DIMENSIONS

COMPONENT	PLS 4000	WIDTH		LENGTH	HEIGHT	WEIGHT
		Shipped	Installed			
		In. (mm)	In. (mm)	In. (mm)	In. (mm)	Lbs. (kg)
MAIN FRAME	5 x 10	126	183	265	92	26,500
	(1.5 x 3.0 m)	(3200)	(4648)	(6731)	(2337)	(12,020)
	6 x 1 2	144.5	202	308	92	32,000
	(2.0 x 4.0 m)	(3670)	(5131)	(7823)	(2337)	(14,515)
LOAD FRAME	5 x 10	83		134	40	8,750
	(1.5 x 3.0 m)	(2108)		(3404)	(1016)	(3969)
	6 x 12	103		172	40	10,200
	(2.0 x 4.0 m)	(2616)		(4369)	(1016)	(4627)
CHILLER	60 Hz	42.5		68	88.5	1500
		(1080)		(1727)	(2248)	(680)

SPECIFICATIONS

LASER	RATED POWER	TYPICAL RANGE
PLS	4000 W	100-4500 W

WAVELENGTH: 10.6 micron

MODE: PRC "Q" Mode

LASER RESONATOR: Class IV

ALIGNMENT LASER: 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 edge of sheet detection 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 5-400 PSIG (34 to 2758 kPa) for Nitrogen

CHILLER FLUID: Solution of distilled water and 35% to 40% Dowtherm SR-1 or 40% Dowfrost HD by volume.

⚠CAUTION

The minimum specification for heat transfer fluid (35% Dowtherm SR1 or 40% 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.

Deionized water may be used if the pH range is between 6.7 to 7.2 (ideally pH should be 7.0).

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:

- Circuit #1: 68°F (20°C)
- Circuit #2: 80°F (26.6°C)

CHILLER RESERVOIR CAPACITY: 100 gallons (378 liters)

FUME EXHAUST RATING:

MODEL	EXHAUST FLOW	Water Static Pressure
5 X 10 6 X 12	4500 SFCM (127 m^3/min.)	0.75 in. (19 mm)

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 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.

LASER GASES: The resonator has four push connect fittings sized for 6 mm tubing for laser gas connections. Air is supplied to one connection from the air dryer. The remaining gases require separate supplies.

EXTERNAL OPTICAL ELEMENTS

CIRCULAR POLARIZING MIRROR: The first mirror is the circular polarizer. It is coated to produce a quarter wave phase shift.

ADAPTIVE OPTIC: The convex mirror serves an additional function of controlling beam diameter. Coolant supplied to the optic also runs through a pump circuit with a 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 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)	10.12 inch (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 Gases:**

GAS QUALITY SPECIFICATIONS					
Gas	**Min. Purity**	**Max. Moisture**	**Max. Oxygen Content**	**Pressure Into Laser Cabinet**	**Max. Hydrocarbon Content**
Air*	Oil free	Dew point: Not above 40°F (4.5°C)	Not Specified	60 to 100 PSI (4 to 6.9 bar)	Not Specified
Carbon Dioxide (CO_2)	99.995%	56 ppm**	Not Specified	60 to 100 PSI (4 to 6.9 bar)	50 ppm**
Helium (He)	99.995%	15 ppm**	10 ppm**	60 to 100 PSI (4 to 6.9 bar)	10 ppm**
Nitrogen (N_2)	99.995%	32 ppm**	50 ppm**	60 to 100 PSI (4 to 6.9 bar)	10 ppm**
* If not free or hydrocarbons, CFC's, etc., beam distortion may occur in the beam path. ** ppm = parts per million					

Notes: *During installation of the machine, a minimum of two cylinders of each laser gas is recommended. 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 400 PSI (34 to 2758 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 SPECIFICATION	APPROXIMATE GAS USAGE
LASER	He, N_2, CO_2 (See "Gas Quality Specifications")	GAS IN (on resonator)	99.995%	60-100 PSI	5 to 125 PSI CGA 580 Grade 5	
	Air		Oil free	60-100 PSI		
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.

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 Assist Gas Flow

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

Nozzle Pressure (PSI)	Approximate Flow (SCFH) Required for Nozzle Orifice		
	.060 in.	.080 in.	.100 in.
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 150 PSI (1034 kPa) maximum inlet pressure of the membrane 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 667 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 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.

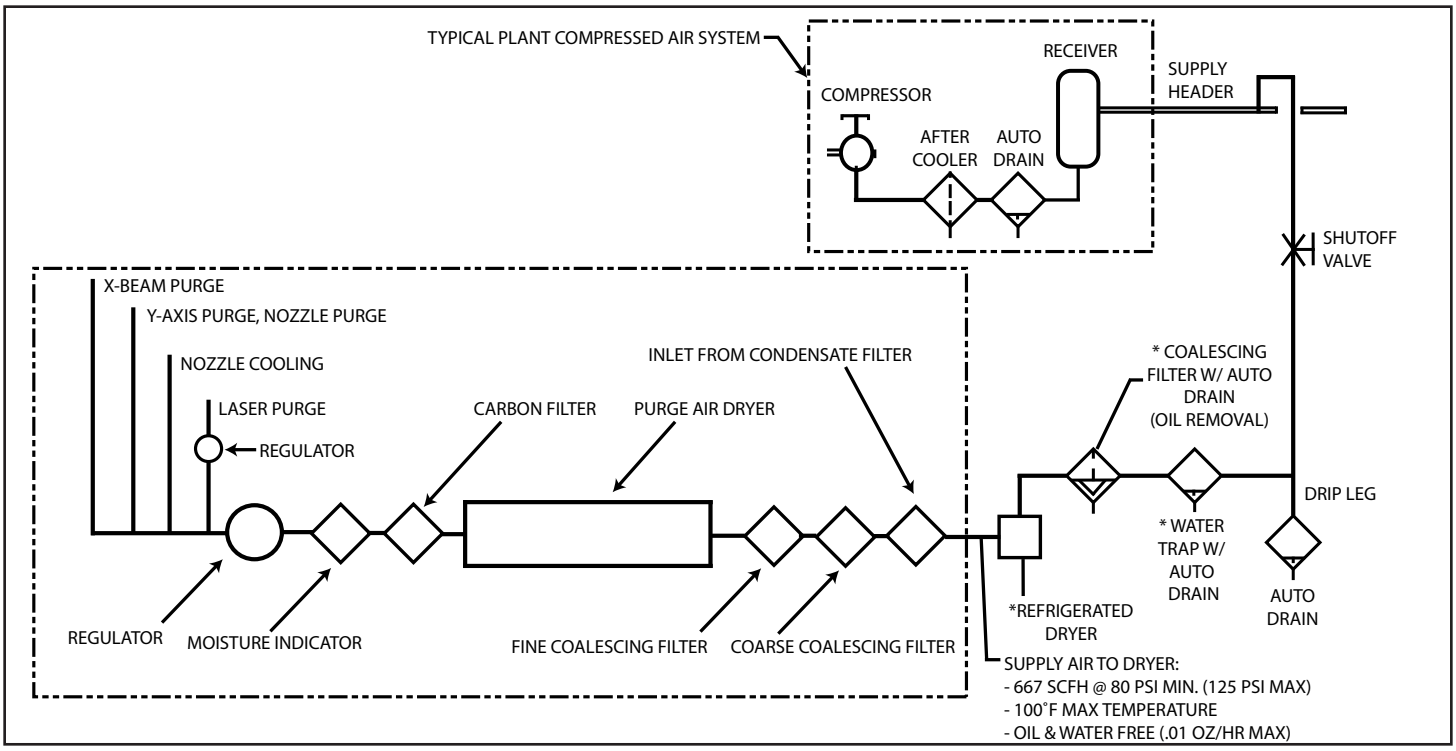


FIGURE 4-1 Schematic of compressed air supply system for purge requirements. "Basic" system components and recommended pretreatment (*) components to comply with air dryer inlet specifications.

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.

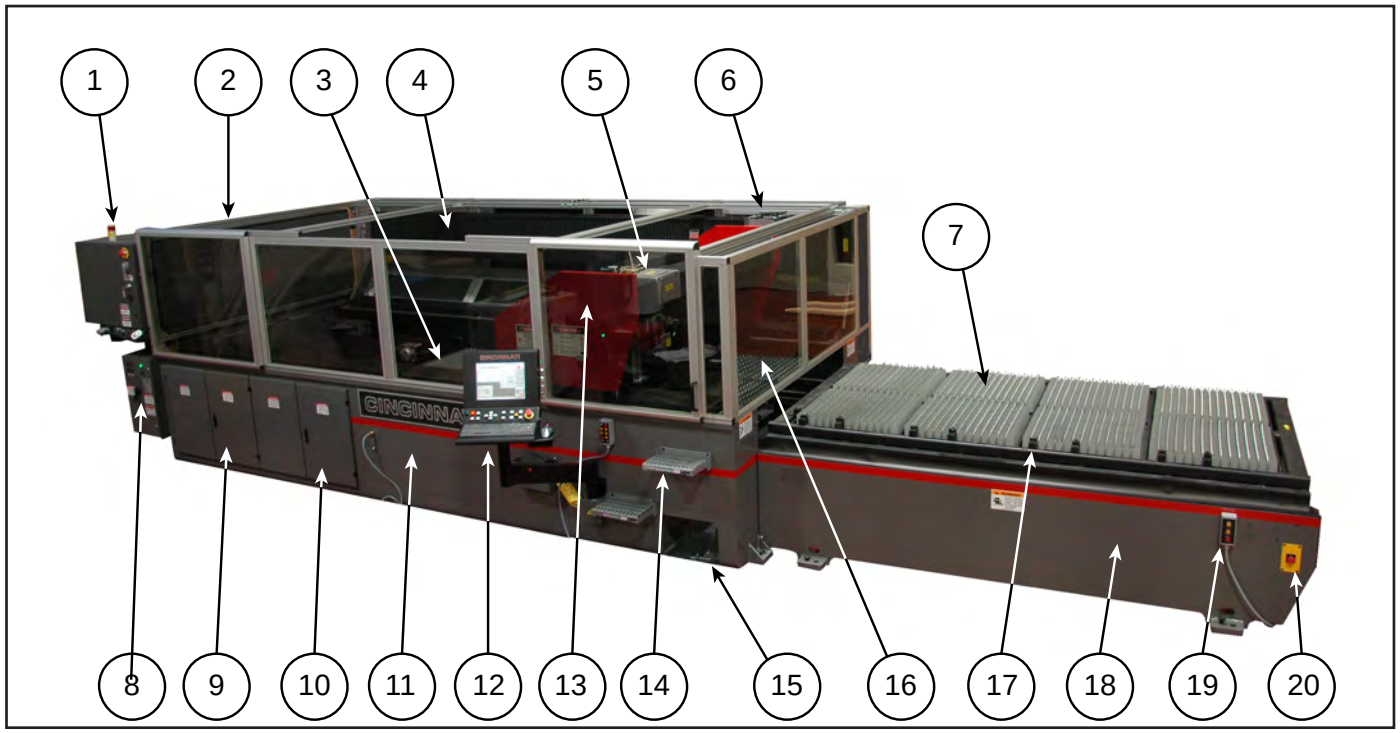
The gantry moves the mirrors and lens to produce the programmed workpiece geometry. A motion controller commands servo drives to control gantry motion. The program provided by the user includes commands to specify feedrate, laser power, and assist gas.

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

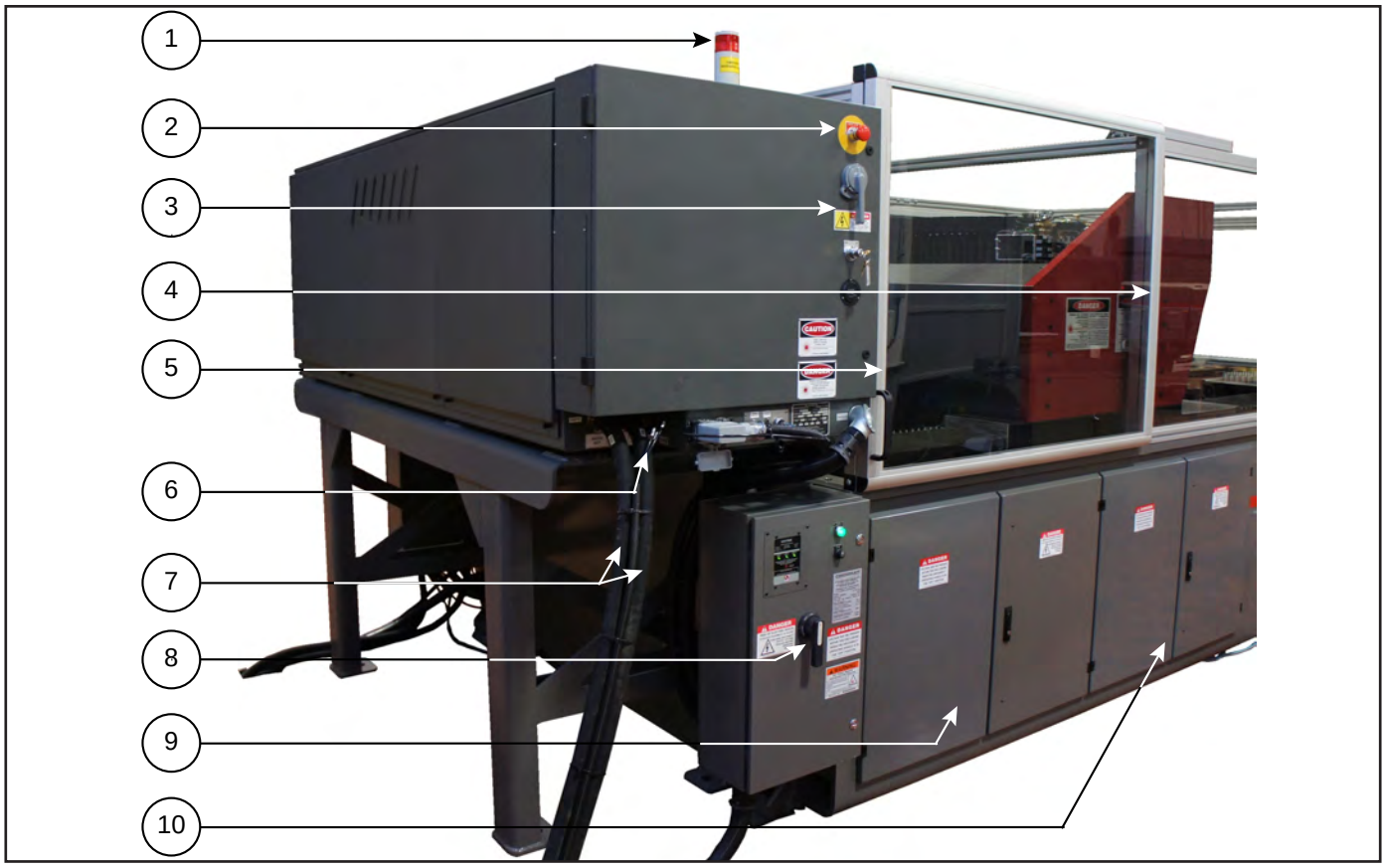
Contouring accuracy is a function of the feedrate and the curvature of the path. The maximum feedrate at which the laser system can maintain a given hole roundness is a function of the hole diameter.

CL-400 SERIES LASER SYSTEM



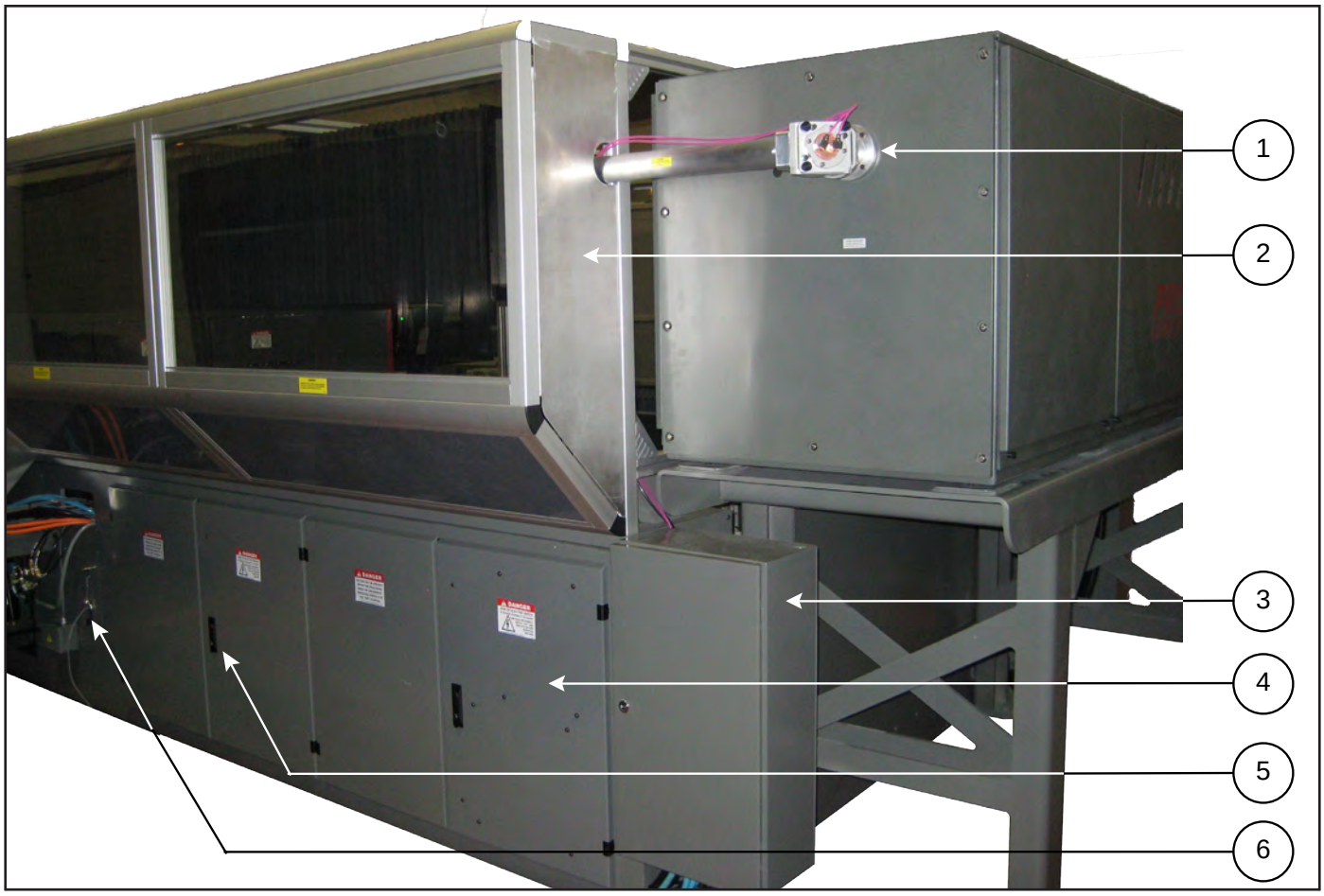
1. RESONATOR HIGH VOLTAGE LIGHT
2. RESONATOR
3. LOWER PALLET
4. X-AXIS BEAM TUBE
5. Y-BEAM DELIVERY BOX
6. X-BEAM DELIVERY BOX
7. UPPER PALLET
8. MAIN DISCONNECT
9. POWER ENCLOSURE
10. CONTROL ENCLOSURE
11. MAIN FRAME
12. OPERATOR CONTROL STATION
13. GANTRY
14. SERVICE FOLD-UP STEPS
15. SCRAP BIN ACCESS
16. CUT AREA ENCLOSURE
17. MATERIAL CLAMPS
18. LOAD FRAME
19. BALL TRANSFER REMOTE (OPT)
20. E-STOP

FIGURE 1-1 Front View



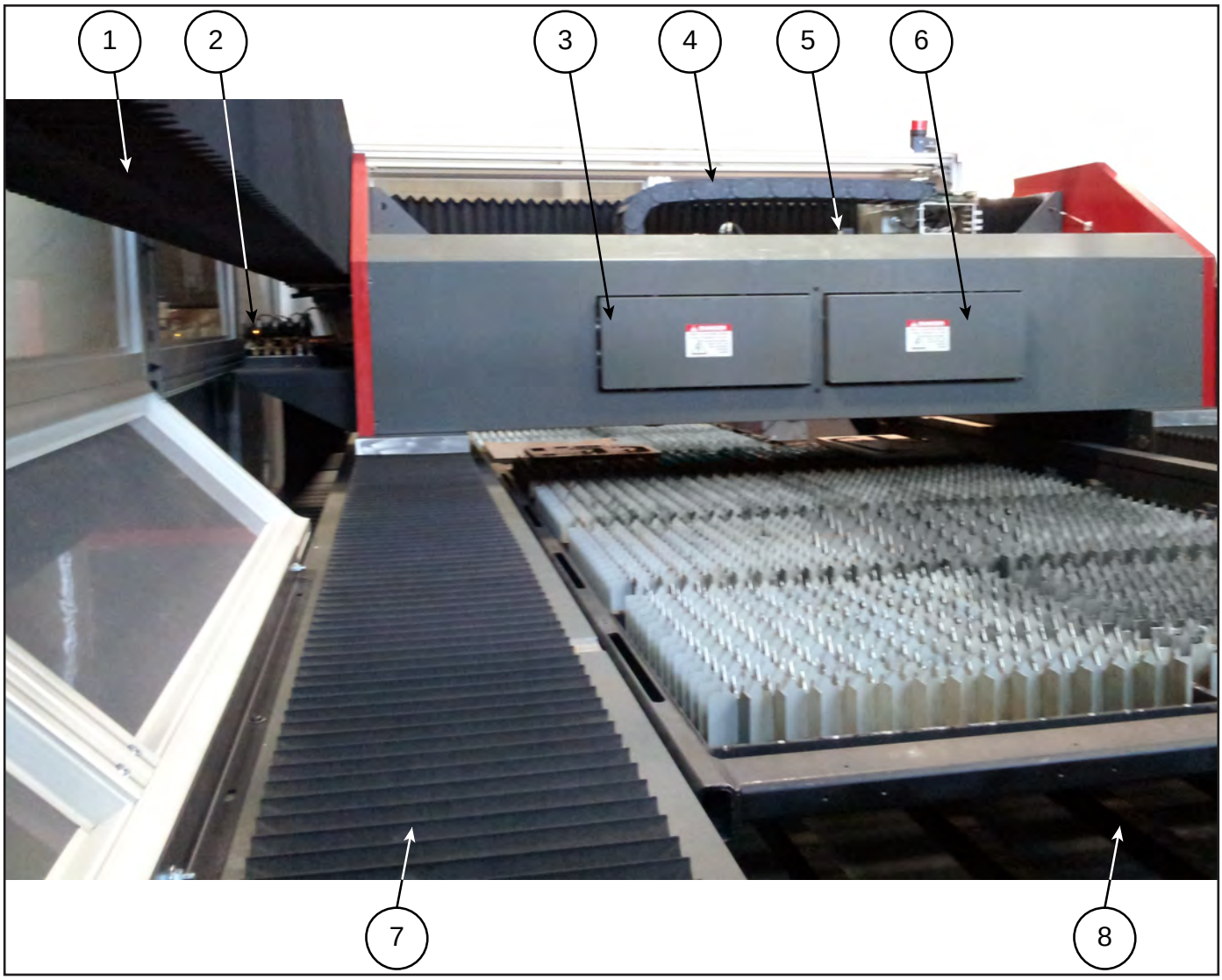
1. RESONATOR HIGH VOLTAGE LIGHT
2. RESONATOR E-STOP
3. RESONATOR MAIN DISCONNECT
4. CUT AREA ENCLOSURE
5. RESONATOR ACCESS SAFETY DOOR
6. RESONATOR GAS SUPPLY LINES
7. RESONATOR COOLANT SUPPLY & RETURN LINES
8. MAIN DISCONNECT
9. POWER ENCLOSURE
10. CONTROL ENCLOSURE

FIGURE 1-2 Right Rear View



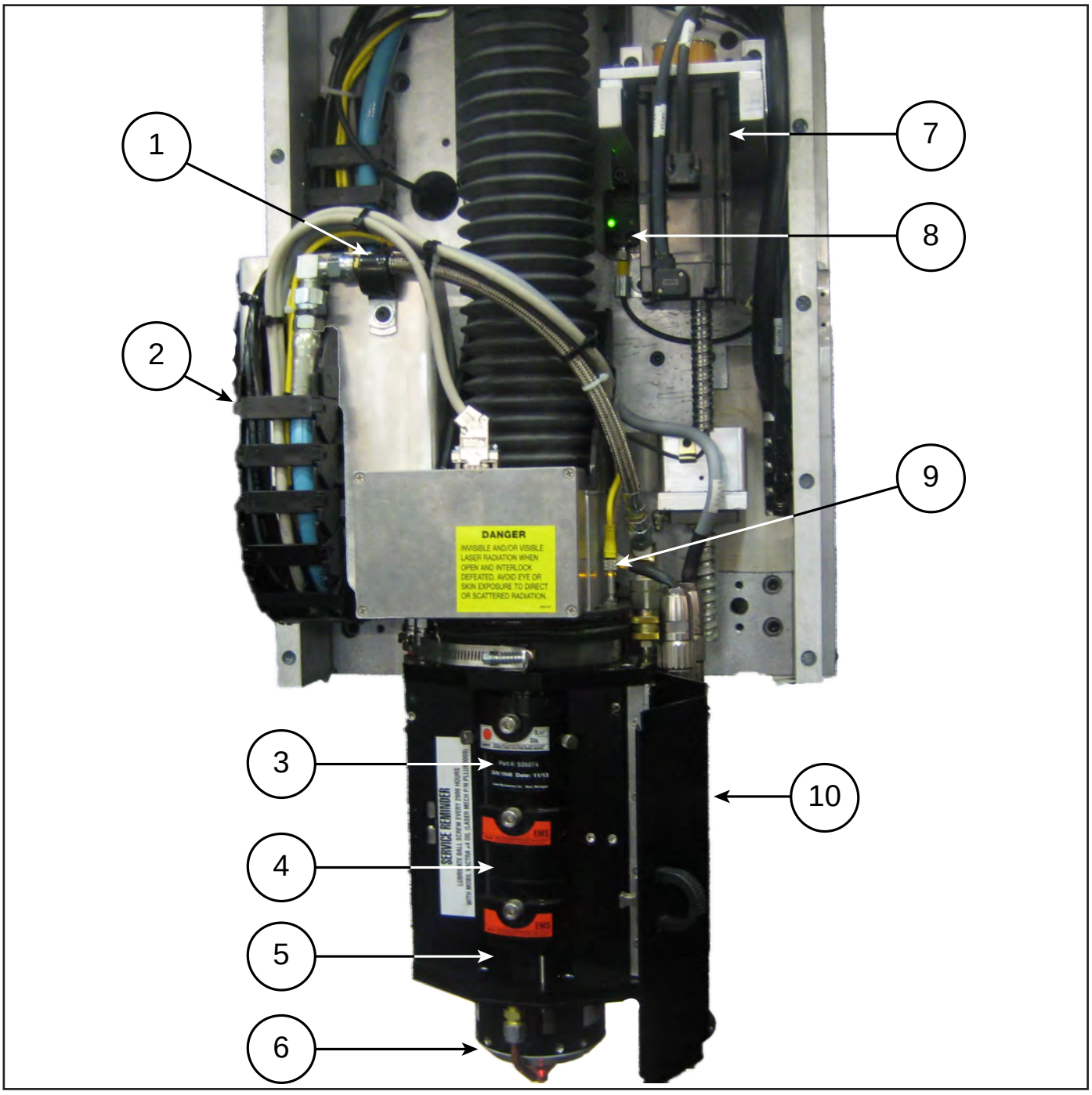
1. POLARIZER MIRROR
2. CUT AREA ENCLOSURE
3. GAS AND COOLANT ENCLOSURE
4. DRIVE ENCLOSURE
5. I/O ENCLOSURE
6. REMOTE STATION CONNECTION

FIGURE 1-3 Left Rear View



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

FIGURE 1-4 Gantry View



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

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