (NHZ) as "the space within which the level of the direct reflected or scattered radiation during operation exceeds the applicable Maximum Permissible Exposure (MPE)". When considering a CINCINNATI Laser System, the radiation hazard is the laser beam 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 nominal hazard zone 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 beam tube and exits only at the cutting head. Figure 3-4 shows the usual path of the laser beam. On some models, this path is slightly changed due to different positions of the laser resonator or additional features enclosed within the path. 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



DIRECTION	HAZARD DISTANCE
A, B or C	2439.1 Ft. (743.4 m)
D	56.1 Ft. (17.1 m)

FIGURE 3-4 Uncontained beam hazard distance

The CINCINNATI Laser System's design deals with beam exposure categories in various ways:

- Intra-beam (Direct) Exposure occurs when an object is in the beam's path. See directions A, B, C & D in Figure 3-4.

  The fully enclosed beam tube guards this potential exposure, by appropriate interlocks and warning labels on service access panels. After the beam leaves the lens, the Laser System's two-axis motion system provides for a fixed downward beam direction. Automatic beam shutoff occurs through redundant mechanisms if the cutting head is knocked off or rises more than 1-1/2" (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.

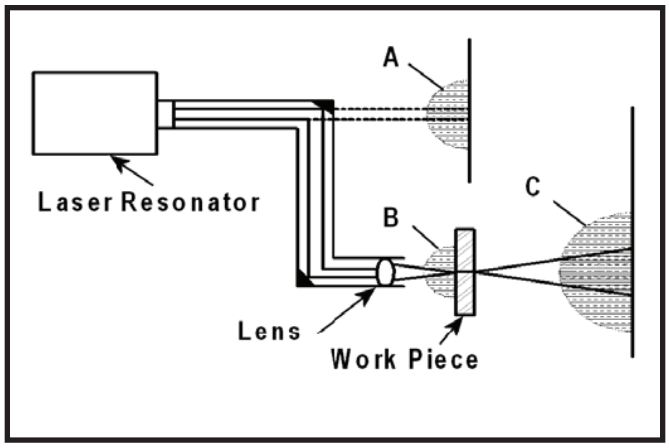


FIGURE 3-5 Diffuse Reflection

"A" indicates energy reflecting off an object being hit by an unfocused beam not contained within the beam tube.

"B" indicates energy reflecting off the material being cut.

"C" 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", "B" or "C") in order to be weak enough in intensity to not burn your 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.

RESONATOR		Φ POWER (WATTS)	NOMINAL HAZARD ZONE RADIUS	
SUPPLIER	MODEL		(CM)	(IN.)
FANUC	C 2000 C	2500	89.2	35.1
	C 4000 E	4000	112.8	44.4
	C 5000 E	5000	126.2	49.7

TABLE 3-2 Nominal Hazard Zone Radius

Table 3-2 lists calculated distances for various power levels on CINCINNATI Lasers. These calculations assume that the object being hit reflects all of the energy (the worst-case situation). The calculated distance, called the Nominal Hazard Zone Radius in the ANSI Z136.1 standard, was obtained using the method shown in this section.

Calculation:

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

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

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

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

MPE = Maximum Permissible Exposure Level in watts per CM^2. For CO_2 laser beam exposure lasting more than 10 seconds, the MPE is 0.1 watts per CM^2.

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

- The Main Frame
- The Safety Enclosure
- The Awareness Barrier

ASSOCIATED HAZARDS

ELECTRICAL

! ! DANGER ! !

HIGH VOLTAGE OF UP TO 30,000 VOLTS IS PRESENT IN THE LASER RESONATOR AND POWER SUPPLY CABINET. EVEN IF YOU DO NOT CONTACT A VOLTAGE CARRYING CONDUCTOR, ENERGY AT THIS POTENTIAL CAN JUMP TO A CLOSE BODY AT GROUND POTENTIAL – SUCH AS YOURSELF, CAUSING IMMEDIATE DEATH. DO NOT ENTER ANY HIGH VOLTAGE AREA WITHOUT FIRST DISCONNECTING POWER. REFER TO LASER MANUFACTURER'S SERVICE MANUAL BEFORE ENTERING THIS CABINET.

Because of the high electrical energies used to generate the laser beam in the CINCINNATI Laser System, electrocution hazards are possibly a far greater danger to personnel than the hazards of the laser beam itself. For that reason, no access to high electrical energy is possible without going through a safety interlocked door or panel. Before any maintenance or service is undertaken, ensure that the laser component has been isolated from the electrical service and all other precautions are taken as prescribed in this manual and the other component manuals provided.

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, i.e.: 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 you cut on your Laser System. These will contain information on the potential fire hazards you may encounter and the type of fire fighting equipment you may need.

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 your laser cuts only ferrous metal, clean the fume box and duct every 5000 hours; if cutting only aluminum, every 1000 hours. However, if your 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 2 to 4 hours, depending on the type of system and the tools available.

! ! DANGER ! !

BEFORE ENTERING THE MAIN FRAME AREA OR THE AREA ENCLOSED BY THE AWARENESS BARRIER, 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 Piece 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.

FUME 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, i.e. 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 un-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 he/she is in 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 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 resonator.

There is an flashing amber beacon on top of the laser resonator. This light is illuminated any time high voltage to the resonator 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 resonator cabinet.

The machine has a beacon on the operator's side. The light is a red beacon and indicates the status of the shutter. If this red light is on, the shutter is open and a laser beam may be present outside the resonator, up to and including the cutting head. It is important to know the status of the shutter and high voltage by paying attention to these awareness lights.

Numerous other indicators and displays located on the Laser System Control touch screen serve to inform personnel of the status of various Laser System functions. Read the Machine Control sections of this manual and the online help. Become familiar with the purpose of these illuminated switches and displays.

SAFETY ENCLOSURE

The Safety Enclosure has an operator's door and a resonator door. The doors have several functions. First, opening either door will interrupt laser operation. This forms the Nominal Hazard Zone on the operator's side of the cutting area. The safety enclosure also provides localized protection from strike and pinch hazards caused by automatic motion of the gantry, cutting head and pallets.

Under normal operation, opening the Safety Enclosure doors removes power from all axes and pallets, and closes the shutter. The MAIN DRIVES light will turn off, indicating that drive power is off. This ensures protection for operators and maintenance personnel, who must enter the cutting area temporarily to perform adjustments, retrieve parts, make repairs, etc. To resume automatic operation, close both Safety 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 CYCLE START will allow the program to resume from the start of the block where it was interrupted.

OVERRIDING SAFETY ENCLOSURE DOORS FOR LASER SHOT

In certain cases, it will be necessary to perform a Laser Shot, with the Safety Enclosure door(s) open. For this case, an override function has been provided. To override the shutter interlock, and enable Auto Focus, Assist Gas and Z-axis operation, turn the REMOTE STATION ENABLE switch to ENABLE **before** the door(s) are opened. If the door(s) are already open, it is also possible to turn the MAIN DRIVES back on, if they are OFF. With the REMOTE STATION enabled, and the MAIN DRIVES light ON, the door interlocks continue to ensure that the X and Y axes, as well as the pallets, are disabled. For this mode ONLY, the MAIN DRIVES ON light merely indicates that the Auto Focus, Assist Gas, and Z-axis are ENABLED. To maintain perpendicularity, the gantry has a clamp mechanism that will enable in this mode, while the Y-axis must be manually pushed to the desired laser shot location. To recover in the least number of steps, start by closing all Safety Enclosure doors, then turn the REMOTE SATION ENABLE switch to OFF. Next, press RESET to re-enable all servo drives.

SAFETY SIGNS

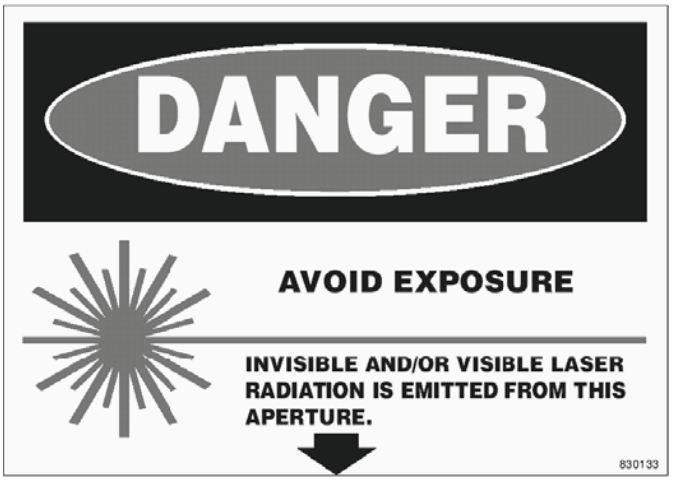
To warn laser operators and maintenance personnel of certain potential hazards that may exist - unless specified procedures are followed - a number of warning signs are attached to CINCINNATI Lasers. Warning signs are not intended to be a substitute for reading and understanding this Safety Section and the machine Operation and Maintenance Manuals.

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 resonator 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.

DANGER - APERTURE (830133)

This sign is mounted on the front cover of the cutting head housing. It warns that laser radiation, which is not visible, is emitted from the cutting head nozzle. An arrow indicates the direction of emission.

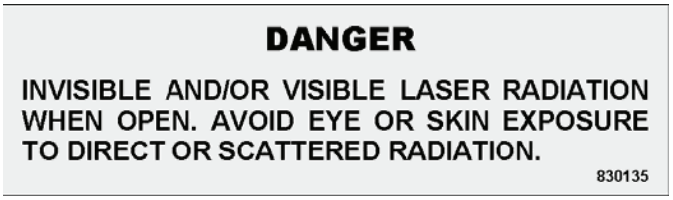


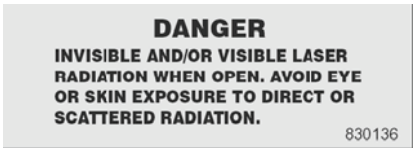
AVOID EXPOSURE - APERTURE (830134)

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, 840136 and 922908)

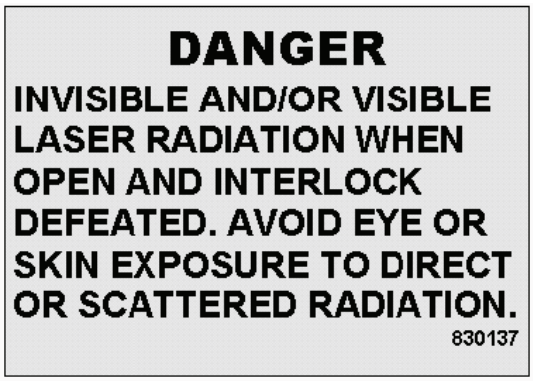
These signs warn of a laser radiation hazard that will be present when a cover is removed from the machine. The signs are located on removable covers and on the interior surfaces that are exposed when the cover is removed. The warning descriptions on the signs are identical; the only difference between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

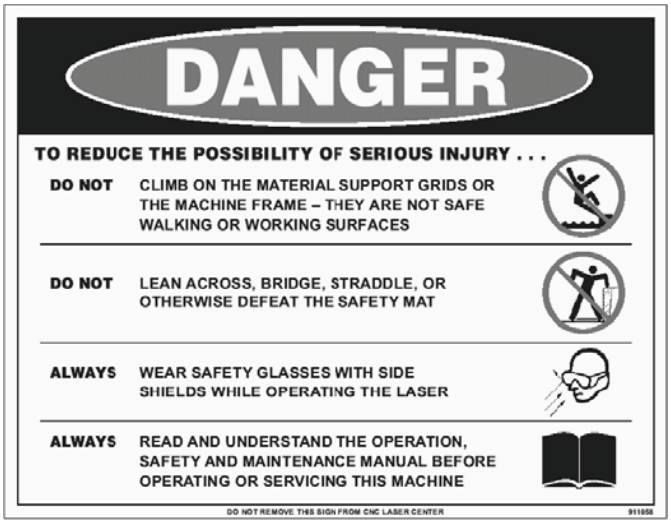


HIGH STRENGTH MAGNETIC FIELD (921533)

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 your hands.

DANGER – TO REDUCE THE POSSIBILITY OF SERIOUS INJURY (911058)

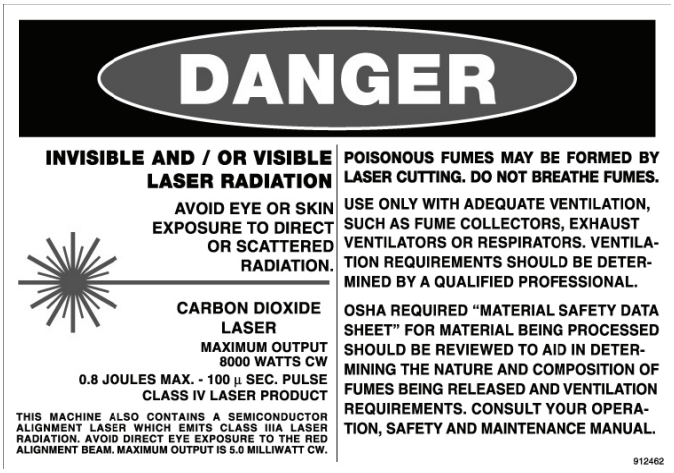
This sign is mounted on the operator side of the gantry. It warns against the dangers of climbing on the material support grids or machine frame and defeating the safety mat. It instructs operators to wear safety glasses, and instructs all personnel to read and understand this manual before operating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



DANGER - LASER SPECIFICATIONS / POISONOUS FUMES / ALIGNMENT BEAM (912462)

On 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 two places: one sign is on operators' side of the main frame and another sign is mounted on the X-beam tube.

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

- Safeguarding, such as panels, covers, safety mats are in place and working.
- All safety interlocks are engaged and operating properly.
- Ensure no portion of your 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 your controls; be familiar with emergency shutdown procedures.
- Fume and dust control system is operating properly.
- Do not position any part of your 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.
- Make sure there are no obstructions between the laser cutting head and the material being processed.
- Use material handling devices for movement of heavy workpieces.
- Do not stack material on the idle pallet.

SAFETY MAINTENANCE CHECK

- SAFETY ENCLOSURES operating properly.
- BEAM PATH ENCLOSURE TUBE and bellows system in good working condition.
- 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 MAN-UALS in holder near the Operator Control Station.

SCHEDULED NORMAL MAINTENANCE work completed.

SAFETY IS PART OF YOUR JOB... THE MORE ATTENTION YOU PAY TO DEVELOPING SAFE HABITS, THE LESS THE CHANCES OF INJURY TO YOU AND YOUR FELLOW EMPLOYEES.

SECTION 4 SPECIFICATIONS

DIMENSIONS

COMPONENT	MODEL	WIDTH		LENGTH	HEIGHT	WEIGHT
		Shipped	Installed			
		In. (mm)	In. (mm)	In. (mm)	In. (mm)	Lbs. (kg)
MAIN FRAME	5 X 10	130	187	282	105	28,000
	(1.5 X 3.0 m)	(3302)	(4750)	(7163)	(2642)	(12701)
	6 X 12	142	202	322	105	32,000
	(2.0 X 4.0 m)	(3607)	(5138)	(8179)	(2642)	(14528)
LOAD FRAME	5 X 10	83		131	40	8,750
	(1.5 X 3.0 m)	(2108)		(3328)	(991)	(3969)
	6 X 12	102		168	40	10,200
	(2.0 X 4.0 m)	(2591)		(4267)	(991)	(4631)
CHILLER	60 Hz	42		69	86	1,900
		(1067)		(1753)	(2184)	(861)

SPECIFICATIONS

LASER	RATED POWER	TYPICAL RANGE
C 2000	2500 W	100-2500 W
C 4000	4000 W	100-4500 W
C 5000	5000 W	100-5500 W

WAVELENGTH: 10.6 micron

MODE: Predominantly TEM_{00}

LASER SYSTEM: Class IV

ALIGNMENT LASER (OPTIONAL): Semiconductor type, (less than 5.0 mWatts) Class IIIA

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)

*** 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, except for a restricted area around each material clamp. The minimum distance between the Autofocus head and a clamp is 1 inch (25.4 mm). See Figure 1-1 for material clamp locations.

Except in the restricted clamp areas, 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 cutoff 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 2.5 in. (0 to 38 mm) above each pallet
6 X 12	0 to 157.5 (0 to 4000 mm)	0 to 78.75 in (0 to 2000 mm)	

ACCURACIES:

- Absolute Positioning (X & Y-Axis): ±0.001" (0.025 mm)
- Repeatability (X & Y-Axis): .001" (0.025 mm)

MACHINE SPEEDS (Programmed moves):

- Cutting feedrate is programmable up to the Rapid Traverse Speed. Maximum feedrate depends on material type and thickness.
- Rapid Traverse Speeds

  X & Y-Axis: 8500 IPM (215.9 m/min.)
  X & Y-Axis Simultaneous: 12020 IPM (305.3 m/min.)
  Z-Axis: 1700 IPM (51 m/min.)

- Accelerations

  X & Y-Axis: 5 X 10: 1.65G (16.2 m/sec^2)
  X & Y-Axis: 6 X 12: 1.50G (14.7 m/sec^2)
  Z-axis: 2.00G (19.6 m/sec^2)

MACHINE SPEEDS (In JOG Mode):

- Normal jog (X & Y-Axes): 300 IPM (7.6 m/min.)
- Rapid traverse jog (X & Y-Axes): 1200 IPM (30.5 m/min.)
- Z-Axis Speed: 250 IPM (6.4 m/min.)

PROGRAMMABLE ASSIST GASES: Three

PROGRAMMABLE ASSIST GAS PRESSURE: 5-200 PSIG (34 to 1379 kPa) for Oxygen and Air and 5-500 PSIG (34 to 3447 kPa) for Nitrogen

CHILLER FLUID: 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 or de-ionized water:

Maximum Hardness: 200 mg $CaCO_3$/liter
Maximum Cl Concentration: 50 mg/liter
pH Range with additive: 6.5 to 8.0
Maximum Conductivity: 1000 µ S /cm

CHILLER TEMPERATURE SETPOINT: 80°F (26.7°C)

CHILLER RESERVOIR CAPACITY: 120 gallons (378 liters)

FUME EXHAUST RATING:

MODEL	EXHAUST FLOW	Water Static Pressure
5 X 10 6 X 12	4500 SFCM (127 m³/min.)	0.75 in. (19 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) can achieve an exhaust rate of up to 6500 SCFM (184 m^3/min).*

Fume exhaust flow rate depends on customer-installed exhaust ducts. Longer duct runs may reduce flow to an unacceptable level. 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 of this manual for more information.

PIPING CONNECTIONS

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

BEAM DELIVERY PURGE: The gas manifold has a 3/8" NPT port for the beam purge gas, which is connected to, an air dryer. Connect shop air to the air to this port.

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.

EXTERNAL OPTICAL ELEMENTS

CIRCULAR POLARIZING MIRROR: The Circular Polarizing mirror is coated to produce a quarter wave phase shift. It changes the laser beam from linear to circular polarization, for consistent cutting in all directions.

COLLIMATOR MIRRORS: The collimator uses two curved mirrors to reduce the laser beam divergence. Lower divergence makes the beam more uniform over the travel length of the machine. Since it also increases the beam diameter, the collimator is sometimes called a Beam Expander.

ADAPTIVE OPTIC (OPTION FOR FANUC 2000): The convex collimator mirror serves an additional function of controlling beam diameter. Coolant supplied to the optic also runs through a pump transducer that controls the pressure applied to the mirror. This pressure controls the curvature of the optic, which in turn changes the beam diameter. The beam size is controlled in the material library

BEAM BENDER MIRRORS: The beam bender mirrors are the second external mirror and the moving X and Y mirrors. To minimize any effect on polarization, these mirrors are coated for zero phase shift.

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)	(5.12 inch (130 mm)
7.5 inch (Middle)	7.5 inch (191 mm)	7.63 inch (194 mm)
10 inch (Upper)	10.0 inch (254 mm)	10.12inch (257 mm)

GAS REQUIREMENTS

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

1. **Laser Gas:** Premix laser gas must meet the following specifications:

LASER PREMIX GAS C2000, c4000 & c5000		
Carbon Dioxide	5 ± 0.25%	99.99%
Helium	60 ± 2%	99.99%
Nitrogen	35 ± 2.75%	99.99%

Water Vapor: Less than 5 PPM

Hydrocarbons: Less than 1 PPM

Note: *During installation of the machine, a minimum of two cylinders of the laser pre-mix gas should be available. Cylinders should be "certified". The first cylinder will be used for initial checkout of the laser. After proper operation of the laser is confirmed, this cylinder should be removed and stored for no longer than 6 months for use as a benchmark if needed during maintenance. The second cylinder should be connected to the laser system for demonstration and start of production.*

2. **Programmable Assist Gas:** Two programmable valves control the assist gas pressure commanded by the program for piercing and cutting. One Valve is for Oxygen or Air and the other is for Nitrogen. The Oxygen and Air has a pressure range from 5 to 200 PSI (34 to 1379 kPa) and the Nitrogen has a pressure range from 5 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 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).

GAS USE	GAS TYPE	MANIFOLD LABEL	GAS PURITY	TYPICAL PRESSURE	REGULATOR SPECIFI-CATION	APPROXIMATE GAS USAGE
LASER	Premix (See "Gas Requirements")	GAS IN (on resonator)	99.99%	28 PSI	5 to 125 PSI CGA 580 Grade 5	0.36 SCFH
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
BEAM PURGE	Dry Air from Air Dryer	Beam Purge Supply	-20 °F Dew Point	30 PSI	0.25 in. NPT	480 SCFH *
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 Figure 4-1 for total air flow requirements at machine inlet.

TABLE 4-1 Gas Requirements

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). For example, to cut with 400-PSI nitrogen using a .100" nozzle, the gas supply system must deliver 3394 SCFH of nitrogen with an inlet port pressure of 500 PSI.

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.
15	82	157	218
25	111	209	304
50	181	333	504
75	252	471	696
100	322	610	892
150	463	876	1280
200	603	1142	1670
250	744	1407	2058
300	884	1673	2447
350	1024	1939	2835
400	1165	2205	3224

TABLE 4-2 Oxygen and Air Assist Gas Flow

Nozzle Pressure (PSI)	Approximate Flow (SCFH) Required for Nozzle Orifice		
	.060 in.	.080 in.	.100 in.
15	87	164	230
25	118	216	320
50	192	345	530
75	268	485	732
100	342	624	939
150	492	896	1347
200	641	1168	1758
250	790	1440	2166
300	940	1712	2576
350	1089	1984	2984
400	1238	2256	3394

TABLE 4-3 Nitrogen or Air Assist Gas Flow

Nozzle Pressure (PSI)	Air Supply Pressure (PSI) Required for Nozzle Orifice		
	.060 in.	.080 in.	.100 in.
75	83	90	96
80	88	95	102
85	93	101	107
90	99	106	114
95	104	111	120
100	109	116	126
105	115	121	131
110	120	128	138
115	125	133	144
120	130	138	150
125	135	143	156

TABLE 4-4 Air Assist Gas Supply Pressure

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 230 PSI (1586 kPa) maximum inlet pressure of the refrigerated air dryer.

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 (Dioctyl 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 down-stream 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 your gas supplier for additional information.

3. **Rapid Pierce:** Clean, dry, compressed air is required for the air-blast system used with rapid pierce.

4. **Beam Delivery Purge:** The beam purge gas keeps the beam delivery enclosure free of airborne contaminants by maintaining a slight positive pressure. Note that paint fumes and other airborne contaminants in the beam delivery system will seriously degrade cutting performance and reduce optic life.

5. **Air Dryer Supply:** The air dryer requires up to 980 SCFH of compressed air at 80-125 PSI (28 standard m^3/hr at 550 to 860 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).

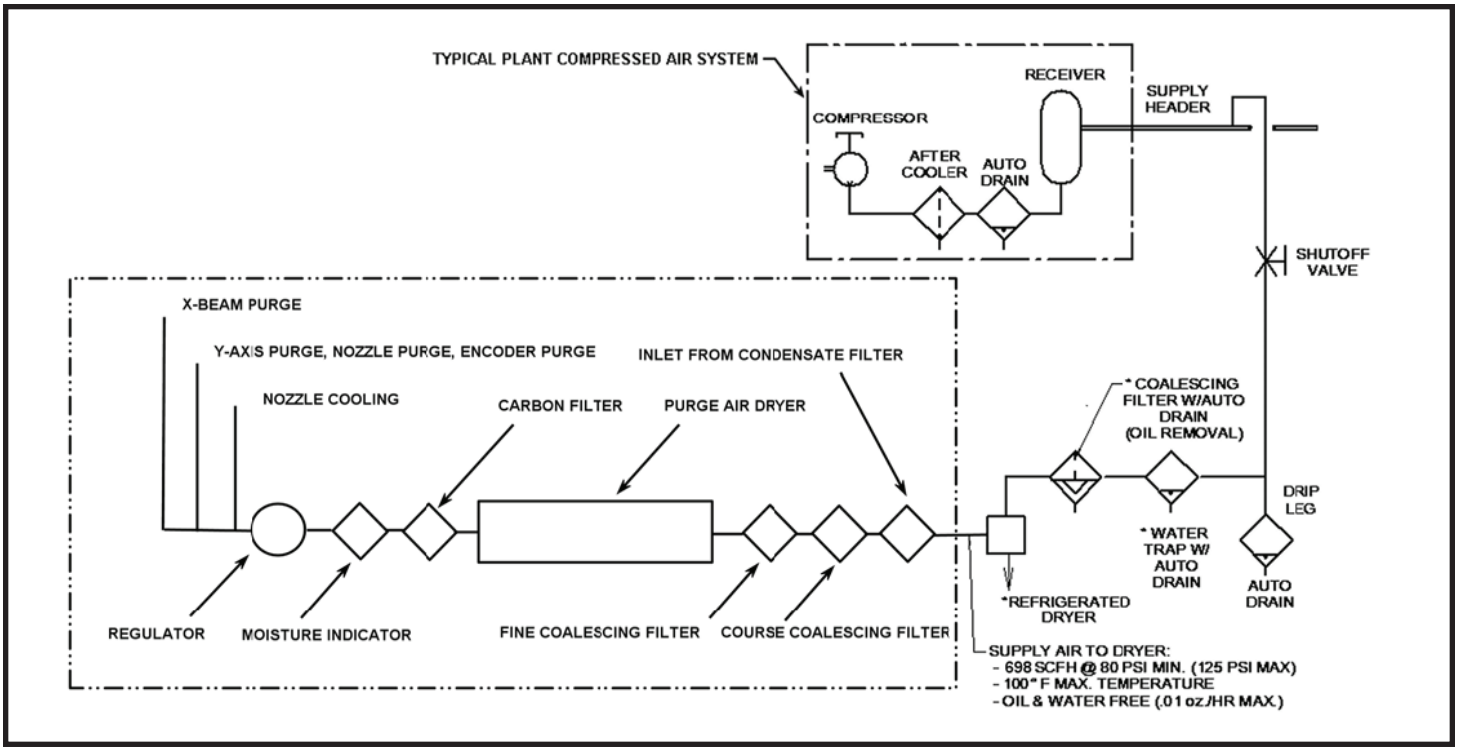


FIGURE 4-1 Schematic of compressed air supply system for purge requirements. "Basic" system components and recommended pretreatment (*) components to comply with air dryer inlet specifications.

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

6. **Nitrogen for Beam Purge:** The laser system can use welding grade nitrogen regulated to 30 PSI (207 kPa) for beam purge. However, at 480 SCFH (13.6 standard m3/hr), the operating cost is usually higher than filtered air.

7. **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 feedrates are determined by material type, thickness, surface condition, required part accuracy, laser power and proper machine setup.

PRINCIPLE OF OPERATION

The 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 resonator is directed to a moving lens by two mirrors mounted on 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 mirrors and lens to produce the programmed workpiece geometry. A motion controller commands servo drives to control gantry motion. The program provided by the user includes commands to specify feedrate, 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 feedrate and the curvature of the path. The maximum feedrate at which the laser system can maintain a given hole roundness is a function of the hole diameter.

LOADING MATERIAL

Each load table or pallet has a stop pin at the X = 0 end of the cutting area and a stop bar at each clamp location to locate the Y = 0 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 = 0 in the machine coordinate system. In order to accurately represent the Y=0 location along the sheet, these stops are cut by the machine.

The following procedures must be completed before the Y = 0 stops can be cut:

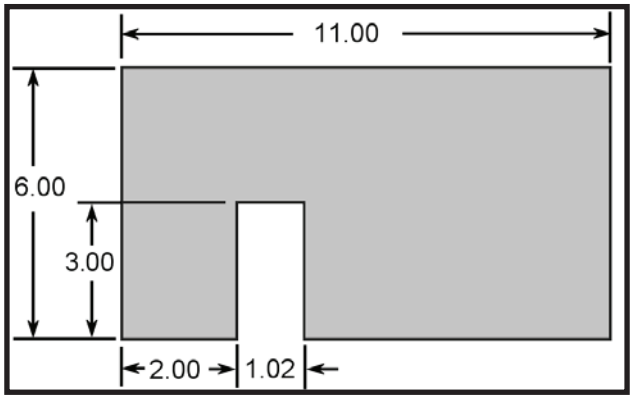
- LASER SETUP, ELECTRICAL (by CINCINNATI Laser Service) specifically setting of Y-Axis Home Offset.
- BEAM DELIVERY ALIGNMENT
- LENS CENTERING
- LENS FOCAL POINT LOCATION
- MACHINE START-UP

MATERIAL REQUIRED

- **Y-Stops:** The number of Y-stops depends on the machine size:
  - All models use C.I. #923531 stops per pallet.
- One piece of mild steel with the same thickness as the Y-stops. C.I. #923531 stops are .5 inch (12.7 mm) thick. Minimum plate size is 7.0 x 12.0 inches (178 x 305 mm).
- One set of feeler gages.
- Programs located in "CNCLSR32\PROGRAM\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 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 START-UP AND SHUT-DOWN (SECTION 7). Confirm the AXIS HOME operation by checking that the MACHINE coordinates are zero on the AXES POSITION window.

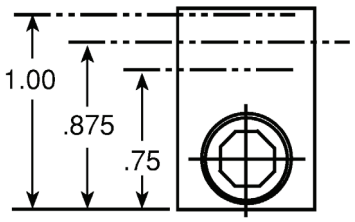
4. The Y = 0 machine location will now be checked to be sure the material edge will be under the clamp head.

   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" (19 mm) and 1.0" (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" (19 mm) to 1.0" (25 mm) dimension, change the home offset parameter to move the Y = 0 machine position. Determine the distance required to move the scribed line inside the .75" (19 mm) to 1.0" (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 = 0 scribed lines on all stops are within the .75" (19 mm) to 1.0" (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 = 0. 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" (3 mm) to the left (-X) of the stop.

   Use the program to cut all Y-stops.

6. Test the Y = 0 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" = 4" (100 mm). Set parameters for the plate thickness and run the program.

   c. Unclamp the 4" (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"= 3" (76 mm) and run program.

   e. Unclamp the 3" (76 mm) part and measure its width. The "Y" position error is:

      ERROR =
      commanded width - measured width - (kerf / 2)

      Example:

      ERROR = 3.000 – 2.996 – (0.006 / 2) = 0.001"

   f. If error is .002" (0.051 mm) or less, this procedure is complete.

   g. If error is more than .002" (0.051 mm), change the home offset parameter to make machine "Y" = 0 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" (0.051 mm) or less. It is not necessary to test Y = 0 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 CL-800 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 = 0 in the machine coordinate system of the control. The Gantry moves to the MACHINE X = 0 position when the AXIS HOME (under "START-UP AND SHUT-DOWN", SECTION 7) operation is done. This procedure describes how the cutting position of each pallet is adjusted so the edge of its stop pin coincides with MACHINE X = 0.

MATERIALS REQUIRED

- Inside calipers accurate to .001" (.025 mm) over a 2 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" x 38" (300 x 965 mm) or larger.

The following procedures must be completed before the X = 0 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.

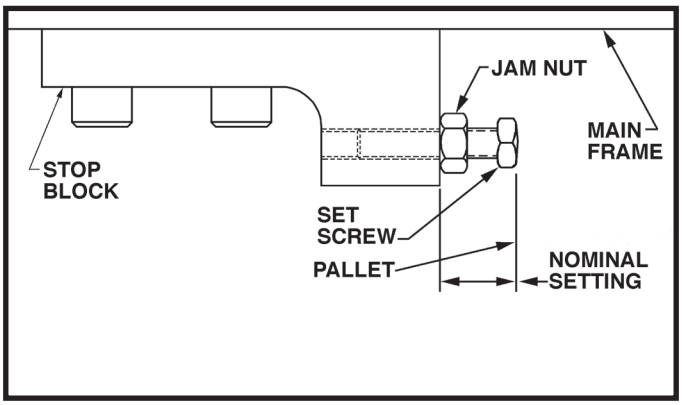


FIGURE 5-1 Pallet Stop Block

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 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” (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.

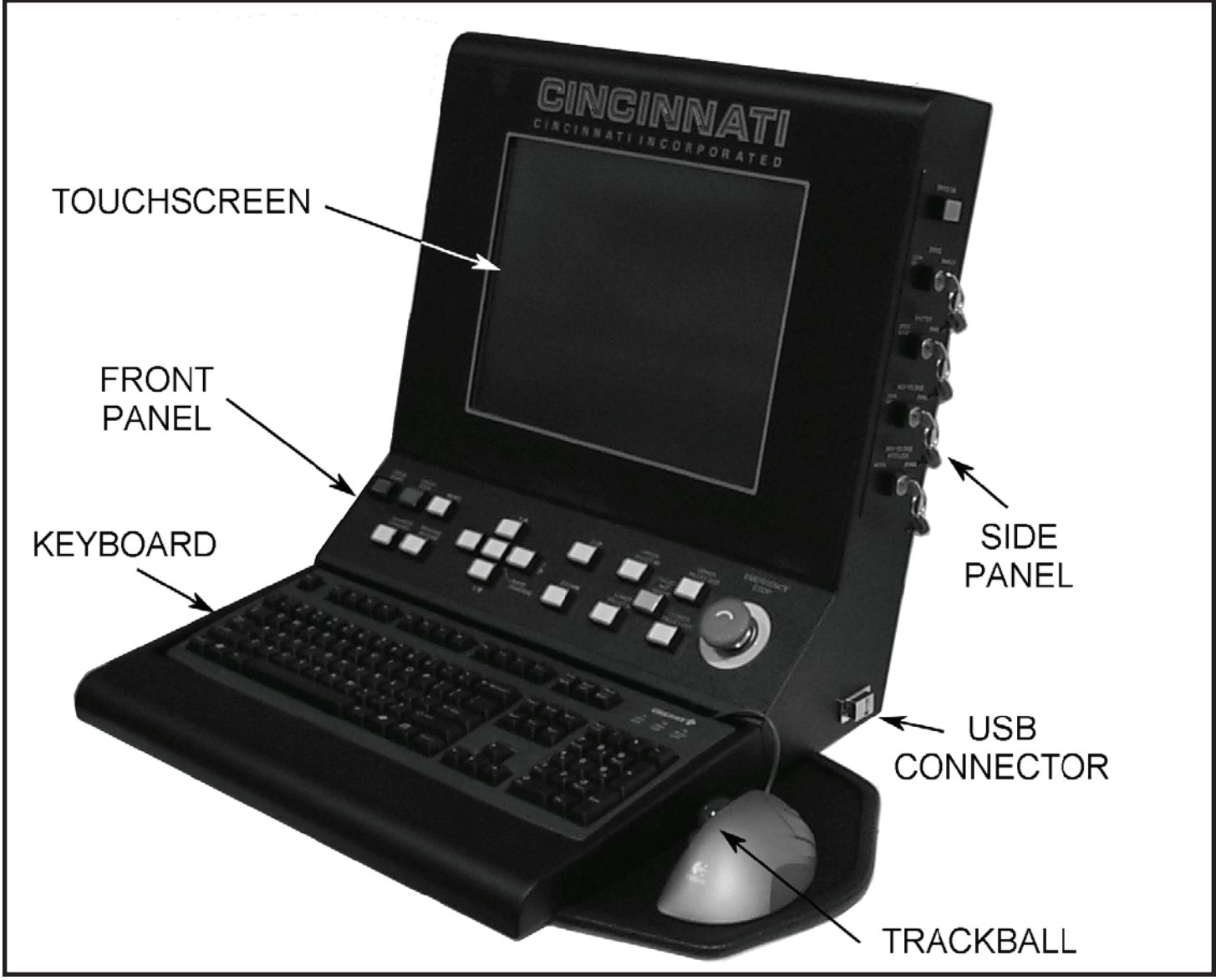


FIGURE 6-1 Operator Control Station

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, Axis 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 below.

Keyboard: The keyboard is used to enter alphabetic, numeric and other characters into the control for program and data entry. The keyboard can also beused 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.

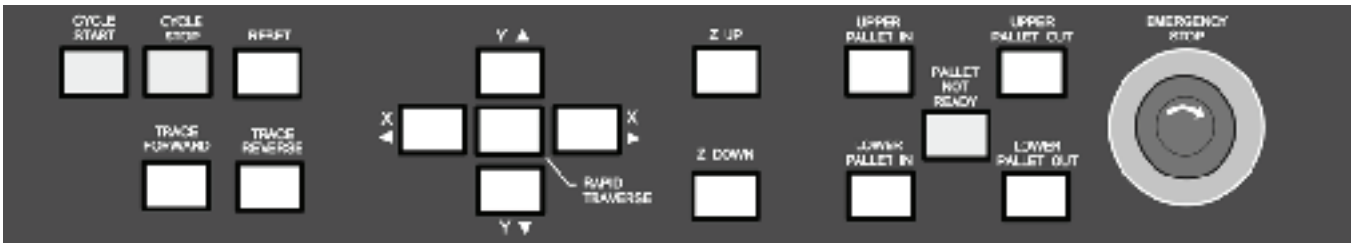


Figure 6-2 Front Panel Controls

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

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.

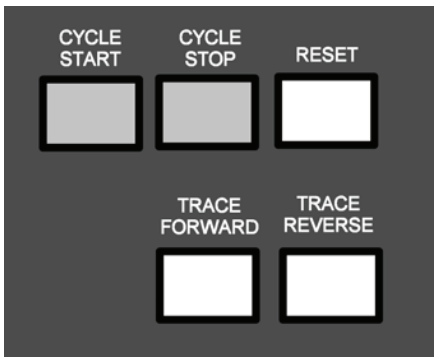
MACHINE OPERATOR PANELS

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



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. In JOG mode, the Maintenance / Mirror Alignment window and the Utilities / Lens Centering window use the CYCLE START pushbutton to begin operating the laser at the Warm-up settings. Manual Power Control mode (Maintenance / Diagnostics / Resonator menu) also uses the CYCLE START pushbutton to begin laser operation.

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

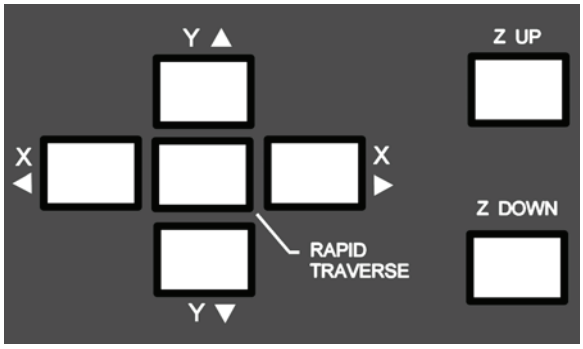
CYCLE STOP pushbutton/indicator: When this button is pushed during automatic operation, axis motion decelerates to a stop, all cutting functions such as laser beam and assist gas are turned off, and the shutter closes. Cycle Stop status is indicated by illumination of this indicator. The indicator will 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, or by stepping on the safety mat.

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.)

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 for more details.)

AXIS MOTION CONTROLS



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.
- 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.

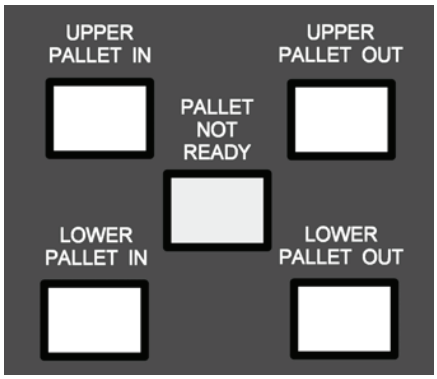
RAPID TRAVERSE pushbutton/indicator: When the RAPID TRAVERSE button is illuminated, and the X or Y-axis is jogged from the Machine Operator Front Panel, the jog speed is the value specified by the "X/Y Rapid Jog Speed" parameter in the General page of the Machine Configuration window. This function remains 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> push-button/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



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.

EMERGENCY STOP

Pressing the Emergency Stop pushbutton stops all axis motion, turns off High Voltage, and inhibits all cutting functions such as: assist gas flow and opening the shutter. 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.

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 YOUR 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 High 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.

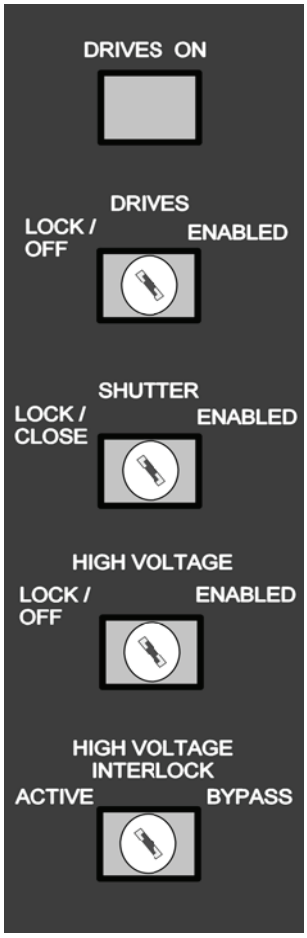


Figure 6-3 Side Panel Controls

SHUTTER keyswitch: When this keyswitch is in the LOCK/CLOSED (Left) position or the key is removed, the shutter within the laser resonator is prevented from opening. (Key can be removed only in the left position.) When the key is in the ENABLED (Right) position, the shutter can be opened three different ways:

- Automatically under program control.
- Manually using the SHUTTER FLASH button on the Remote Station (shown in Figure 6-4).
- Manually using the Shutter button/indicator on the touchscreen (if High Voltage is OFF).

HIGH VOLTAGE keyswitch: Turning this keyswitch to the LOCK/OFF (Left) position or removing the key disables the high voltage power supply. This cancels the action of the High Voltage touchscreen button. When this keyswitch is in the ENABLED (Right) position, electrical power can be connected to the high voltage power supply by selecting the HIGH VOLTAGE button on the touchscreen.

Note: *The laser system uses two indicators to notify operators when High Voltage is ON: the amber light on top of the resonator flashes, and the color of the High Voltage 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 shutter will close and high 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 can be used for Z-axis beam alignment (to allow the shutter to open with cutting head removed), or to disable lens coolant in order to switch cutting heads.

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

- The laser shutter can only be opened by pressing the SHUTTER FLASH pushbutton while the Mirror Alignment dialog box is open. Lens Centering function is disabled.
- Program execution is DISABLED.

NOTE: *THE HIGH VOLTAGE INTERLOCK KEYSWITCH IS PRIMARILY INTENDED FOR USE BY PERSONNEL TRAINED BY CINCINNATI INCORPORATED.*

REMOTE STATION

FIGURE 6-4 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 set-up or maintenance. Refer to Figure 6-4.

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 and the shutter closes. 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 SHUTTER keyswitch and SHUTTER FLASH pushbutton on the Remote Station are enabled. The requirements and functions of these controls are described below.

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

SHUTTER FLASH pushbutton: This pushbutton is used to manually open the shutter and flash the laser beam for the Laser Shot procedure (See Section 7.) The shutter flash will only occur when the following conditions are met:

1. The SHUTTER keyswitch is in the "ENABLED" position, and High Voltage is ON.
2. The Lens Centering or Mirror Alignment window is open.
3. The Remote Station selector switch is turned to "STATION ENABLE".
4. The ARM SHUTTER selector switch is held in the clockwise position.
5. The SHUTTER FLASH button is pressed no later than 2 seconds after turning ARM SHUTTER.

If the above conditions are met, then the shutter will open and the beam will flash for the length of time specified in the Lens Centering or Mirror Alignment window ("Length of Flash"). Assist gas will be commanded to flow if specified in the Lens Centering or Mirror Alignment window. If the ARM SHUTTER selector switch or the SHUTTER FLASH button is released before the specified Length of Flash, then the shutter closes 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 SEE SUPPLEMENT MANUAL EM OR ONLINE HELP

FOR ADDITIONAL SETUP AND OPERATIONAL INFORMATION FOR THIS MACHINE, REFER TO EITHER THE ONLINE HELP INFORMATION THAT CAME WITH THE MACHINE SOFTWARE OR TO EM-, "*SECTION 7, OPERATION – A SUPPLEMENT TO THE OPERATION MANUAL FOR THE CINCINNATI CL-800 SERIES PC CONTROL*", INCLUDED WITH THIS MANUAL.

SECTION 7 OPERATION

FOR ADDITIONAL SETUP AND OPERATION INFORMATION FOR THIS MACHINE, REFER TO EITHER THE ONLINE HELP INFORMATION IN THE MACHINE SOFTWARE OR TO EM-544, “SECTION 7 OPERATION – A SUPPLEMENT TO THE OPERATION MANUAL FOR THE CL-800 LASER SYSTEM”, INCLUDED WITH THIS MANUAL.

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.

LOWER PALLET SPECIAL FUNCTION (LPSF)

In normal operation, the laser beam can only be on when the cutting nozzle is within 1.5 inches (38 mm) of the work support height on either pallet. The Lower Pallet Special Function allows the beam to be on when the nozzle is up to 7 inches (178 mm) above the work support height, but only when cutting on the lower pallet. The LPSF operating mode allows the machine to cut on flat horizontal surfaces of square tubing, rectangular tubing or other formed workpieces. The program selects or cancels the LPSF operating mode with M-codes. For programming instructions, see Programming Manual EM-423.

Most material intended for LPSF processing will not fit under the upper pallet. Therefore, LPSF mode temporarily disables pallet motion. Since the pallets cannot move, the operator can only reach material from one side of the machine. To accommodate this limitation, the LPSF mode uses a restricted Y-axis travel range, specified on the Y-axis page of the Configuration window.

When using LPSF mode, the user may need to provide fixtures to hold or locate the workpiece.

MODULAR MATERIAL HANDLING SYSTEM (MMHS)

This system enables fully automated sheet loading and unloading integrated with laser operation. A Sheet Handler separates the workpiece from a stack of material and loads it onto a Transporter. The Transporter delivers the workpiece to the laser pallet and moves finished nests to a storage location. Optional modules include a Bundle Handler for unloading raw material from a shipping pallet, tables for temporarily storing or loading/unloading material drawers, one or more Towers with Elevators for storing and retrieving material drawers, and a Transfer Cart to move material drawers between the Sheet Handler and the other modules. 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 multi-stage filtration and 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 and moisture separator at 110 to 125 PSI (760 to 860 kPa). Compressed air assist gas is suitable for cutting thin metals.

SECTION 9 MAINTENANCE AND ADJUSTMENTS

LUBRICATION REQUIREMENTS

DRIVES LUBRICATION

The X, Y and Z-axes have "extended lube interval" linear bearings. Re-lubrication is recommended every 6000 hours of operation. 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 4 truck bearings .

To access the manifolds shown in Figure 9-1, remove the metal cover on the side of the gantry. 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

CAUTION

Do not over-lube 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 280mm.
- 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, edit the parameters labeled "Time Elapsed Since Lube", "X-Axis Travel Since Lube" and "Y-Axis Travel Since Lube" to zero.

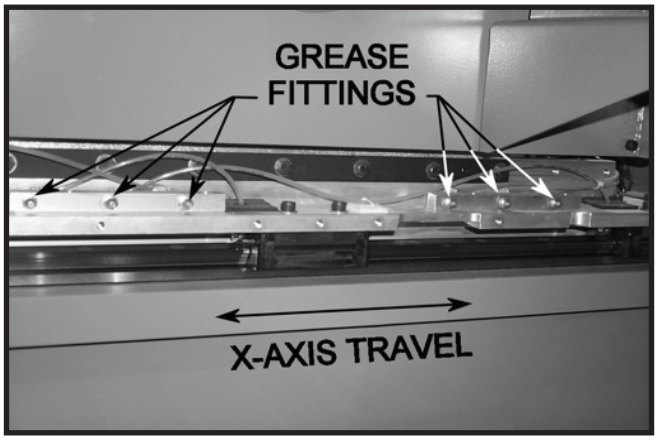


FIGURE 9-1:X-Axis Linear Bearing Grease Manifolds, Operator and Beam Side (Do not over-grease.)

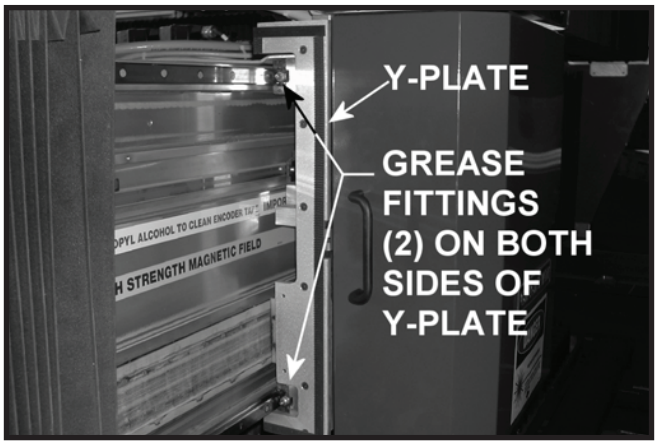


FIGURE 9-2: Y-Axis Linear Bearing Grease fittings (Do not over-grease.)

Z-AXIS LUBRICATION

The Z-Axis ballscrew require manual lubrication every 6000 hours of operation. Figure 9-3 shows the Z-axis ballscrew bearing lube point. Remove the ballscrew cover to provide access to the lube fittings.

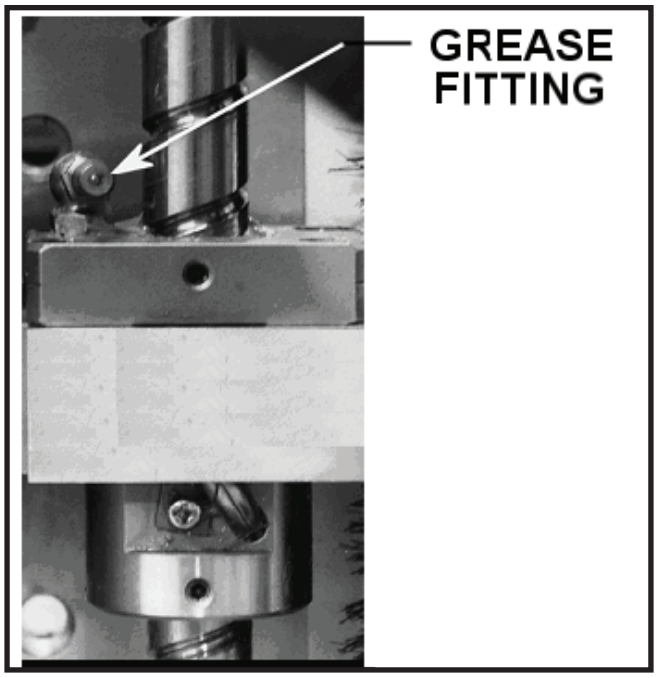


FIGURE 9-3 Ballscrew lube point

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.

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.

BEAM DELIVERY SYSTEM

Two compounds are used for maintaining the beam delivery system. One compound is a synthetic grease (C.I. #922230) that lubricates the bellows support surfaces. The other compound is a vacuum grease (C.I. #922433) that creates a particle trap in the X and Y-boxes. Both of these compounds have been selected because of their low outgas properties and evaporation rates.

The guide surfaces of the X and Y-axis beam bellows are pre-lubricated with a thin grease film. Check the grease film and reapply with a small sponge once a year, or more frequently if the bellows produce a squeaking sound. Use only C.I. #922230 for this procedure.

Clean the particle traps in the X and Y-boxes once a year and apply a fresh layer of vacuum grease. Use only C.I. #922433 for this procedure.

CAUTION

Compounds that are not approved by CINCINNATI INCORPORATED may chemically attack beam delivery components or outgas into the beam delivery cavity, resulting in poor cutting performance and reduced optic life.

MAGNETIC TRACK MAINTENANCE

! WARNING !

A VERY POWERFUL MAGNETIC FIELD SURROUNDS THE MAGNET TRACK. KEEP ALL FERROUS (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” (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 9-4):

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 load 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 "FIRE", for more information.

PALLET GUIDE RAILS

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

Remove dirt and debris from the entire length of the upper and lower rails on a regular basis. As a guideline, inspect the rails weekly and, if necessary, clean with a stiff brush and a non-flammable, nontoxic solvent. Stubborn deposits can be removed with an abrasive pad such as Scotch-Brite®, or in extreme cases with 240 grit wet-or-dry silicon carbide paper.

ENCODER MAINTENANCE

The laser system X and Y-axes have "open style" linear encoders covered by flexible bellows. The encoder scales require periodic inspection and cleaning to maintain reliable operation. The X-axis carriage has air purge jets directed at the encoder scale to help remove debris. To reduce purge air consumption, the air jets are only active when the machine axes move.

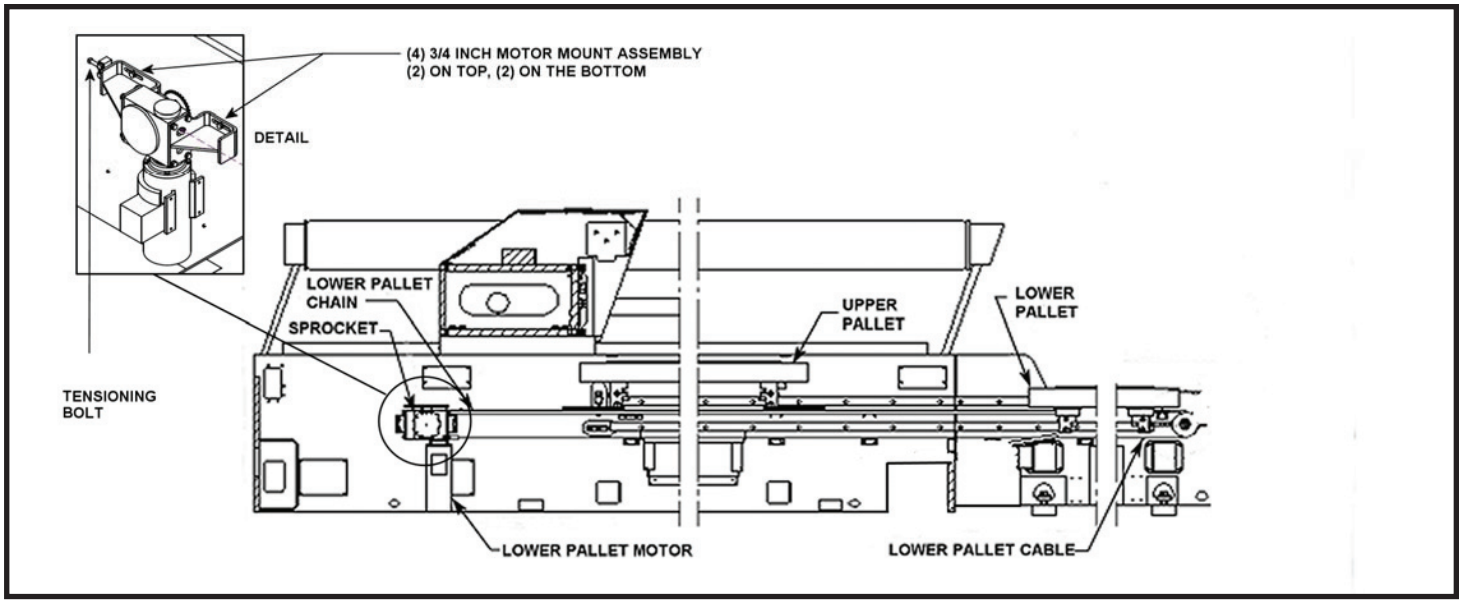


FIGURE 9-4 Adjusting Pallet Cable Tension

ENCODER CLEANING

The open construction allows access for cleaning the encoder scale. Clean the scale if axis motion is unstable, or if the X-Axis encoder signal strength indicator changes color from GREEN to RED. The encoder signal strength indicator is on the X-Axis Read Head shown in Figure 9-5.

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 poly 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.

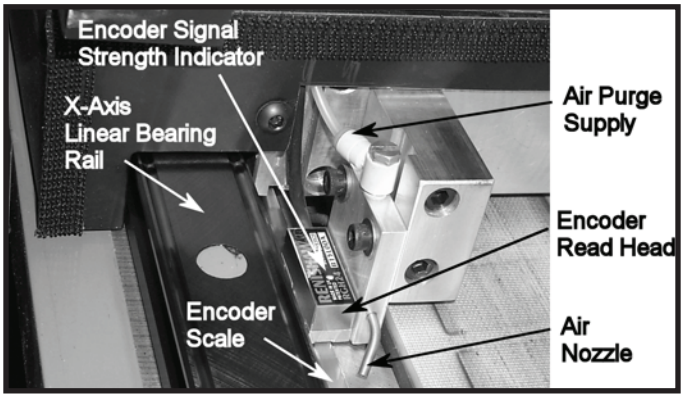


FIGURE 9-5 X-Axis Encoder Read Head with LED Signal Strength Indicator and Air Nozzle Scale Purge

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.*

The Y-axis scale surface is unprotected gold. Clean the Y-axis scale with a soft, dry, lint-free cloth. To remove stubborn contamination, lightly wet the cloth with Isopropyl alcohol or h-Heptane solvent.

Note: *Do not use aggressive mechanical cleaning techniques 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 & CLEANING

The beam bending mirrors and focusing lens are the most critical components in the external beam delivery system. The optical elements are made of materials that either reflect the laser beam (in the case of the mirrors) or transmit the laser beam (in the case of the focusing lens) 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 external beam delivery system is designed to protect the optics from most airborne industrial contaminants by enclosing the beam path in a positive pressure environment, which is continuously purged with inert gas (nitrogen or dry filtered air). To further extend the optics life, periodic cleaning is also required.

CLEANING SUPPLIES

- Isopropyl alcohol or 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
- Optical polishing compound (10 micrometer grit or smaller)
- 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 and alcohol.

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.*

4. Each mirror (beam bender or collimator mirror) is held in its mount by a mirror cap fastened with four shoulder 3/32" hex screws and springs. See Figure 9-6. There are three 1/8" hex screws and springs that hold the mirror mount in place.

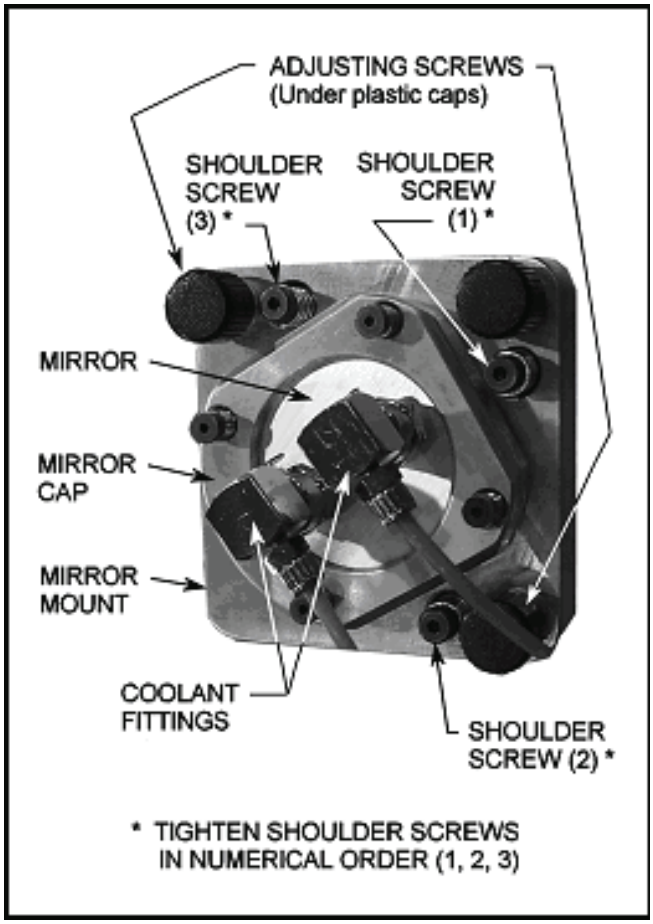


FIGURE 9-6 Mirror mount assembly

LENS INSTALLATION AND REMOVAL

1. The focus lens is in a drawer in the cutting head assembly (see Figure 9-25). 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 from the lens holder, remove the threaded lock ring using the tool provided (C.I. #907525). 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 re-install it before re-installing the lens.

   To replace the lens 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.

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 your 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 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.

CAUTION

DO NOT pour solvent onto the lens while it is in the lens holder. Some of the solvent 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 solvent. 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 solvent and gently drag it across the surface so the solvent just evaporates behind the tissue. Repeat with a clean tissue after each pass until the lens is clean.

4. If contaminants are still visible, use the alternative solvent (acetone or alcohol) and 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 alcohol or 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.

MIRROR COOLING

Each mirror in the laser system is cooled by flowing liquid coolant through the back of the mirror. The coolant tube fittings are dual shutoff quick disconnect type, to prevent excess leakage when disconnecting the tubing from the mirror. See Figure 9-6.

CAUTION

Access to optics should be restricted to trained personnel. See "OPTICS HANDLING AND CLEANING" in this section.

MIRROR INSTALLATION AND REMOVAL

To remove a mirror for beam alignment, cleaning or replacement, follow this procedure:

1. Be sure the shutter is closed and the high voltage is OFF. If removing the X-Moving Mirror or Y-Moving Mirror (see Figure 9-12), use the Remote Station to maintain control of machine motion, or turn the DRIVES keyswitch to the LOCK/OFF position and remove the key.

2. Disconnect the coolant lines at the quick-disconnect couplings.

3. Remove the four spring-loaded 3/32” socket head shoulder screws and remove the mirror assembly. Lift the mirror cap off so the mirror stays in the mount.
4. Gently remove the mirror from the mount. Do not turn the mirror adjusting screws (1/8” hex socket).
5. If replacing a mirror, remove the fittings from the back of the old mirror and install them on the new mirror.
6. To re-install the mirror, reverse the process.

MIRROR CLEANING

Perform only as many steps of this procedure as are required to get the mirror (reflective optic) clean.

1. Use an air bulb or clean, dry, filtered air to blow away any loose particles on the surface of the optic. Do not breathe on the optic to remove loose particles. The moisture in your breath may damage the optic.

2. Gently wipe the optic with a cotton swab moistened with solvent. Roll the cotton swab as you wipe so particles on the optic are picked up rather than dragged across the optic surface. Use a new swab after every one or two wipes.

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

3. If contaminants are still visible, use the alternative solvent (acetone or alcohol) and repeat Step 2.

4. If contaminants are still visible, clean the optic 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 2 using alcohol or acetone to remove acetic acid residue. If any acetic acid residue is allowed to dry on the optic, repeat this step to remove it. Acetic acid will damage the optic coating if not removed.

5. If the previous steps do not clean the optic, use optical polishing compound. Dampen a cotton ball with polishing compound and gently wipe the surface. Do not rub hard.

   After polishing, repeat Step 2 using alcohol or acetone to remove polishing compound residue.

6. If the above steps do not satisfactorily clean the optic, 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 ballscrew 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 ballscrew shaft again.

4. Make sure the upper and lower ballscrew support bearings are free of debris. Clean if necessary with lint-free cloth or brush

5. Apply (4) drops of Mobil Vactra #4 oil (CI P.N. 913071) or equivalent (ISO viscosity grade 220) directly into the top of the ballnut. Also add one drop to the ballscrew shaft on either side of the ballscrew.

6. Inspect supports bearings for lubrication. If dry apply (2) drops of oil (same type as step 6)

7. Re-install the head side cover.

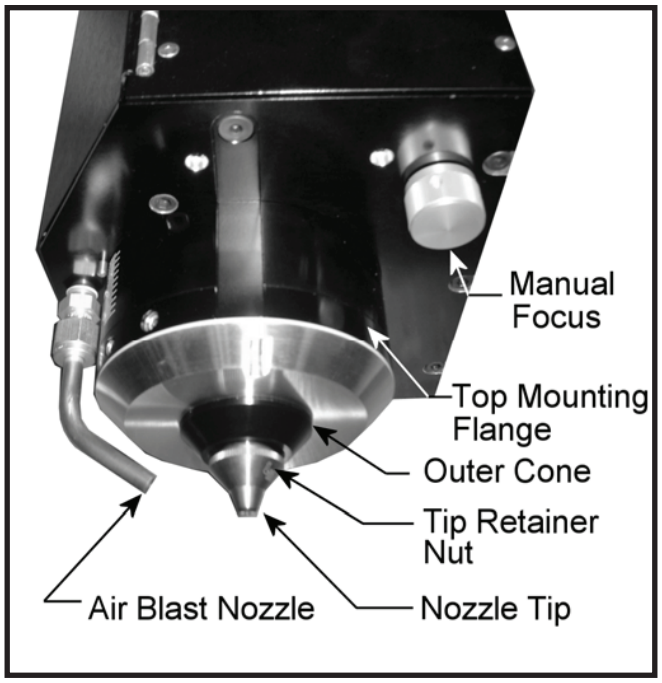


FIGURE 9-7 Auto Focus Lower Tip

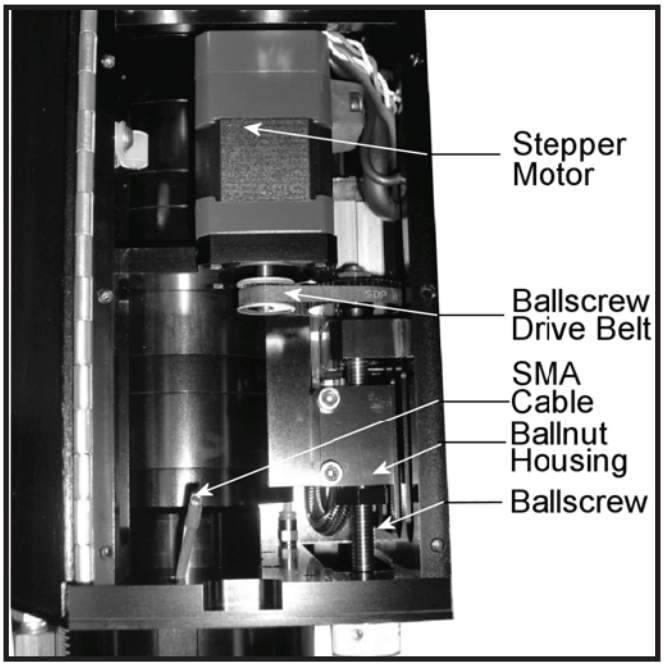


FIGURE 9-8 Auto Focus Drive Mechanism

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 drive LED is in the gantry enclosure on the side of the main frame.

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.*

BEAM BELLOWS ATTACHMENT

PURPOSE

The beam delivery and optics are protected from the shop environment with protective bellows. The bellows are kept at a slightly positive pressure with a purge gas to help prevent contamination of the beam delivery system.

Proper fastening of the X and Y-axes beam bellows is important for maintaining a clean, dry atmosphere within the beam delivery system. The X and Y-axes beam bellows are attached with screws and sealed with rubber gaskets, except for the X-axis beam bellows attachment to the X-box.

! WARNING !

SET THE DRIVES KEYSWITCH ON THE MACHINE OPERATOR PANEL TO THE "LOCK/OFF" POSITION AND REMOVE THE KEY TO PREVENT UNINTENDED MOTION DURING THIS PROCEDURE.

The X-box beam bellows are attached to the X-box with four latches. Closed-cell sponge gaskets attached to the X-box seal out contamination. Refer to Figure 9-9. To open bellows, pull and lift the latches from their keeper plates. To reinstall the X-axis beam bellows, slide the bellows against the X-box and re-engage the latches. Push the bellows flange toward the gantry end panel and against the X-box spacers. This will ensure the bellows are centered on the beam tube.

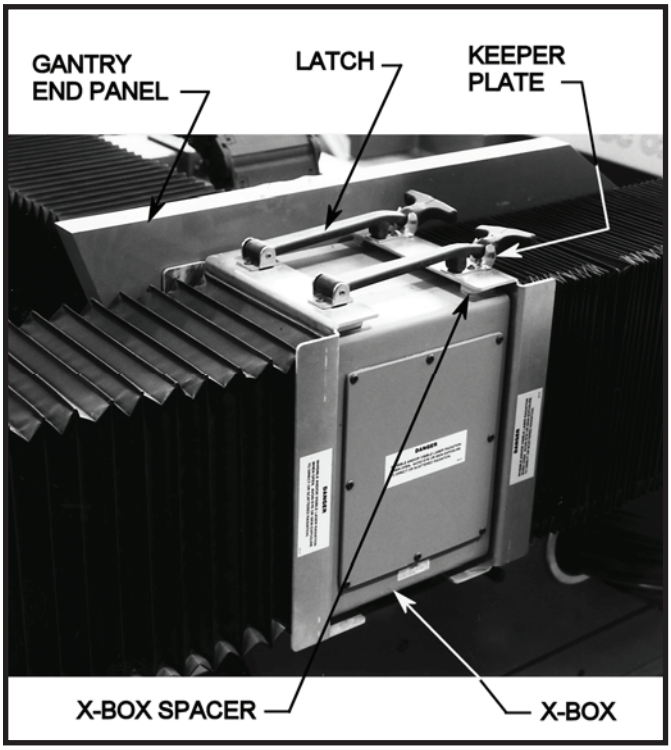


FIGURE 9-9 Bellows X-box attachment

BEAM DELIVERY ALIGNMENT

PURPOSE

The laser produces an invisible beam of light, which exits the laser and travels in a straight line path if not influenced by any other optics. The purpose of beam delivery alignment is to make the beam path coincide with the X, Y and Z motions of the machine in all planes. The alignment must be done so the laser beam is nearly centered on each optic in the system and never "clips" or strikes any other component inside the beam enclosure.

Figure 9-10 illustrates the process of aligning the beam with axis motion. Steering adjustments make the beam parallel with the axis motion, even if the beam is not centered in the target. After the beam is parallel with the axis motion, positioning adjustments center the beam in the target.

WHEN ALIGNMENT IS REQUIRED

The beam delivery system must be aligned after either of the following procedures:

1. Cleaning or adjusting the internal optics of the laser resonator. The pointing direction of the beam can change.

2. Removing an optical element of the beam delivery system (beam bender or collimator mirror) for cleaning or replacement. In this case, an alignment check must be made at the removed optic and all downstream elements in the system. For example, if the moving X-mirror is removed, the incoming beam alignment should be verified at the near-field and far-field positions of the gantry before replacing the mirror. Then, alignment of the beam into the downstream components (moving Y-mirror and focusing lens) must be verified and adjusted if necessary.

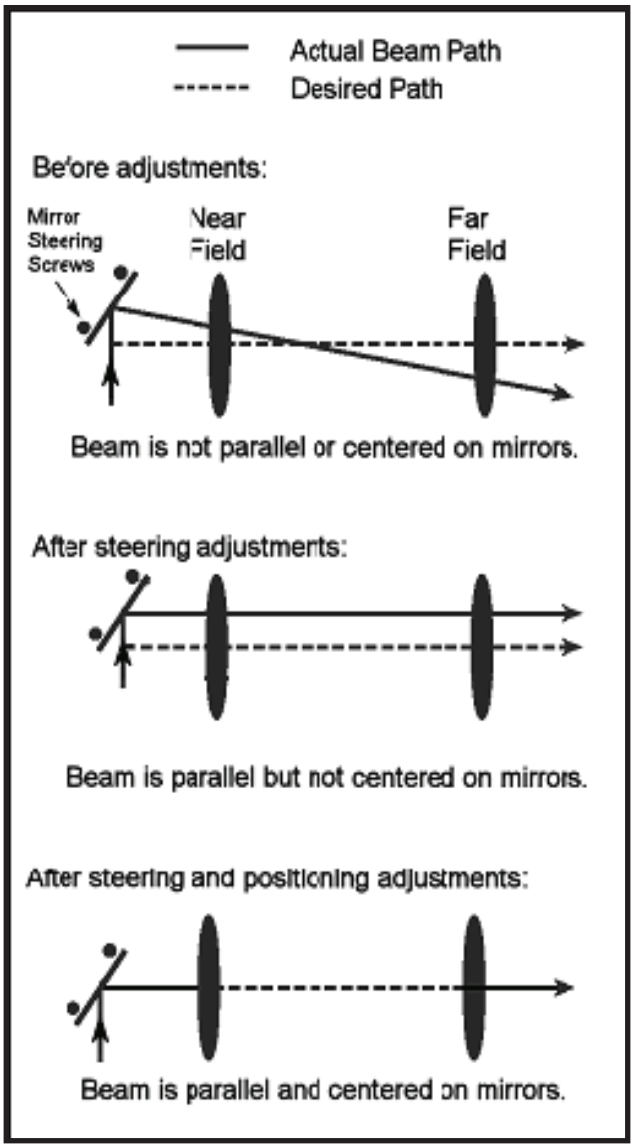


FIGURE 9-10 Laser beam alignment

! WARNING !

THE ALIGNMENT PROCEDURE IS TO BE PERFORMED ONLY BY CINCINNATI TRAINED SERVICE PERSONNEL. DO NOT ATTEMPT TO ALIGN THE BEAM DELIVERY SYSTEM WITHOUT PRIOR TRAINING, PROPER TOOLS, AND HAVING READ AND UNDERSTOOD THIS PROCEDURE. FAILURE TO COMPLY WITH THIS WARNING COULD RESULT IN SERIOUS INJURY OR DEATH TO YOU OR OTHERS.

TOOLS REQUIRED

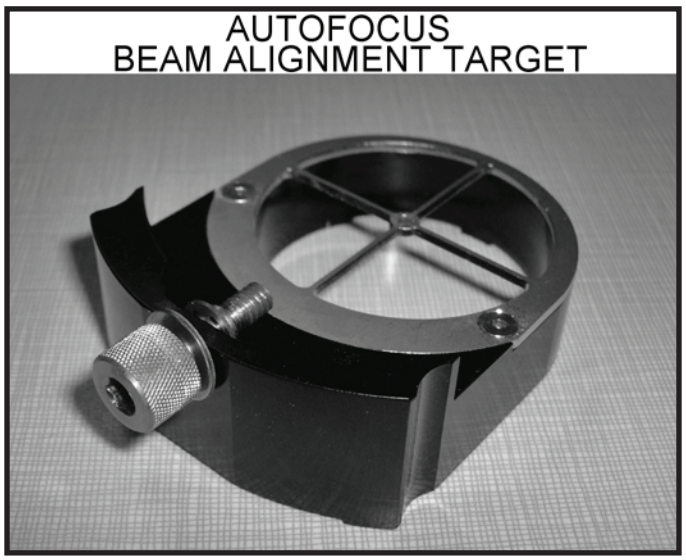


FIGURE 9-11 Alignment fixture

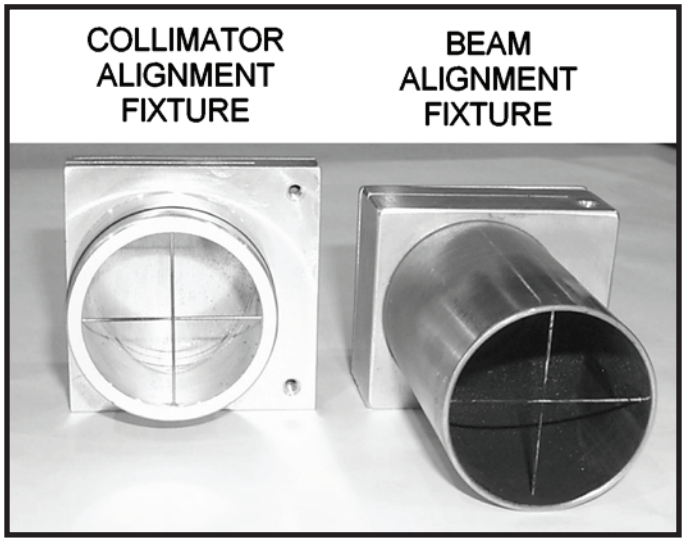


FIGURE 9-11a Alignment fixtures

In addition to common hand tools, a special alignment fixture is required to align the beam at each mirror. Another target is used in the auto focus cutting head, for Z-axis and final four corner shots. The alignment fixture for the beam bender mirrors (see Figure 9-11a) consists of a tube containing a pair of cross hairs and an attachment for safely holding the target card. A similar alignment fixture is used for the collimator mirrors. The collimator alignment fixture is shorter than the beam bender alignment fixture. Thermal transfer paper (C.I. #923025) is recommended as the "target"

CARD SHOT

! ! DANGER ! !

KEEP HANDS CLEAR OF THE LASER BEAM PATH.

The heart of this procedure is the "card shot" which is a special case of the "laser shot" described in SECTION 7 "CALIBRATION AND ALIGNMENT PROCEDURES-LASER SHOT". For a card shot, the laser beam passes through one of the alignment fixtures (see Figure 9-11a, b) and leaves an impression on the target card indicating the beam position relative to the alignment fixture. When taking a card shot, it may be necessary to adjust the power level, duty cycle and/or the shutter flash timer to get a clear impression of the beam and cross hairs in the card. These adjustments are described in SECTION 7 "CALIBRATION AND ALIGNMENT PROCEDURES -LASER SHOT".

COMPLETE SYSTEM ALIGNMENT

A complete system alignment includes alignment of the laser beam relative to the first external mirror, the second external mirror, the collimator mirrors, the X-axis motion, the Y-axis motion and the Z-axis motion. See Figure 9-12.

The alignment procedure begins by removing the first external mirror and checking the position of the beam in the mirror mount. The vertical position is adjusted by raising or lowering the resonator cabinet (see Figure 9-15). The horizontal position is adjusted by moving the base of the collimator support.

When the laser beam is centered in the first mirror mount, the mirror is installed and the alignment procedure continues by steering the laser beam through the second external mirror and then through the first collimator mirror. The objective of those steering adjustments is to center the beam on the second collimator mirror. Since none of those mirrors move with a machine axis, no positioning adjustments are required. The next step of the alignment procedure is to align the beam with the X-axis motion, by steering the second Collimator mirror and positioning the X-Moving mirror. The procedure continues by steering the X-Moving mirror and positioning the X and Y-Moving mirrors to align the beam with the Y-axis motion. In the final step, the beam is aligned with the Z-axis motion by steering the Y-Moving mirror.

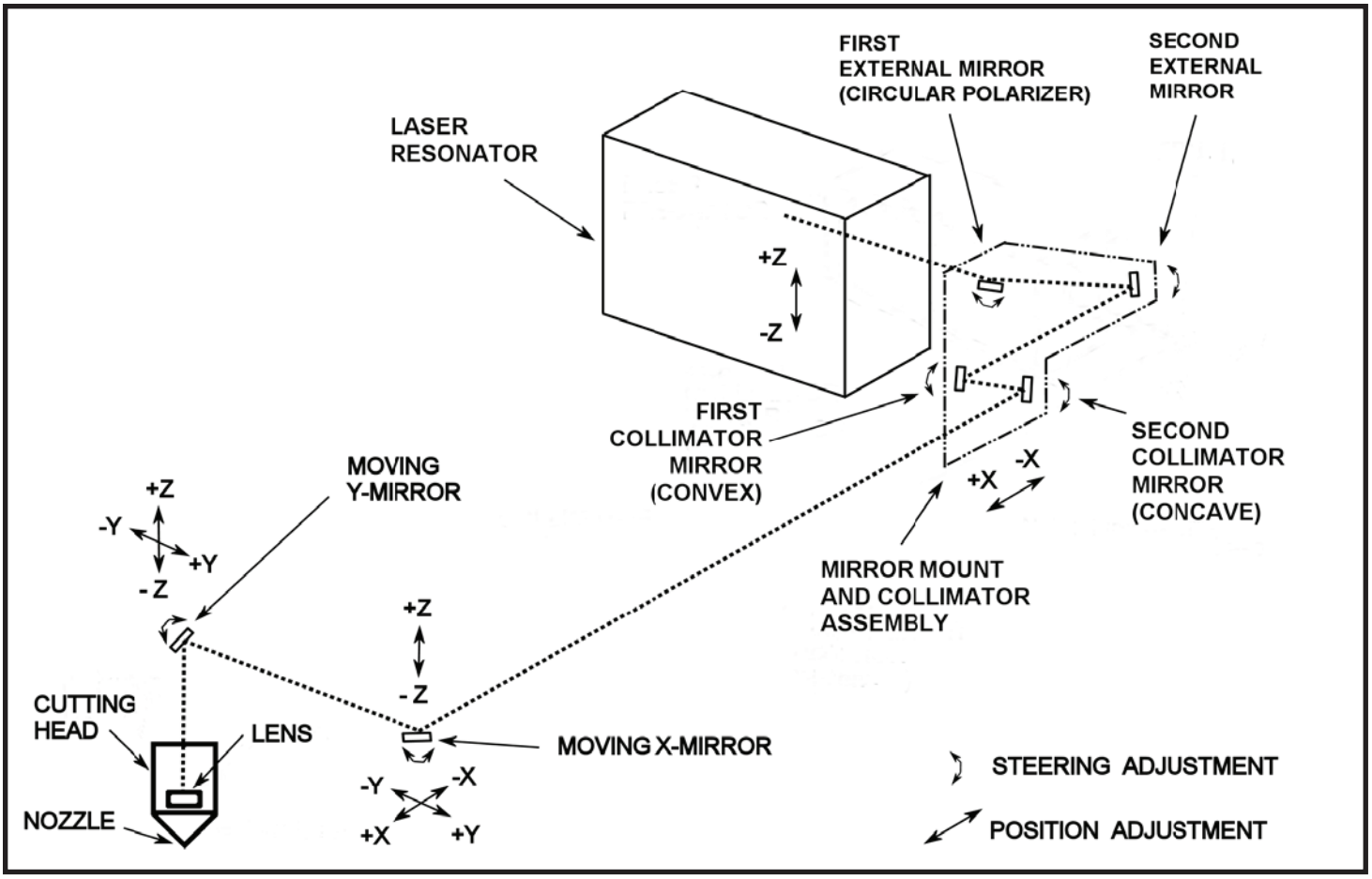


FIGURE 9-12 Laser beam delivery system (4000 and 5000 Fanuc shown)

In the following procedure, two types of adjustments are made to the mirrors - steering adjustments and position adjustments. Steering adjustments are made by turning the adjusting screws in the mirror mount. See Figure 9-6. These adjustments require the use of a 1/8" hex socket key.

Note: *The clearance between the mirror mount and housing should be set to roughly .100" (2.5 mm) before beginning the alignment process. The center (pivot) adjusting screw should only be adjusted to set this clearance.*

Position adjustments are made by sliding the mirror mount assembly (See Figure 9-13) or sliding the mirror housing in a dovetail support (See Figure 9-20).

The first and second external mirrors are mounted to the same structure as the collimator. The combined assembly is adjusted in the X-axis direction using setscrews located where the structure mounts to the resonator base. See Figure 9-13.

To slide the moving X or Y-axis mirror housing, loosen the locknuts and set-screws that lock the dovetail in position. Turn the set-screws using a 3/32" hex socket key. When the mirror housing has been repositioned, retighten the set-screws and the locknuts.

When a mirror mount position is changed, the steering might also change due to slight rotation of the housing. To minimize undesired steering changes, tighten the set-screws to lock the slide in the following sequence:

1. Tighten the center setscrew.
2. Tighten the two remaining setscrews together by alternately tightening each a small amount.

If a position adjustment is made to an optic for which the steering adjustment is already complete, then that steering adjustment must be rechecked.

Each time a mirror mount assembly is re-installed, tap the mount gently to ensure that the three adjusting screws seat firmly in the matching hard points of the mirror housing. See Figure 9-6. Hard points must have a light coating of grease (C.I. #922230). Check the steering adjustment of the mirror after tapping on the mount.

RESONATOR WARM-UP

Before starting the beam alignment procedure, warm-up the resonator to simulate operating conditions. To warm-up the resonator, open "Maintenance/Mirror Alignment" window and select "Beam On" checkbox. Edit the Warm-Up Settings to use the "Guaranteed Power" of the resonator (See Section 4) at 100% duty cycle and 2000 Hz. Enable the remote pendant and Press Cycle Start to begin the warm-up process, wait 5 minutes, and then continue with the beam alignment procedure.

When configured for Mirror Alignment with "Beam On", the laser operates at the Warm-up settings before and after each card shot. The laser uses the Flash Settings during a card shot. The flash settings: use "Guaranteed Power, 50 Hz, 0.020 seconds for shutter flash. Start with 2% duty cycle and increase until beam shot is visible without creating ash.

FIRST EXTERNAL MIRROR ALIGNMENT

If the laser internal optics have been adjusted or replaced, a complete system alignment must start by centering the beam on the first external mirror.

1. Remove and inspect the first external mirror assembly (mirror cap, mirror and mirror mount). See Figure 9-13. Clean if necessary.

   This assembly should be removed as a single unit. Using a 1/8" hex key, remove the three shoulder screws that hold the mirror mount on the housing. Do not turn any of the three mirror adjusting screws.

2. Insert the alignment fixture in the mirror housing and insert the target card. See Figure 9-14.

3. **Be absolutely sure that no one, including yourself, is in the beam path.**

4. Take the card shot as described in "SECTION7, CALIBRATION AND ALIGNMENT PROCEDURES-LASER SHOT".

5. Remove the target card from the fixture and inspect the cross hair impression. If the resonator and the first external mirror are properly aligned, the round burn should be centered on the cross hair impression within ±.020" (.5 mm). If the round burn is not centered vertically, adjust the laser resonator to raise or lower the beam. If the cross hair impression is not centered horizontally, adjust the first external mirror position by moving the collimator support assembly.

Horizontal Adjustment - To move the first external mirror housing along the X axis, loosen the bolts that fasten the collimator support assembly to the machine frame, and then adjust the setscrews to slide the collimator support assembly. See Figure 9-13. Adjust the setscrews at both ends of the base.

Vertical Adjustment – Before making any vertical adjustments of the laser resonator, shut the laser down and turn off the main disconnect as described in SECTION 7 – "START-UP AND SHUTDOWN". Next, the four mounting bolts and jam nuts must be loosened.

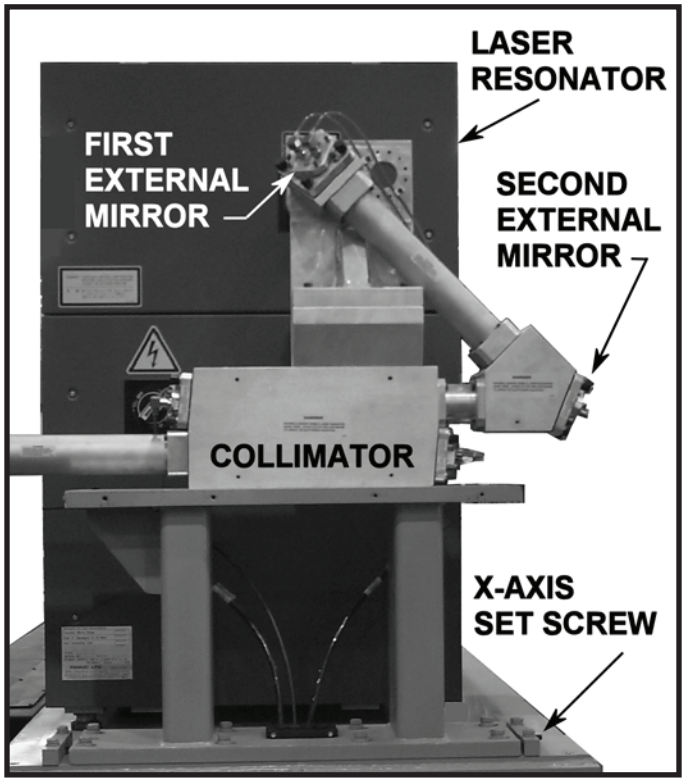


FIGURE 9-13 Mirror mount and Collimator assembly

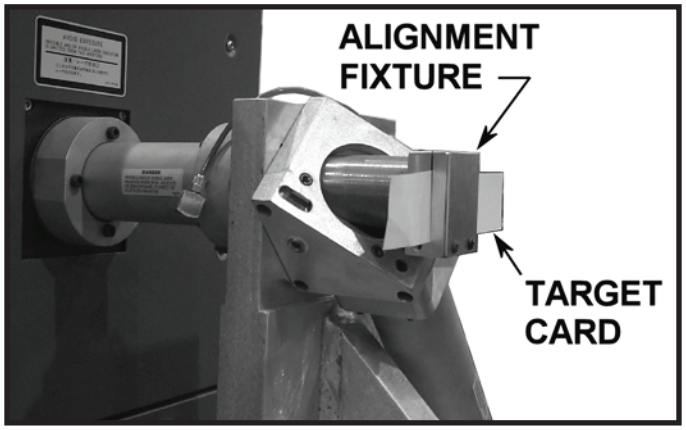


FIGURE 9-14 First external mirror alignment

Note: *If vertical adjustment is not necessary, then do not loosen the resonator mounting bolts or jam nuts.*

The mounting bolts are accessed near high voltage power inside the electrical compartment below the laser resonator.

! ! DANGER ! !

WORKING IN THE AREA OF HIGH VOLTAGE INSIDE THE ELECTRICAL COMPARTMENT COULD LEAD TO ELECTROCUTION, RESULTING IN YOUR DEATH. DO NOT ENTER THE ELECTRICAL COMPARTMENT WITH POWER ON. SHUTDOWN THE LASER AND OPEN THE MAIN DISCONNECT BEFORE OPENING ANY ACCESS PANELS.

To adjust the laser resonator vertically, use the four jackscrews (one at each corner). See Figure 9-15. Each jackscrew is locked in place by a large jam nut. Loosen each mounting bolt and jam nut several turns to allow sufficient room for vertical adjustment. Do not retighten the bolts or jam nuts until Step 7.

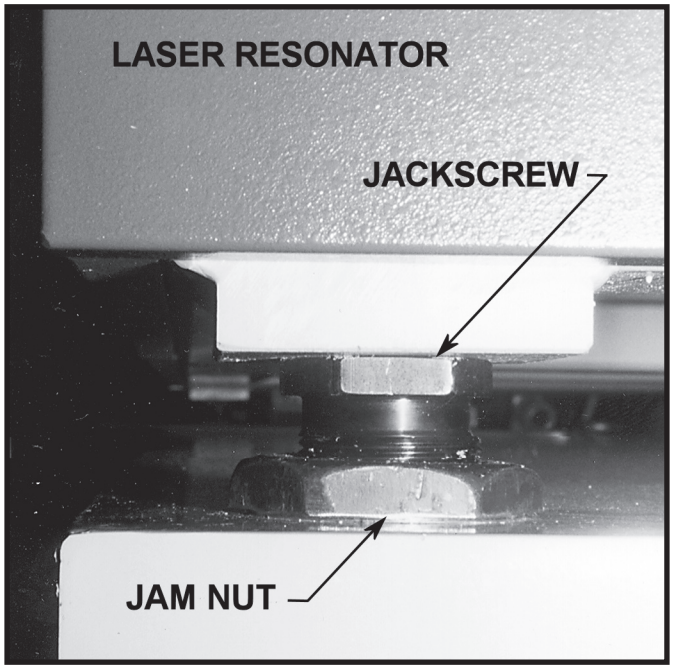


FIGURE 9-15 Laser resonator adjustment

6. Repeat Steps 4 and 5 as many times as necessary to center the round burn with the cross hair impression on the target card. If horizontal adjustments were made, tighten the bolts to fasten the collimator support to the frame, and then take another card shot to verify alignment did not change. If the resonator mounting bolts and jam nuts have not been loosened, proceed to Step 8.
7. Shut down the machine and turn off the main disconnect as described in SECTION 7 – "START-UP AND SHUTDOWN". Retighten the mounting bolts and jam nuts locking the jackscrews (Figure 9-15). Start the laser and take one more card shot to verify alignment of the laser resonator.
8. Label the last target card "1EX" and keep for reference. Re-install the first external mirror assembly. Tighten the mirror mount shoulder screws in numerical sequence as shown in Figure 9-6.

SECOND EXTERNAL MIRROR ALIGNMENT

This alignment procedure consists of adjusting the first mirror to center the beam in the housing for the second mirror.

1. After centering the laser beam in the first mirror housing (and re-installing the first mirror), remove and inspect the second mirror. Clean the mirror if necessary.
2. Remove the second mirror mount.
3. Install the alignment fixture in the second mirror housing and insert a target card (See Figure 9-16).
4. **Be absolutely sure that no one, including yourself, is in the beam path.**
5. Take the card shot as described in SECTION 7, "Calibration and Adjustment Procedures-Laser Shot".

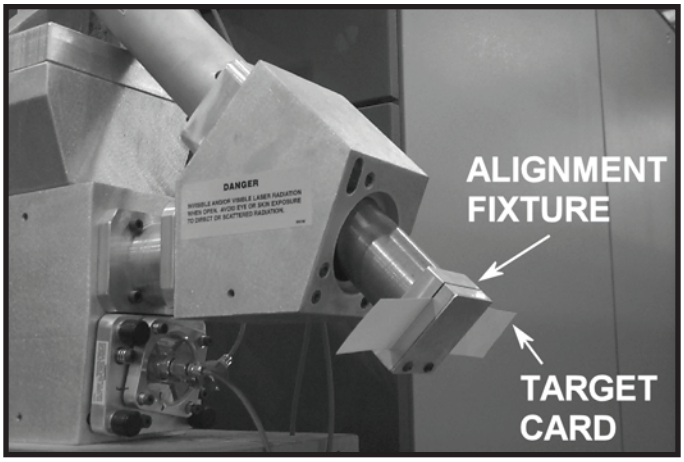


FIGURE 9-16 Second external mirror alignment

6. Remove the target card from the fixture and inspect the cross hair impression. The round burn should be centered on the cross hair impression within ±.020" (.5 mm). If the round burn is not centered, make steering adjustments with the first mirror to move the beam. Remove the plastic caps and use the three adjusting screws (see Figure 9-6).

7. Make small adjustments and repeat Steps 4 through 6 after each adjustment. Repeat as many times as necessary to center the round burn on the cross hair impression. Label the final card “2EX” and keep for reference. Replace the plastic caps on the first mirror adjusting screws.

8. Remove the alignment fixture and re-install the second mirror. Tighten the mirror mount shoulder screws in numerical sequence as shown in Figure 9-6.

COLLIMATOR BEAM ALIGNMENT

The purpose of this alignment is to steer the laser beam through the centers of the two collimator mirrors.

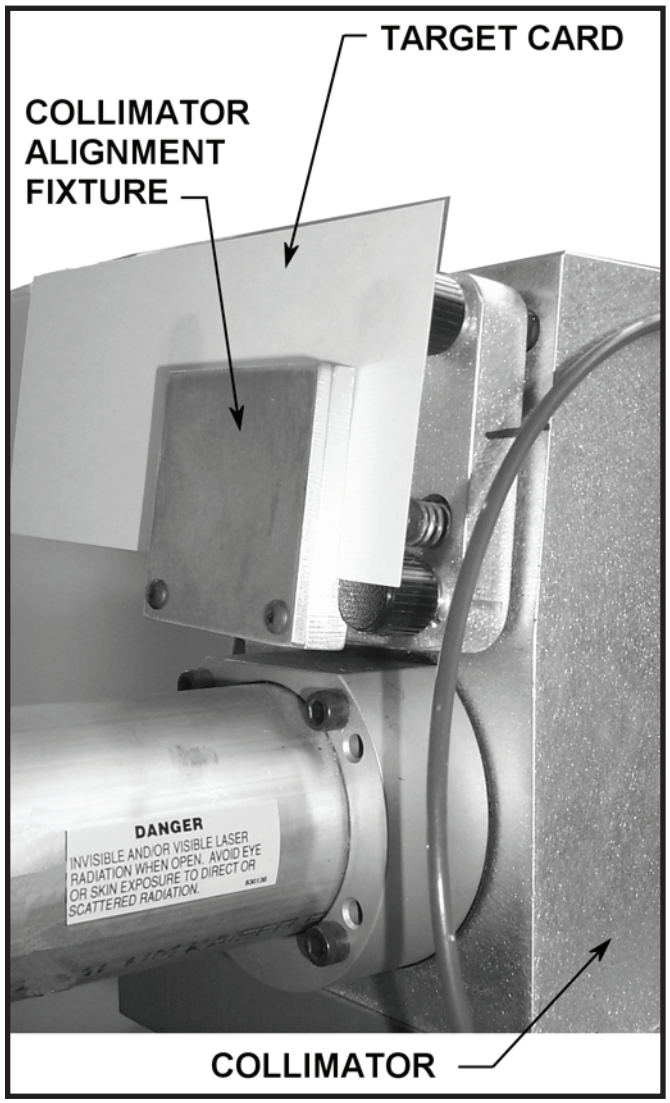


FIGURE 9-17 First collimator mirror alignment

1. Using a 3/32” hex key, remove the mirror retainer and mirror of the first collimator mirror assembly. See Figure 9-6. Note that the mirror mount is not removed from the collimator housing as is done for the beam bender mirrors.

2. Insert the collimator alignment fixture in the mirror mount completely and insert a target card. See Figure 9-17.

3. **Be absolutely sure that no one, including yourself, is in the beam path.**

4. Take the card shot.

5. Remove target card from the fixture and inspect the cross hair impression. If the previous mirror is aimed properly, the round burn will be centered on the cross hair impression within ±.020” (.5 mm). If the round burn is not centered, make steering adjustments to the second external mirror to move the beam.

6. Make small adjustments and repeat Steps 3 through 5 after each adjustment. Repeat as many times as necessary to center the round burn on the cross hair impression. Label the final card “1C” and keep for reference.

7. Re-install the mirror cap and mirror of the first collimator mirror assembly.

8. Repeat Steps 1 through 7 with the alignment fixture in the second collimator mirror mount (See Figure 9-18). Make steering adjustments to the first collimator mirror. Label the final card “2C” and keep for reference.

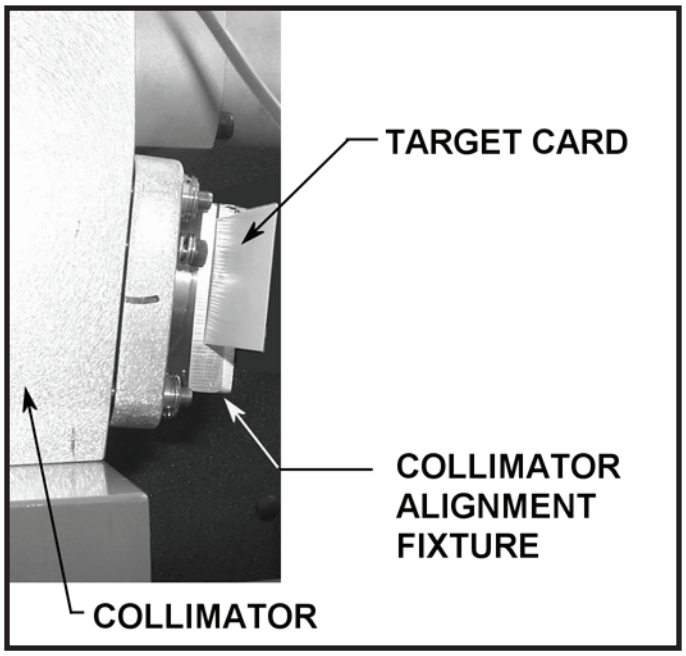


FIGURE 9-18 Second collimator mirror alignment

X-AXIS BEAM ALIGNMENT

The purpose of this alignment is to steer the laser beam parallel to the X-motion of the machine and to center the beam in the moving X-mirror. See Figure 9-15. Steering is done by adjusting the second collimator mirror. Centering is done by position adjustments of the moving X-mirror in the Y or Z-direction.

Necessary adjustments are determined by taking card shots in the moving X-mirror housing when the gantry is at the X-near (closest to the laser resonator) and the X-far (farthest from the laser resonator) positions.

1. Move the gantry to the X-near position (resonator end).

   Remove the external access cover for the moving X-mirror. See Figure 9-19.

2. Remove the near-field beam tube access panel for the moving X-mirror. See Figure 9-19. This cover is accessible by "pulling back" the X-axis beam bellows. Refer to "BEAM BELLOWS ATTACHMENT" in this section.

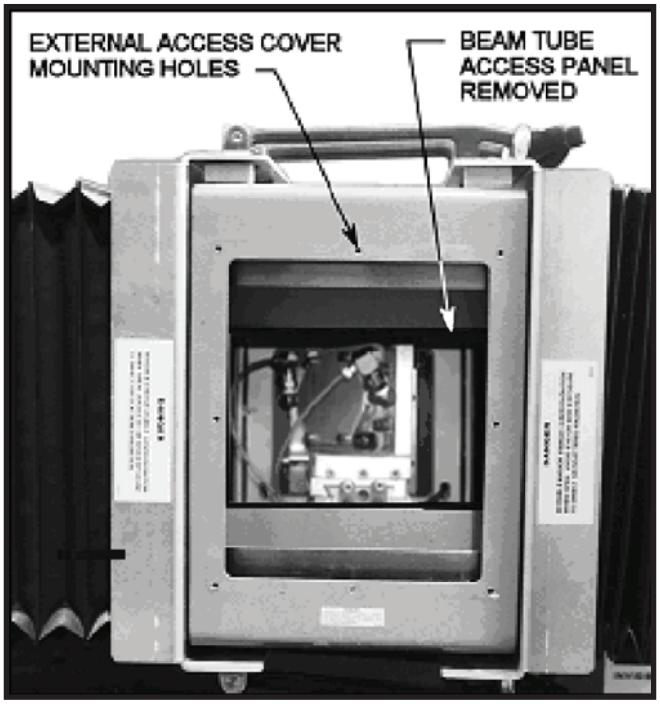


FIGURE 9-19 Moving X-mirror access

3. Remove the moving X-mirror assembly (retainer, mirror and mount). Remove this assembly as a single unit. Using a 1/8" hex key, remove the three shoulder screws that hold the mirror mount on the mirror housing. Do not turn any of the three adjusting screws.

4. Insert the alignment fixture and target card in the moving X-mirror housing. See Figure 9-20.

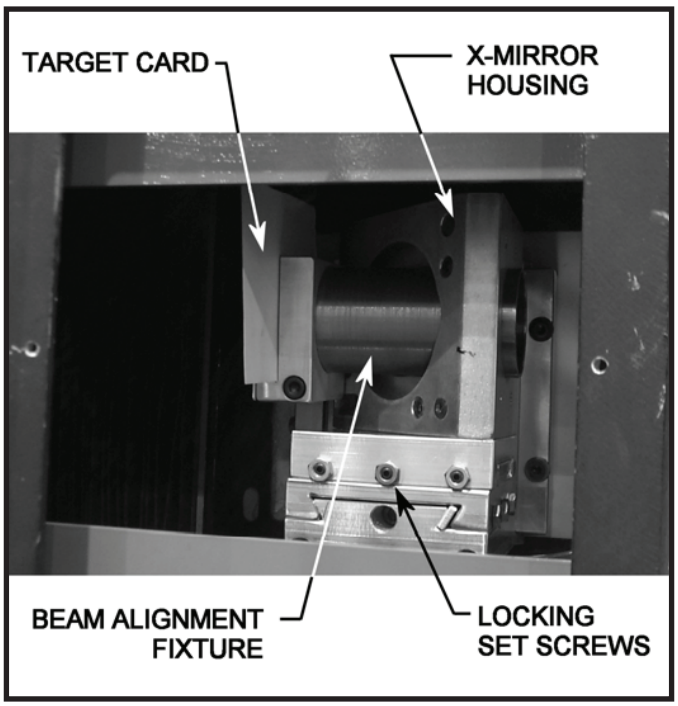


FIGURE 9-20 X-Axis alignment

5. **Be absolutely sure that no one, including yourself, is in the beam path.**

6. Take the card shot and label the cross hair impression "MX-NEAR".

7. Jog the gantry to the X-far position and remove the aluminum panel from the safety enclosure. Then remove the X-far beam tube access panel for the moving X-mirror.

8. Take another card shot and label the cross hair impression "MX-FAR".

9. Compare the two cross hair impressions. If the two card shots do not indicate the same beam position within ±.020" (.5 mm), make steering adjustments to the second collimator mirror.

10. Repeat the two card shots and the adjustments of Step 9 until the two cross hair impressions indicate the same beam position.If the impressions are the same, but the round burn is off-center more than .020" (.5 mm), adjust the position of the moving X-mirror housing to move the cross hairs in the appropriate direction.

11. Repeat the two card shots and the adjustments of Step 11 until both card shots are centered. Keep a single card with the final MX-NEAR and MX-FAR impressions for reference.

12. When the X-axis alignment is complete, re-install the moving X-mirror assembly. Tighten the mirror mount shoulder screws shown in Figure 9-6 in numerical sequence.

    Note: *The X-mirror assembly may be rotated relative to the orientation of Figure 9-6.*

Y-AXIS BEAM ALIGNMENT

The purpose of this alignment is to steer the laser beam parallel to the Y-axis machine motion and to center the beam in the moving Y-mirror. See Figure 9-12. Steering is done by adjusting the moving X-mirror. Centering is done by position adjustments of the moving X-mirror in the X-direction and the moving Y-mirror in the Z-direction.

1. Move the cutting head to the Y-near position (close to the X axis beam tube).

2. Remove the front gantry cover. See Figure 9-24.

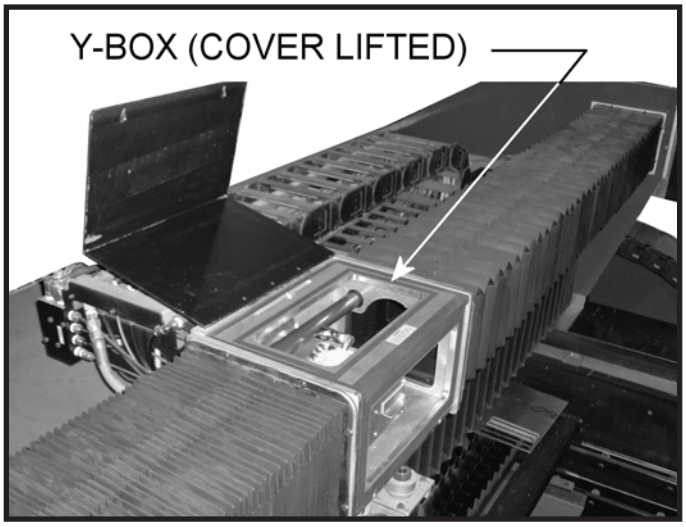


FIGURE 9-21 Gantry cover removed to access moving Y-mirror

3. Remove the Y-box top cover and mirror assembly (cap, mirror and mount).

4. Insert the alignment fixture and target card in the mirror housing. See Figure 9-22.

5. **Be absolutely sure that no one, including yourself, is in the beam path.**

6. Take the card shot and label the cross hair impression "MY-NEAR".

7. Push the cutting head to the Y-far position.

8. Take another card shot and label the cross hair impression "MY-FAR".

9. Compare the two cross hair impressions. If the two card shots do not indicate the same beam position within ±.020" (.5 mm), make steering adjustments to the moving X-mirror.

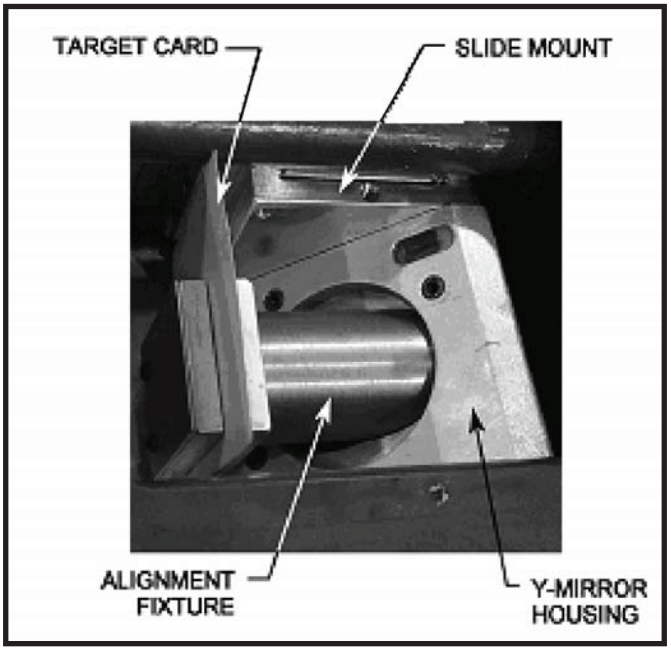


FIGURE 9-22 Y-Axis mirror alignment top view

10. Repeat the two card shots and the adjustments of Step 9 until the two cross hair impressions indicate the same beam position.

11. If the impressions are the same but the round burn is off-center more than .020" (.5 mm), position adjustments must be made. To move the beam horizontally, adjust the position of the moving X-mirror the in the X-direction. To move the cross hairs vertically, adjust the position of the moving Y-mirror in the Z-direction. An adjustment screw is provided on the bottom of the Y-mirror slide mount.

    To make the vertical adjustment, Adjust the slide vertically by turning the adjusting 3/16 " hex located through the access hole labeled Y-mirror vertical adjustment in Figure 9-24.

12. Repeat the Y-near and Y-far card shots and the adjustments of Step 11 until both card shots are centered.

    Keep a single card with the final MY-NEAR and MY-FAR impressions for reference.

13. Replace the Y-axis mirror assembly (cap, mirror and mount). Tighten the mirror mount shoulder screws in numerical sequence as shown in Figure 9-6.

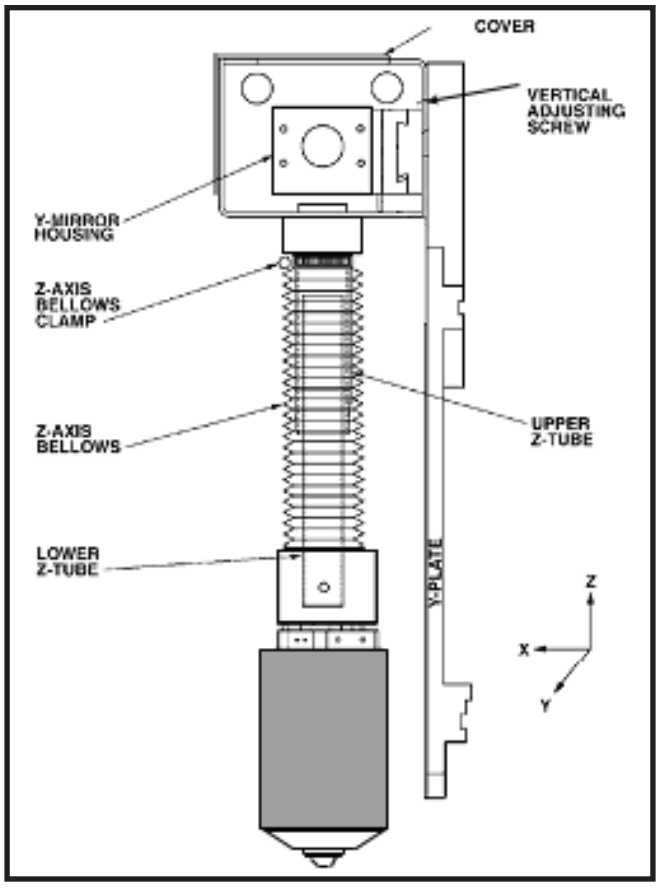


FIGURE 9-23 Z-Axis side view

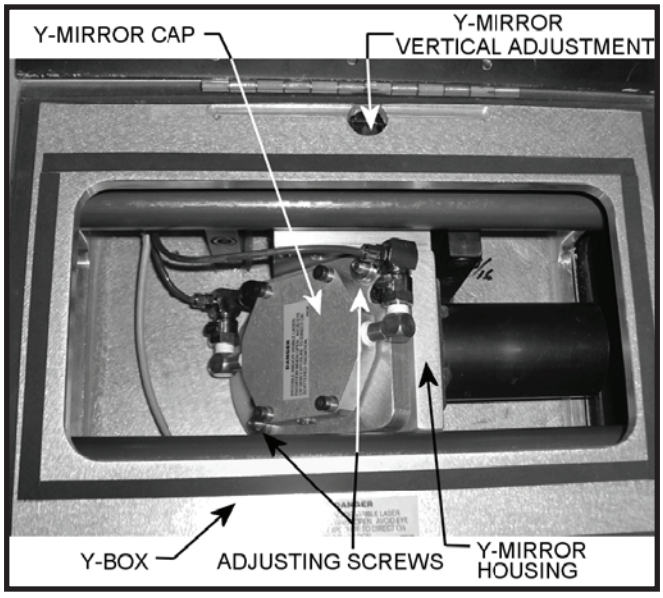


FIGURE 9-24 Y-Axis mirror top view

Z-AXIS ALIGNMENT

The purpose of this alignment is to steer the laser beam parallel to the Z-axis machine motion and to center the beam in the Z-block. See Figure 9-12. Steering is done by adjusting the moving Y-mirror. Centering is done by adjusting the moving Y-mirror in the Y-direction and, if necessary, the moving X-mirror in the X-direction. Alignment shots are taken at the Z-up and Z-down position.

1. Perform Axes Home and Standoff Calibration procedures (if not previously done). Move the X and Y-axes to the "far" position (maximum laser beam length), i.e., move the cutting head close to the operator control station.

2. Remove the 5-inch lens drawer and install the Auto focus beam alignment fixture (see Figures 9-11, 9-25).

3. Ensure that dummy drawers are installed in the 7.5 and 10 inch lens drawer locations.

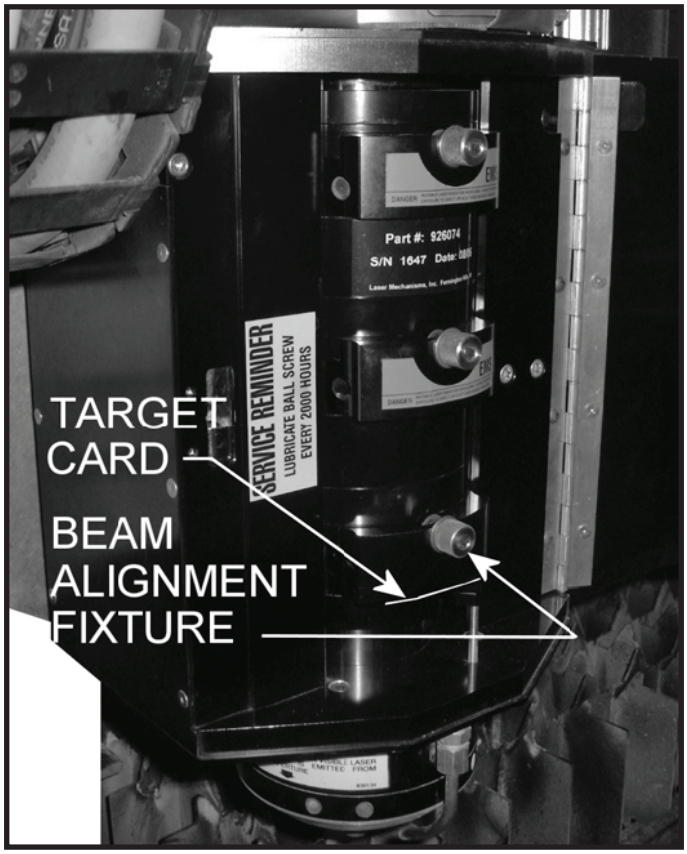


FIGURE 9-25 Alignment fixture in the 5"drawer

4. Be sure beam purge gas is ON.

5. **Be absolutely sure that no one, including yourself, is in the beam path.**

6. Insert a target card and take the card shot. Note the orientation of the card and label the cross hair impression "Z-up".

7. Jog the Z-axis to the Z-down position.

8. Take another card shot and label the cross hair impression "Z-down".

9. Compare the two cross hair impressions. If the two card shots do not indicate the same beam position within ±.020" (.5 mm), make steering adjustments to the moving Y-mirror. See Figure 9-24.

10. Repeat Z-up and Z-down card shots and the adjustments of Step 11 until the two cross hair impressions indicate the same beam position.

11. When the steering adjustments are complete, the laser beam should be centered in the Z-block within ±.020" (.5 mm). If the beam is off center more than this amount, position adjustments must be made. To center the beam in the X-direction, adjust the position of the moving X-mirror in the X-direction. To center the beam in the Y-direction, adjust the position of the moving Y-mirror in the Y-direction.

    Note: *Position adjustments in this step will change the centering of the beam in the moving Y-mirror. It may be necessary to move the beam slightly off center in the moving Y-mirror in order to center the beam in the Z-block.*

12. Repeat the two card shots and the adjustments of Steps 12 and 13 until both card shots are centered. Keep a single card with the final Z-up and Z-down impressions for reference.

Note: *If these adjustments move the beam off center on the moving Y-mirror by more than .03 inches (.8 mm), contact CINCINNATI Laser Service.*

FINAL ALIGNMENT CHECK

After completing the Z-axis alignment, do the following:

1. Position the cutting head at X-near, Y-near and take a card shot in the Z-up and Z-down positions. Label the card "X-near, Y-near". Label each impression "Z-up" or "Z-down" as appropriate.

2. Repeat Step 1 at the other three corners of the machine travel, that is:
   X-near, Y-far;
   X-far, Y-far;
   X-far, Y-near

3. Compare the four corner card shots. If they do not indicate the same beam position within ±0.020" (0.5 mm), then repeat the system alignment procedure.

4. When the card shots at all four corners of the cutting area indicate beam alignment within 0.020" (0.5 mm), re-install the mirror covers, box covers, and access covers. Repeat the four corner card shots to verify alignment has not changed.

5. Label all cards that were kept for reference, with the date and machine serial number. Store these cards for future reference.

AIR DRYER

The laser system is equipped with a compressed air dryer. See Figure 9-26. This dryer supplies treated clean dry air for beam delivery purge requirements. The purge air applies a slight positive pressure within the beam bellows and cutting head, and on the X-axis encoder scales. This purge flow minimizes contamination of these sensitive areas.

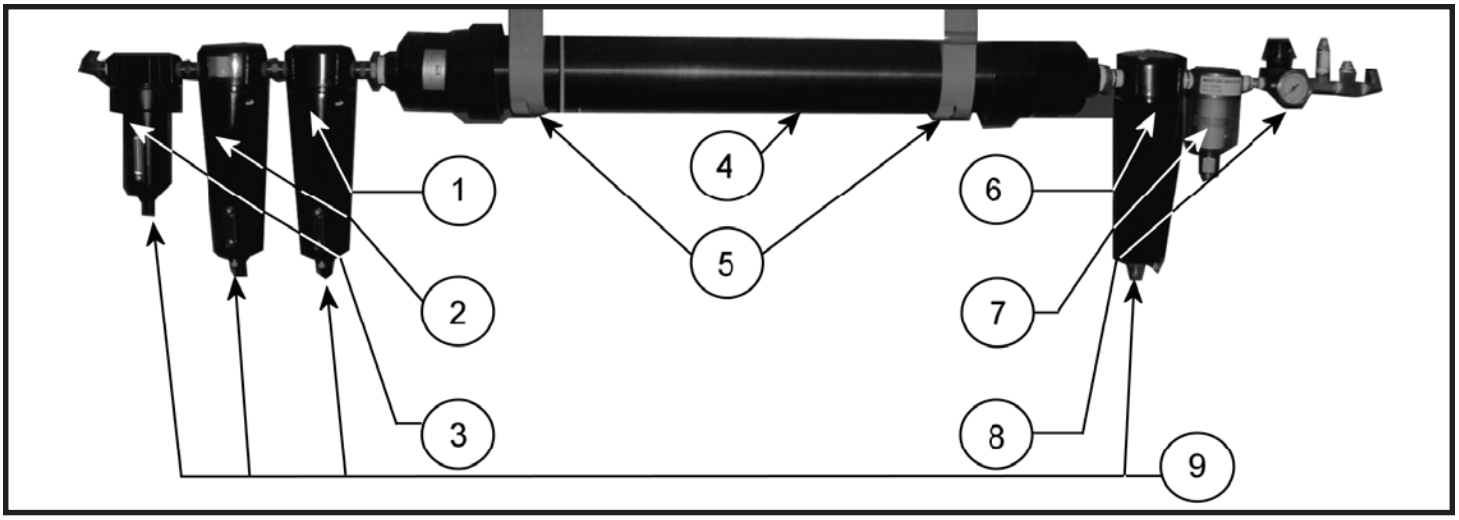
Near the dryer entry, there are two coalescing pre-filters. Each filter has a differential pressure indicator, which monitors the pressure drop across the pre-filter. The cartridge should be changed when the indicator approaches the red zone (or annually, whichever is earlier). A filter kit is available; see assembly drawing C.I. #913204.

! WARNING !

TURN OFF SUPPLY AIR BEFORE CHANGING FILTERS OR PERFORMING SERVICE ON AIR DRYER.

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

If the second stage filter cartridge captures significant amounts of oil or water, the compressed air supply needs additional treatment (oil and water removal). See Figure 4-1 for recommended pre-treatment components.



1. SECOND STAGE COALESCING PRE-FILTER
2. FIRST STAGE COALESCING 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 9-26 Air dryer system

INPUT AIR REQUIREMENTS

- 980 SCFH, 80 PSI Minimum, 125 PSI Maximum. (28 standard m^3/hr, 550 to 860 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 the air dryer.

DEFORMABLE OPTIC ACCUMULATOR CHARGING PROCEDURE

The Deformable Optic has an accumulator to minimize ripple from the deformable optic pump. The accumulator has a 15 PSI pre-charge. The following steps are to pre-charge the accumulator:

1. Ensure the chiller pump and the deformable optic pump are off. If not completed the pressure, indicated at the accumulator pressure gauge, will be at operating pressure of the deformable optic system (approximately 20-80 PSI) and will not allow setting the pre-charge properly.
2. Open N2 shut-off valve to allow N2 into the accumulator pre-charge cavity. Turn off the valve when the gage reads 25-30 PSI.
3. Open bleeder-valve a little to drain the pre-charge until the gage reads 15 PSI. Close the bleeder valve. If pressure goes below 15 PSI, repeat steps

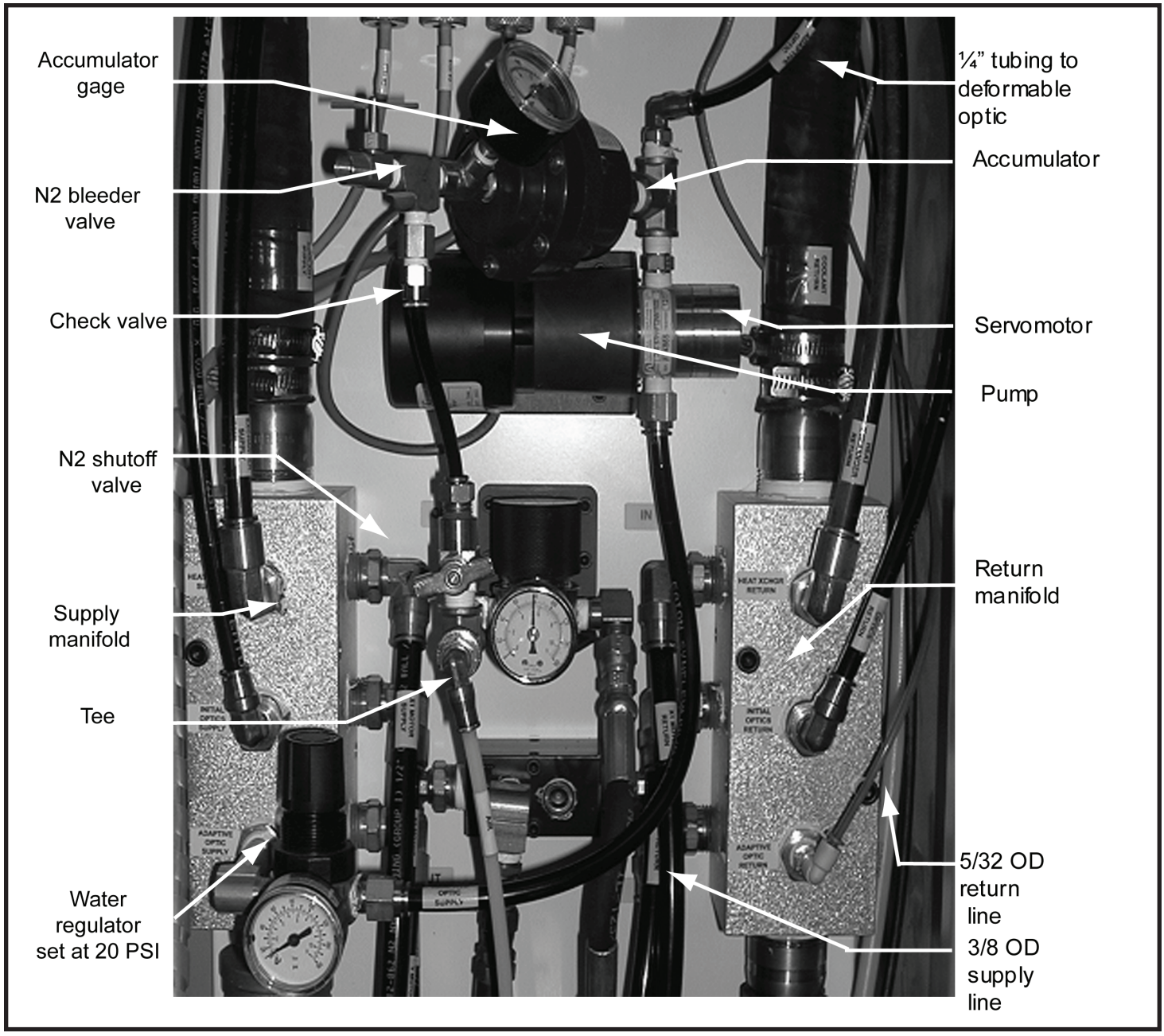


FIGURE 9-27 Deformable Optic Accumulator

PREVENTIVE MAINTENANCE

DAILY MACHINE INSPECTION

1. Empty scrap totes 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.
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 1-3) toward the load frame to expose the fume plenum. 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 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. If the machine is equipped with optional ball transfers, lubricate the ball transfer pivot links (four fittings).

7. Check the vacuum pump oil level. See the Laser Resonator manual for details.

8. Check the turbo blower for evidence of oil leaks. If oil leaks because the drain cock is partly open, close the drain cock and replenish the oil as required. If oil leaks for any other reason, contact CINCINNATI Laser Service.

9. Clean the air filters on the chiller. Dirty filters will reduce the chiller efficiency and lead to poor laser performance.

10. Verify that the laser gas cylinder pressure is at least 150 PSI (1034 kPa). If the pressure is below 150 PSI, replace the cylinder with a full one.

11. Record the laser run-time hours as displayed on the meter in the resonator cabinet.

12. 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. The concentration can be checked with an automotive radiator tester.

13. Verify that the purge gas fault indicators are working by temporarily turning off the purge gas supply.

14. Verify proper operation of the safety enclosure doors. Verify that the mat is clean and free of cuts or other damage that might affect its proper operation.

15. Verify that machine operation is prevented when the Emergency Stop button has been pushed**.**

16. Confirm that high voltage cannot be turned on while the cutting head is removed**.**

17. Clean the Auto Focus cutting head

18. Open the "Maintenance, Statistics" window and record the total X-axis travel. If the X-axis travel has increased by 2 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 17).

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

SEMI-ANNUAL (1000 HOURS) MACHINE INSPECTION

Complete the steps in this procedure semi-annually or at 1000 run-time hours, whichever comes first**.**

1. Perform all service/inspection steps on the 1000 hour service inspection form. Contact CINCINNATI Laser Service for scheduling or proper training. The form includes service and inspection of the resonator.
2. Remove the cover below the fume exhaust fan, and clean the duct.
3. Remove all scrap trays (see Figure 1-2b) 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 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 ballscrew as described in "DRIVES LUBRICATION".

7. Replace the filter element (C.I. #921929) for the chiller water input.

8. Clean the chiller condenser.

9. Replace assist gas filter cartridges (C.I. #923066).

10. 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.

11. Inspect the beam delivery bellows for tears or excessive wear. Replace bellows as necessary. Apply a thin film of grease (C.I. # 922230) to the X-axis beam bellows guide surface.

12. Inspect the inside of the beam delivery system for any evidence of dirt or dust. Clean all areas with a vacuum cleaner if necessary. Re-apply vacuum grease (C.I. #922433) to the internal surfaces of the Y-box. This grease will capture airborne dust particles that remain after cleaning.

13. Inspect the machine for coolant leaks and oil leaks. Correct as necessary.

14. Replace all missing or damaged safety signs.

15. Test all coolant, beam purge and high voltage interlocks for proper operation.

16. Test all machine motion and safety interlocks for proper operation.

17. Remove the bellows 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 very light coating of synthetic grease (C.I. # 922230), then re-install the bellows

18. 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	6	9-1
Y-axis linear bearings	4	9-2
Z-axis linear bearing	1	9-3
Z-axis ballscrew	1	9-3

2. Replace the bulb in the High Voltage warning light on the resonator.

3. Check the vacuum pump oil quality. Drain and replace with new oil if necessary or after 3 years.

4. 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.

5. Additional resonator maintenance requires proper training. To schedule service or training, contact CINCINNATI INCORPORATED.

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 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 (513-367-7100) the factory for instructions and a Returned Goods Authorization number.
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 you with any service needs you might have. This includes service ranging from minor repairs and adjustments to major reconditioning jobs.
2. Planned Maintenance Service (PMS). This program is designed to give you comprehensive inspections and recommendations concerning the condition of your equipment. PMS is specifically tailored to your needs to give you timely inspections, qualified recommendations and expert field assistance with repairs to your 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 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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