

# OPERATION, SAFETY, AND MAINTENANCE MANUAL

## CINCINNATI<sup>®</sup> BAAM-100

BAAMCI



CINCINNATI<sup>®</sup>

CINCINNATI INCORPORATED  
CINCINNATI, OHIO 45211



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## INTRODUCTION

### CINCINNATI BAAM 100 SYSTEM SERIES

The Cincinnati BAAM (Big Area Additive Manufacturing) is an industrial sized, additive manufacturing machine. The machine uses the proven design and technology from Cincinnati laser platform paired with an extruder and feeding system. BAAM was designed to allow 3D printing to be used for production manufacturing. The size and speed allow large parts to be made quickly.

In general, 3D printing or Additive manufacturing is a process of making a three-dimensional solid object from a digital model. The solid model is sliced into layers in software. The software then analyzes each layer and determines the necessary machine commands to build that layer. 3D printing is achieved using an additive process, where layers of material are added, one on top of another to build a complete part. 3D printing is also considered distinct from traditional machining techniques, which mostly rely on the removal of material by methods such as cutting or drilling (subtractive processes).

The BAAM System produces three-dimensional shapes one layer at a time. As each layer is produced the bed indexes down and the next layer can be added on top of the previous layer. The material is extruded like the glue coming out of a hot glue gun and adheres or welds itself to the layer below. While a layer is being deposited the bed remains stationary while a narrow strip of material is added along the travel path. Table heating, material heating, and material drying are available to aid in the additive process.

### PART QUALITY

Until BAAM, most additive manufacturing or 3D printing machines were focused on providing the best surface condition or the finest resolution. As a result, some of the metal laser additive machines have a mile of weld in a one inch cube of material. These machines are very slow and expensive to operate. The materials can be very expensive too. For prototyping this may be OK. If machines are to be used for production there had to be a shift in the thinking. With the BAAM System the idea is to see how fast large parts can be made and how inexpensively they can be made. So rather than fine layer resolution, we see layer heights of 0.10 -0.16". Rather than using expensive feed stock, the BAAM uses pelletized thermoplastics like those used in injection molding or extrusion processes that are much less expensive. Rather than making parts at a pound per day, the BAAM prints at up to 80 pounds per hour.

### ACCURACY

Almost all 3D printer parts are post processed. The surfaces are smoothed or filled. With BAAM it is no different. Many parts need machining or filling to get the surface condition needed.

The BAAM motion system is capable of a positioning accuracy of 0.005". One of the interesting things about the process is that once the thermoplastic is extruded and deposited on the part it tends to shrink. Typical shrinkage is about 0.5%. About half of this shrinkage happens when the material cools. The other half happens over a day or so after the part is printed. It is difficult to print a very accurate part. For high accuracy, parts are printed slightly oversized. After the part has cooled and normalized for a day, it can be machined to very high tolerance. Machining is a secondary process done on another machine. The accuracy of the part is dependent on the accuracy of the router or machining center.

The following factors affect part quality

- Machine condition
- Operator ability
- Set-up and Programming
- Quality and type of material

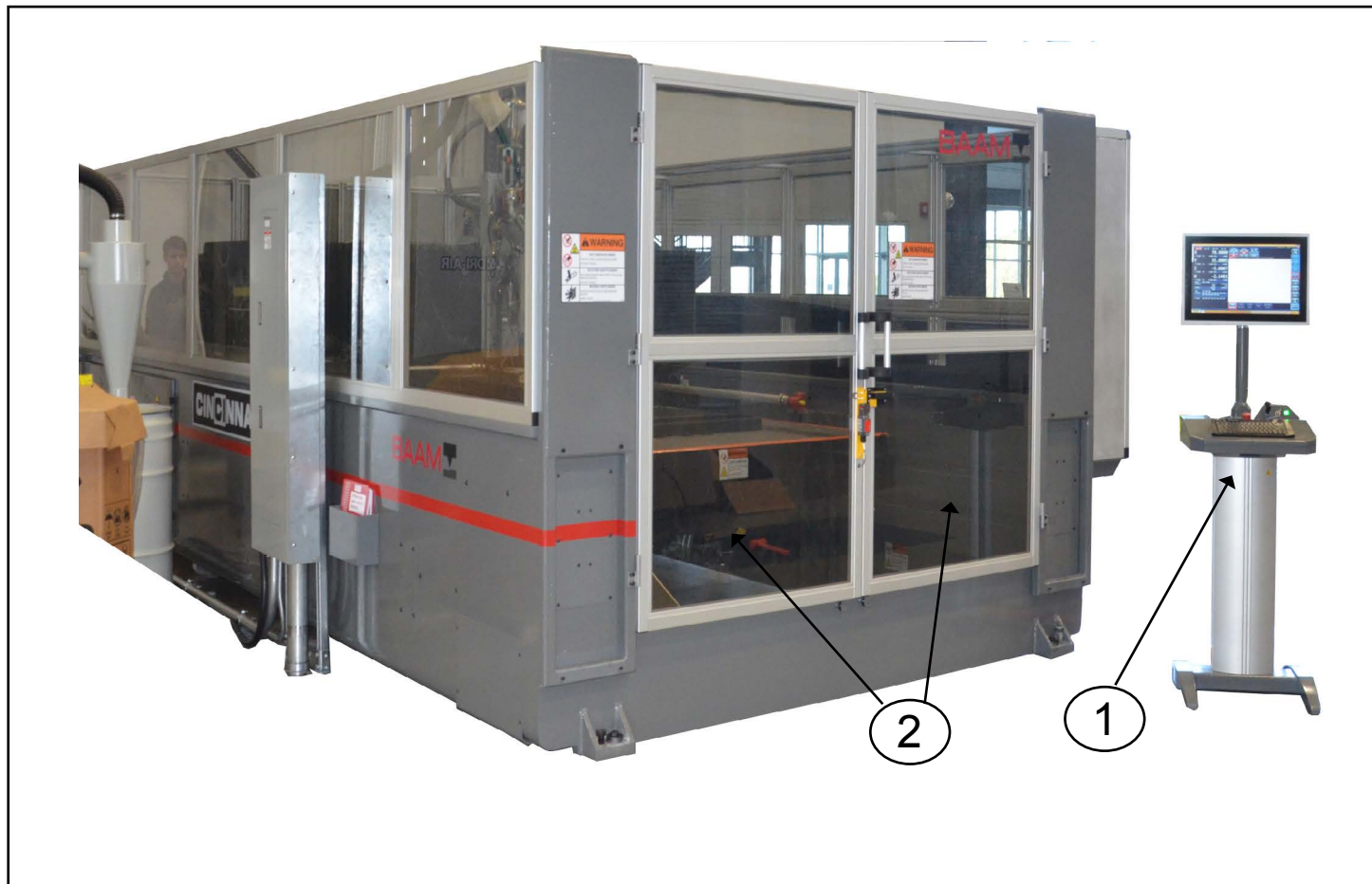
CINCINNATI machines are designed to be rugged and durable. However, improper adjustment or lack of maintenance can reduce the quality of parts produced on the machine.



# SECTION 1

# IDENTIFICATION

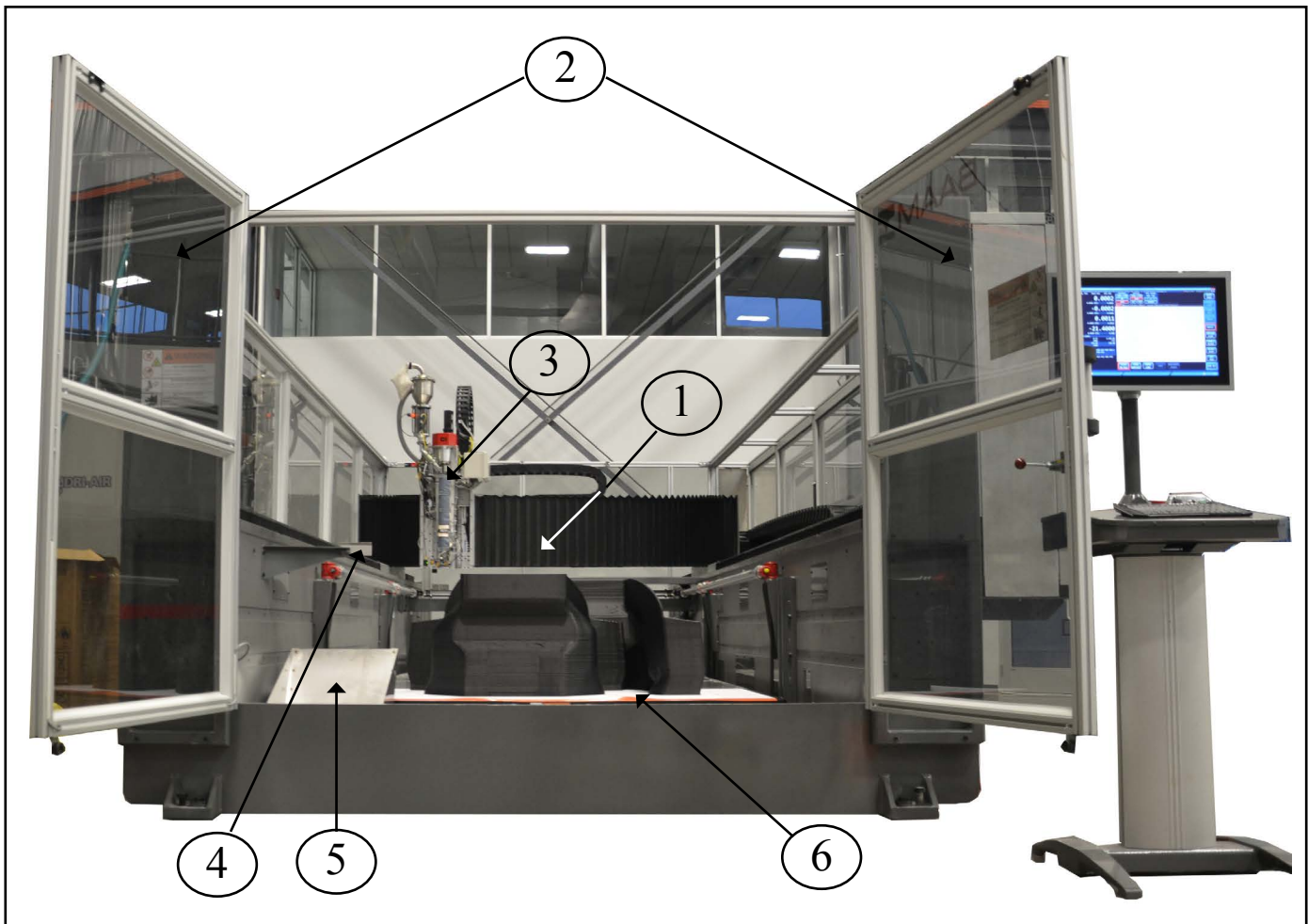
## BAAM-100 SERIES



1. OPERATOR CONTROL STATION

2. PART UNLOADING DOUBLE DOOR

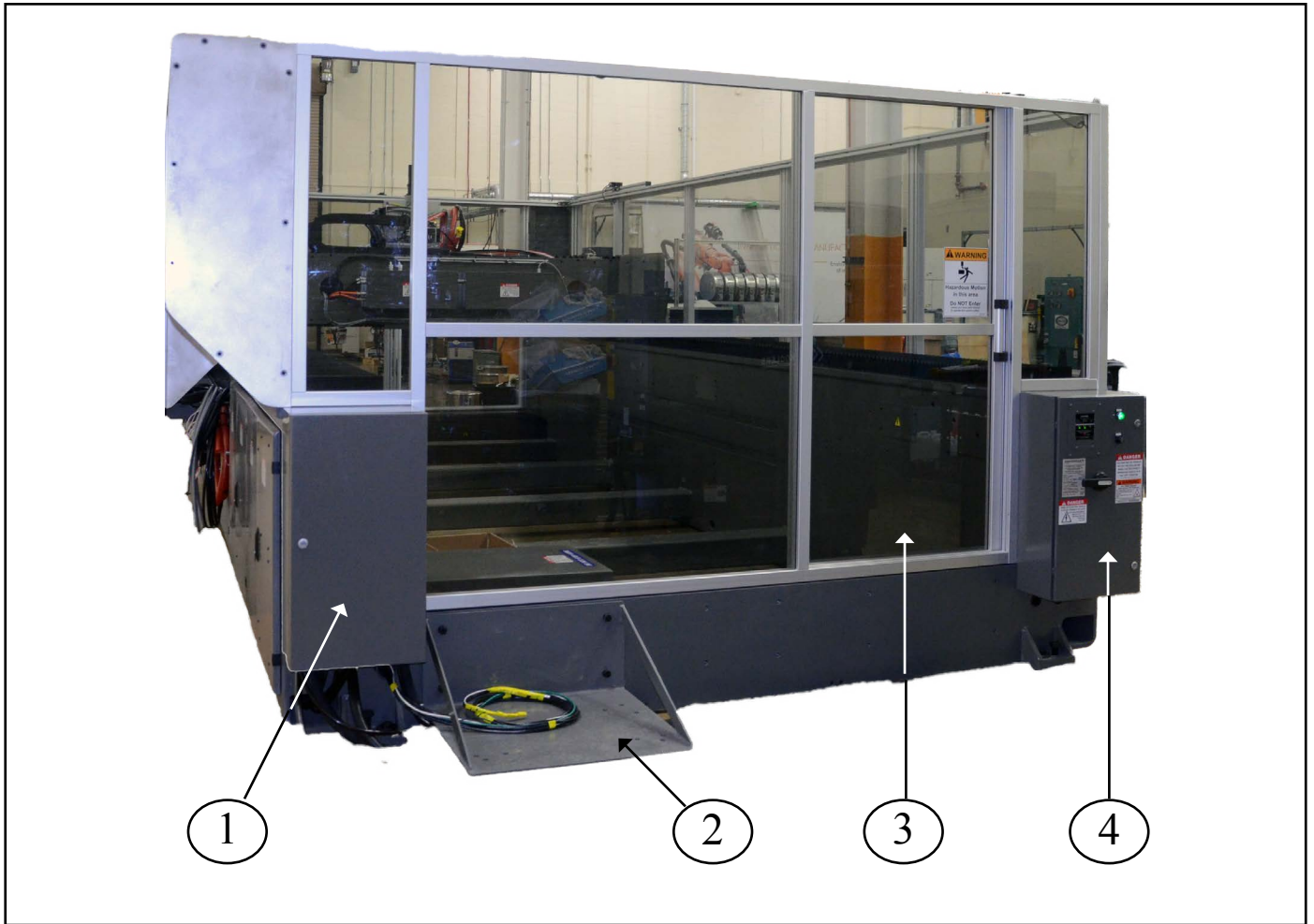
**FIGURE 1-1 Front View**



- |  |                     |
|--|---------------------|
| 1. GANTRY (SEE FIGURE 1-4 GANTRY VIEW) | 4. WIPER STATION    |
| 2. PART UNLOADING DOUBLE DOOR          | 5. PURGE COLLECTION |
| 3. EXTRUDER                            | 6. BUILD TABLE      |

**FIGURE 1-2 Front View**

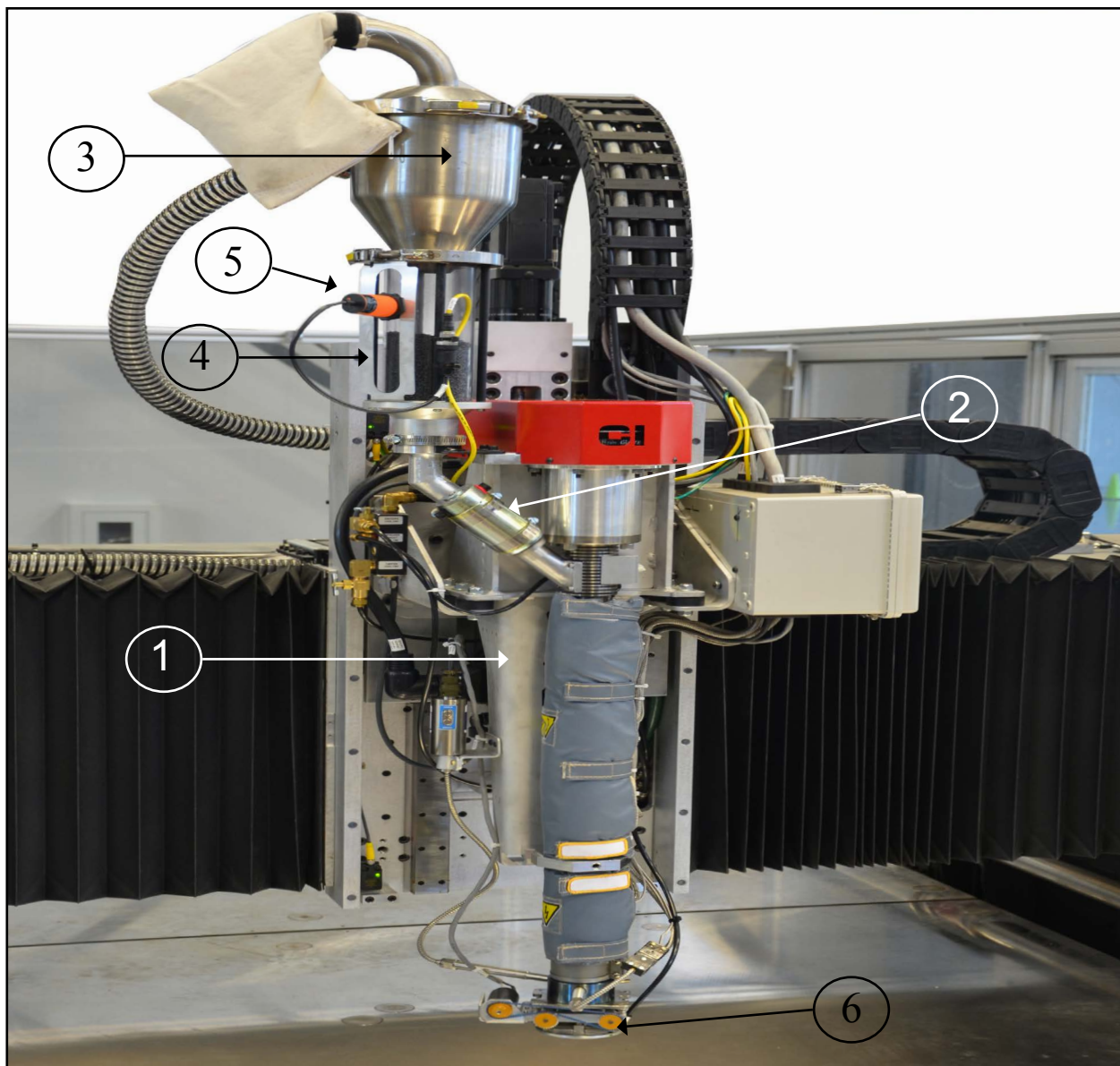




1. AIR PANEL / COOLANT
2. LOCATION OF 240 TRANSFORMER

3. REAR SERVICE ACCESS DOOR
4. MAIN ELECTRICAL POWER AND DISCONNECT

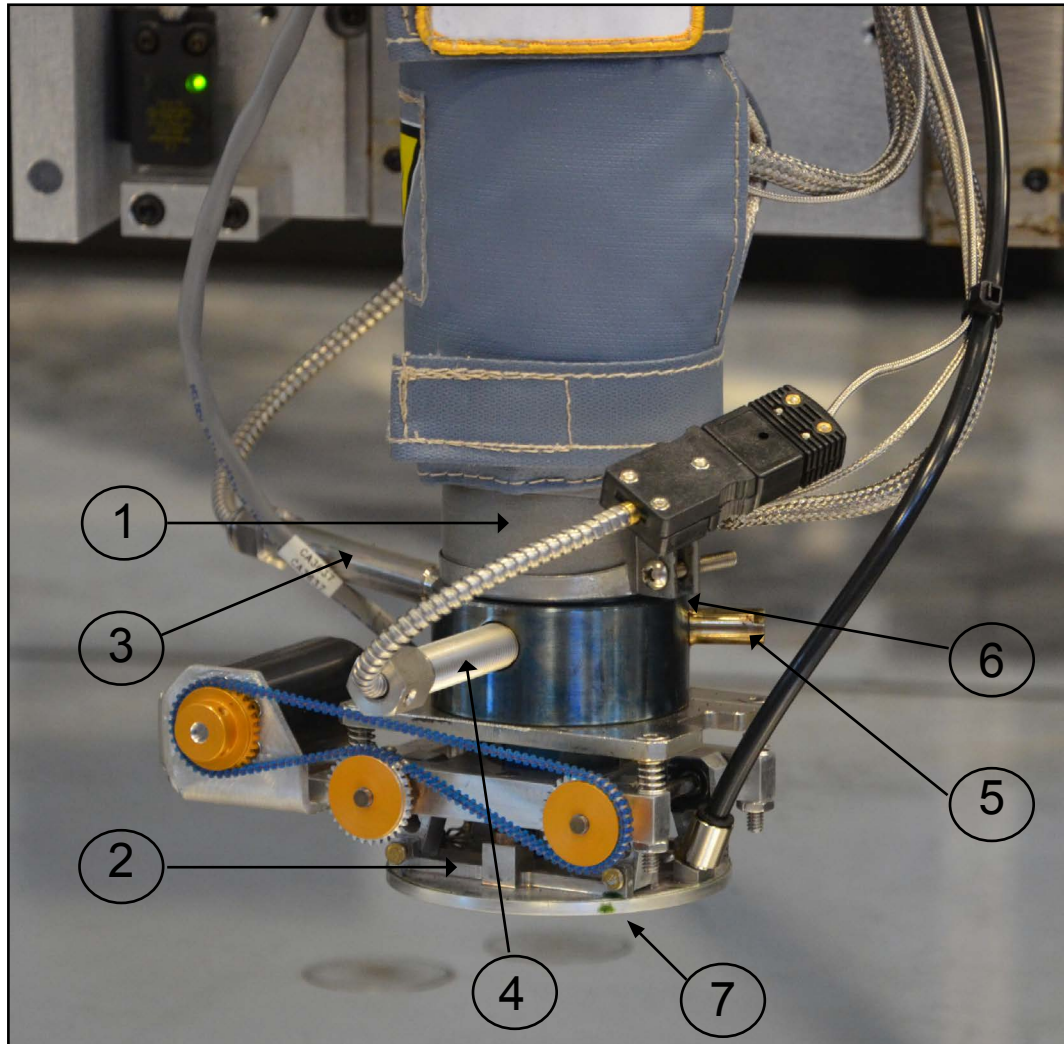
**FIGURE 1-3 Rear View**



- 1. EXTRUDER ASSEMBLY
- 2. ANTI-CLOG TAPPER
- 3. EXTRUDER RECEIVER

- 4. EXTRUDER HOPPER
- 5. MATERIAL LEVEL SWITCH
- 6. TAMPER ASSEMBLY

**FIGURE 1-4 Gantry View Extruder**



- |                            |                                    |
|----------------------------|------------------------------------|
| 1. EXTRUDER HEATER         | 5. PRESSURE RELIEF PLUG            |
| 2. TAMPER ASSEMBLY         | 6. BACK PRESSURE SCREW (not shown) |
| 3. PRESSURE TRANSDUCER     | 7. EXTRUDER NOZZLE (not shown)     |
| 4. MELT TEMPERATURE SENSOR |                                    |

**FIGURE 1-5 Extruder Lower Assembly**





## SECTION 2

## INSTALLATION

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

### LIFTING AND MOVING

Machine weights are provided in SECTION 4.

The main frame, Figure 2-1, 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 2-2.

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.

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



FIGURE 2-1 Main Frame

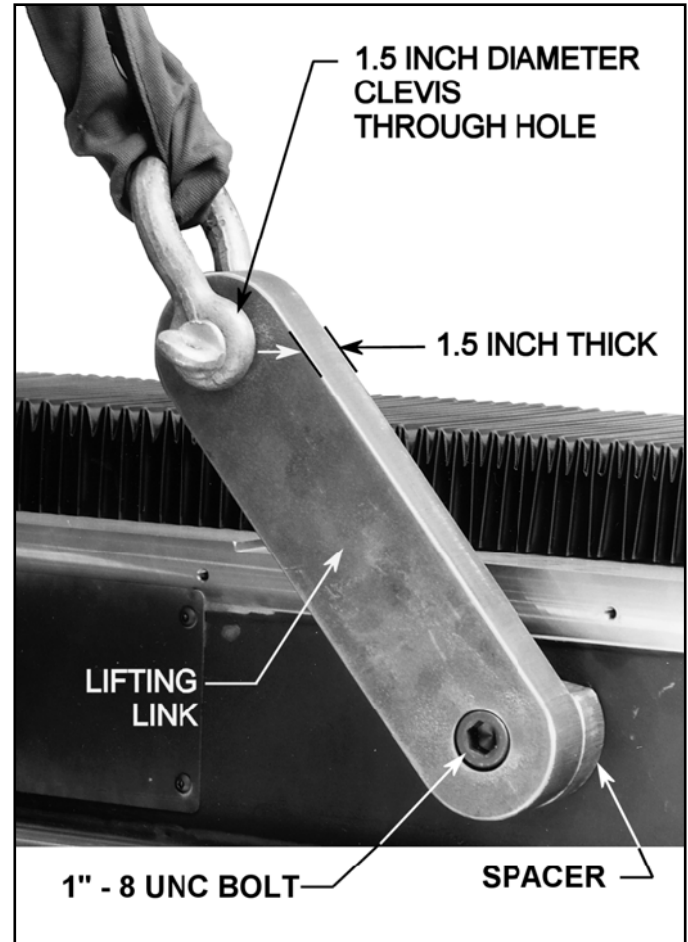


FIGURE 2-2 Lifting Main Frame

### FOUNDATION

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

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

## INSTALLATION OF MACHINE

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

1. Remove lifting clevises and spacers.
2. Remove all steel banding and protective wrappings.
3. Complete preliminary leveling procedure described below.
4. CINCINNATI Service will install the operator control station and complete final electrical connections to the control.
5. Install all 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 the air panel. 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.

## MATERIAL DRYER

The material dryer is a free-standing unit requiring only floor support. Air lines are connected to the main frame at

the pneumatic panel. Electrical lines are **not** connected. Delivery hoses are provided to connect to the mainframe when located as shown on the Foundation Plan.

## LEVELING

Main frame leveling adjustments are made using jackscrews provided at the mounting pads. Figure 2-2 shows the mounting pads. The machine foot mounting pads are located on the outside surface of the main frame in the four corners.

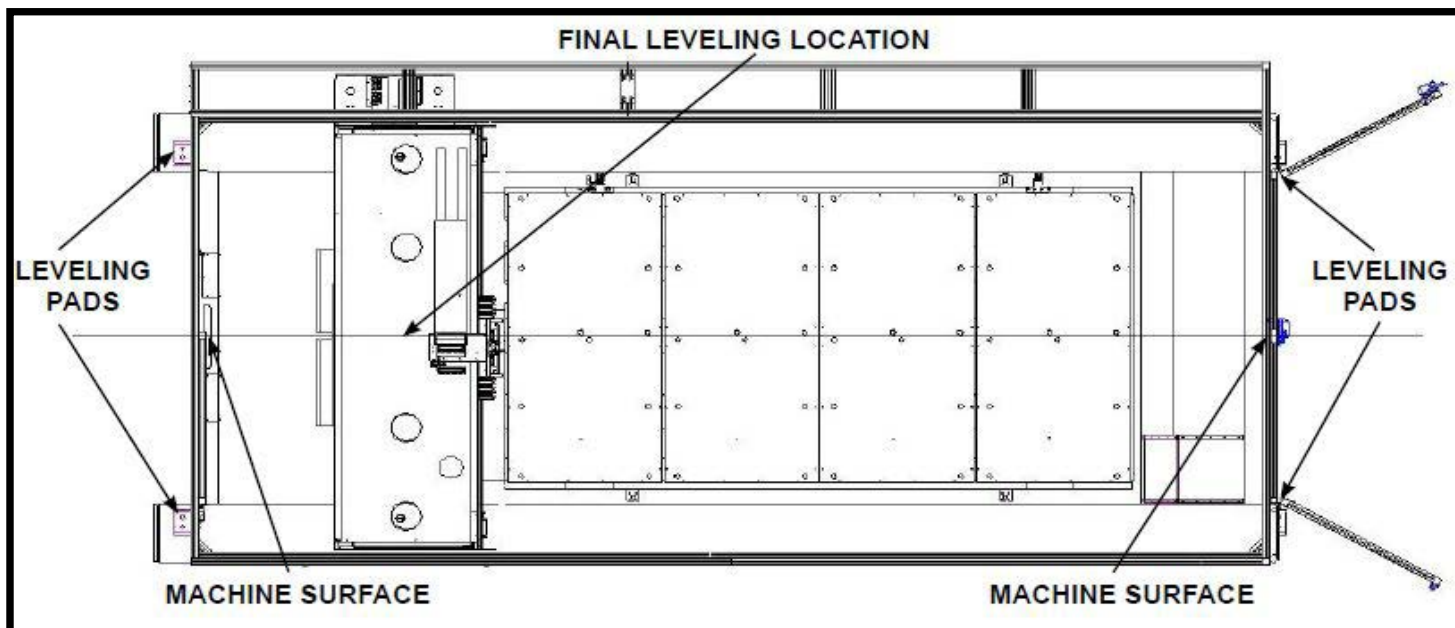
Slotted shims are inserted between the machine foot and steel spacer block as shown on the Foundation Plan drawing. After shims are inserted, jackscrews are to be backed off or removed. The procedure for leveling is described in the next sections.

## 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.

## FINAL LEVELING

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



**FIGURE 2-3 Main Frame Leveling Adjustments**

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.

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.
4. Observe the position of the bubble while moving the gantry from  $X = 0$  to  $X = \text{Maximum travel}$ . 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.

## WARNING

**A very powerful magnetic field surrounds the magnet track. Keep all metal (steel) tools away from this track. Place a piece of wood (2X4) over the magnetic track to protect it and yourself.**

## ELECTRICAL CONNECTION

All BAAM System customers are supplied with 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



**FIGURE 2-4 Cross leveling (Preliminary)**





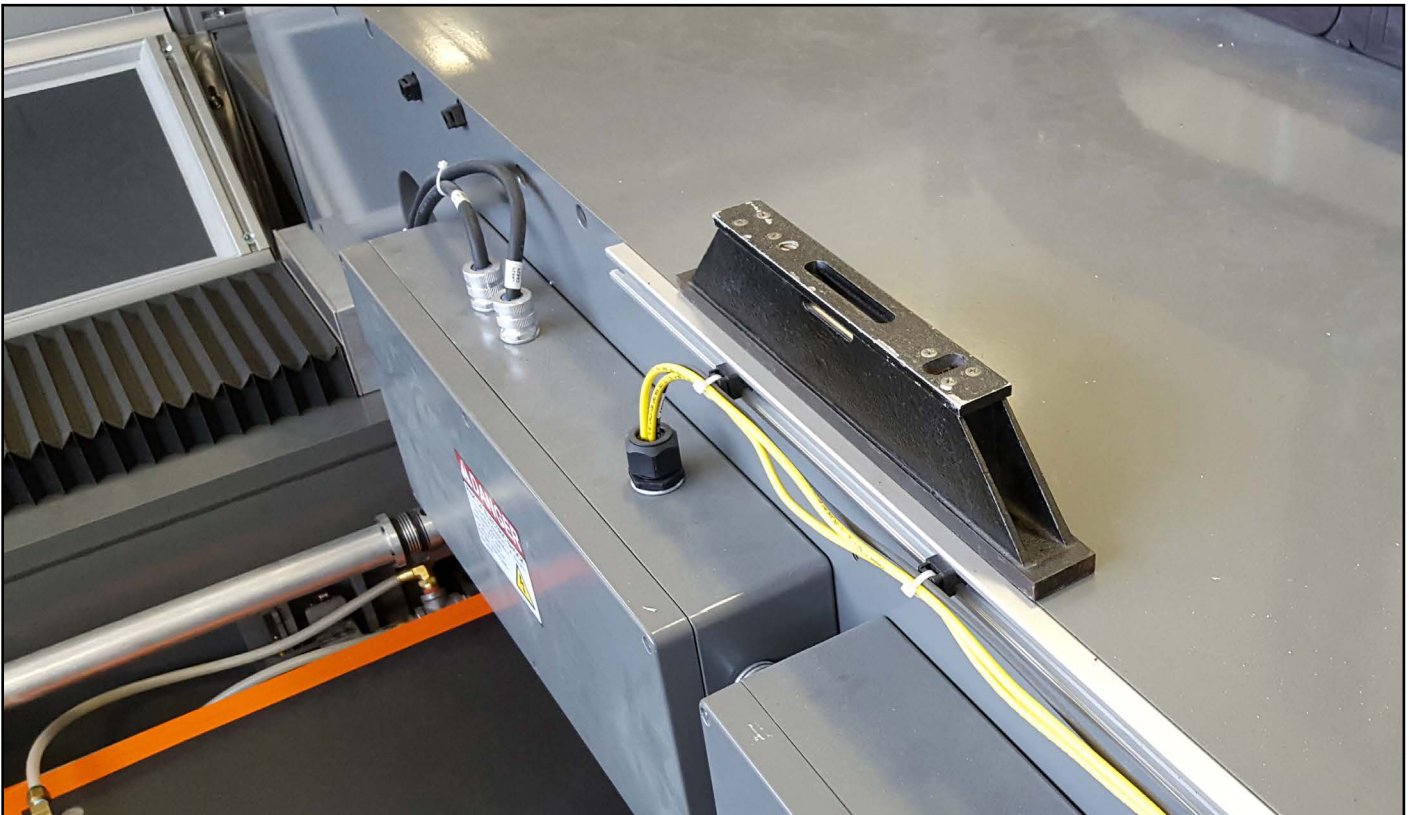
**FIGURE 2-5 Longitudinal leveling**

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.**



**FIGURE 2-6 Final leveling with precision level**



## SAFETY ENCLOSURE

The Safety Enclosure has a rear door and part unloading double door. The doors have several functions. First, opening any door will interrupt operation. The safety enclosure provides localized protection from strike and pinch hazards caused by automatic motion of the gantry, extruder and Z-Table.

Second, under normal operation, opening the Safety Enclosure doors removes power from all axes. 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 print area temporarily to perform adjustments, retrieve parts, make repairs, etc.

To resume automatic operation, close all 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.

## SAFETY SIGNS

To warn 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 BAAM systems.

**Note:** 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 BAAM components for the most effective use. They are a permanent part of the machine and, therefore, must not be removed, covered, hidden or defaced.

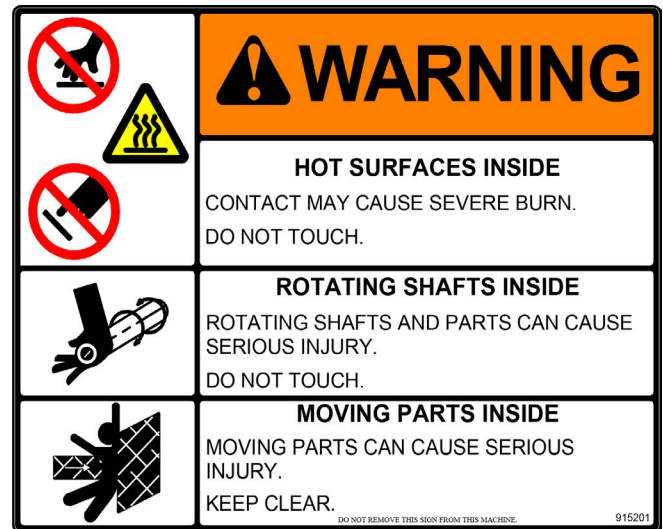
A six-digit number usually located in the lower right corner identifies all signs installed on machines by CINCINNATI INCORPORATED. If any of these safety signs become damaged or defaced, new ones should be ordered by contacting the factory, the nearest CINCINNATI Sales and Service Office, or by visiting our online store at [www.cionlinestore.com](http://www.cionlinestore.com).

The following figures illustrate warning signs commonly used on the BAAM system. Other signs may be furnished to cover possible hazards due to special equipment or machine features. The material dryer and extruder manufacturers furnish additional signs. The user management should also

provide additional warning signs to cover any hazards that may be presented by customer-added auxiliary equipment.

## WARNING LEGEND (915201)

This WARNING sign alerts the operator and the maintenance personnel that hot surfaces, rotating shafts, and moving parts are located within the BAAM enclosure. This sign is located on the doors at either end of the BAAM enclosure, as well as on the access panel near the operator station.



## HIGH VOLTAGE WARNING (825735)

This sign alerts the operator and the maintenance personnel that high voltage is present. This sign is located on the power and control enclosures, the main disconnect, and the left and right gantry enclosures.



## WARNING HOT SURFACE (915203, 915202)

This WARNING sign alerts the operator and the maintenance personnel that high temperatures are involved and that touching surfaces in the area could cause severe burns. These signs are located on the extruder, on the inside of the mainframe along the printing path, and on either side of the gantry.



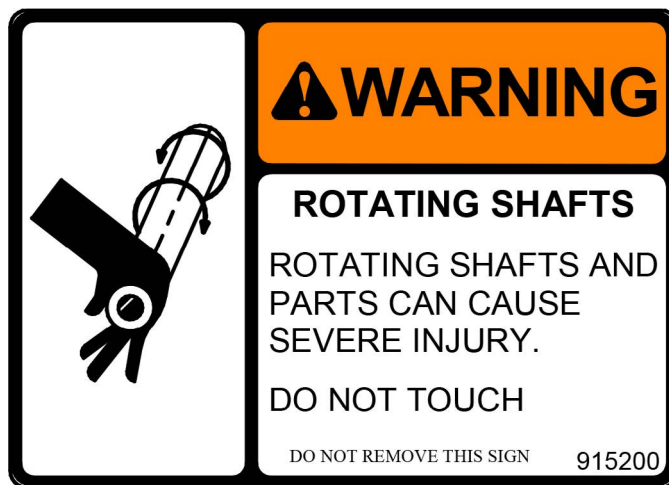
## HIGH STRENGTH MAGNETIC FIELD (921533)

This WARNING sign alerts the operator and the maintenance personnel that a high strength magnetic field is present. The sign is located underneath both X-axis and Y-axis way covers. 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.

**CAUTION: HIGH STRENGTH MAGNETIC FIELD**  
921533

## WARNING ROTATING SHAFT (915200)

This WARNING sign alerts the operator and the maintenance personnel of rotating shafts and that touching these shafts could cause severe injury. These signs are located along inside walls of the mainframe near the X-axis and Y-axis.



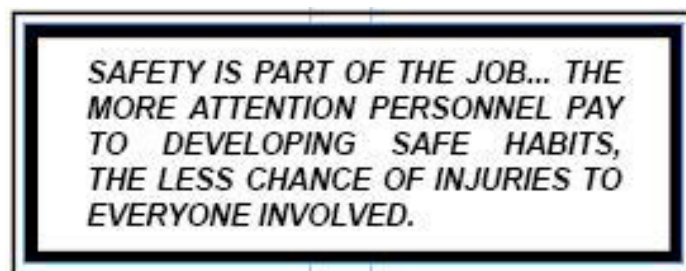
## SAFETY GUIDELINES

- Safeguarding, such as panels, covers, safety enclosures are in place and working.
- Fold-up service steps are in the up-right, or closed position.
- All safety interlocks are engaged and operating properly.
- 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.
- Know your controls; be familiar with emergency shutdown procedures.
- 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 the machine.
- Make sure everyone is clear of the gantry before operating.
- Warning signs and lights are visible to all personnel.
- Use material handling devices for movement of heavy work pieces.

## SAFETY MAINTENANCE CHECK

- SAFETY ENCLOSURES are operating properly.
- ALL service access panels bolted in place.
- PINCH POINT guarding properly installed.
- OPERATOR CONTROLS working properly.
- OPERATING MODES functioning properly.
- GANTRY and HEAD positioning properly.
- SAFETY SIGNS clean and easily read.
- PROCESSING AREA clear of debris.
- ELECTRICAL WIRING in good condition.
- AUXILIARY EQUIPMENT checked and working properly.
- HAND TOOLS and personal protective equipment in good order and readily available.
- SAFETY MANUALS and OPERATOR MANUALS in holder near the Operator Control Station.

SCHEDULED    NORMAL    MAINTENANCE    work  
completed.





# SECTION 4

# SPECIFICATIONS

## DIMENSIONS

COMPONENT		WIDTH		LENGTH	HEIGHT	WEIGHT
		Shipped	Installed			
		In. (mm)	In. (mm)			
	6 x 1 2	144.5	202	308	92	32,000
	(2.0 x 4.0 m)	(3670)	(5131)	(7823)	(2337)	(14,515)
CHILLER	60 Hz	42.5		68	88.5	1500
		(1080)		(1727)	(2248)	(680)

## SPECIFICATIONS

### ACCURACIES:

- ◆ Absolute Positioning (X & Y-Axis):  $\pm 0.05''$  (0.25 mm)
- ◆ Repeatability (X & Y-Axis):  $.05''$  (0.25 mm)

### MACHINE SPEEDS (Programmed moves):

- ◆ Extruder feedrate is programmable up to 400 RPM. Maximum feedrate depends on material type.

- ◆ Rapid Traverse Speeds

X & Y-Axis: 2500 IPM (63.50 m/min.)  
 X & Y-Axis Simultaneous: 3535 IPM (89.79 m/min.)  
 Z-Axis: 200 IPM (5.08 m/min.)  
 Table (w-Axis): 7.0 IPM (5.08 m/min.)

- ◆ Accelerations

X & Y-Axis: 5 X 10: 0.306G (2.943 m/sec<sup>2</sup>)  
 X & Y-Axis: 6 X 12: 0.3G (1.2.943 m/sec<sup>2</sup>)  
 Z-axis: 0.16 G (0.981 m/sec<sup>2</sup>)  
 Table: 0.1G (0.981 m/sec<sup>2</sup>)

### MACHINE SPEEDS (In JOG Mode):

- ◆ X & Y-Axes Jog Speed:
  - 300 IPM (7.62 m/min.)
  - 1600 IPM (40.53 m/min.) (Rapid)
- ◆ Z-Axis Jog Speeds:
  - 50 IPM (1.269 m/min.)
  - 200 IPM (5.08 m/min.) (Rapid)
- ◆ Table Jog Speeds:
  - 1 IPM (0.03 m/min.)
  - 7 IPM (0.18 m/min.) (Rapid)

### CHILLER FLUID:

Solution of distilled water and 30 to 35% Downtherm SR-1 or 35 to 40% Dowfrost HD by volume.

### ⚠ CAUTION

The minimum specification for heat transfer fluid (30% Dowtherm SR-1 or 35% Dowfrost HD) is required to provide corrosion protection. Maintain the minimum concentration according to the Prevention Maintenance instructions in Section 9. If these additives are not available, consult CINCINNATI INCORPORATED for approval of a comparable product from another supplier.

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

Maximum Hardness: 200mg CaCO<sub>3</sub>/liter  
 Maximum Cl Concentration: 50 mg / liter  
 pH Range with additive: 6.5 to 8.0  
 Maximum Conductivity: 1000 u S/cm

**CHILLER TEMPERATURE SET POINT:** 80°F (26°C)

### CHILLER RESERVOIR CAPACITY:

40 GALLONS (151 LITERS)

## MATERIAL DRYER

See the plastic pellet dryer manual for specifications, operations, safety, and maintenance requirements.

## EXTRUDER

See the extruder manual for specifications, operations, safety, and maintenance requirements.



## CHILLER

The chiller is used to cool the linear motors on the X & Y axes and to cool the drive and I/O enclosures. See the chiller manual for additional specifications, operations, safety, and maintenance requirements.

### CHILLER START-UP AND WARM-UP

For chiller start-up and warm-up procedures, see the chiller manual.

## BUILD TABLE

The table has multiple heating zones. The table temperature is typically set to near the glass transition temperature of the material to be printed to help with the adhesion of the first layer and to help prevent part warping. The use of a build sheet as the build surface is recommended. A vacuum system can be used to hold the build sheets down and prevent warping of the build sheet.

### TABLE TEMPERATURE

The table temperature can be adjusted to the optimal build surface print temperature. The table zone temperature is set through the heating software. When turning off the table zone temperature, it is recommended to leave the vacuum on until the table temperature is room temperature to prevent warping of the build sheet.

### BUILD SURFACE

Use build sheets as needed, based on material to be printed. Build sheets should be attached to the build plates to keep the sheet from warping. The build table also has vacuum to help hold down the build sheet. The build surface should be clean and debris free.

### BUILD VACUUM

A vacuum system is supplied to hold the build sheets down and prevent warping of the build sheet. There is a "VACUUM" button on the HMI. Press the vacuum button to turn on the vacuum to the table. The button will be green when the vacuum is on. To turn off the vacuum, press the button when green, a message window will pop-up asking if you want to turn off the vacuum. Press Ok to turn off the vacuum, this prevents accidentally turning off the vacuum. If the vacuum is used, it is recommended to leave the vacuum on the entire print time and cooling time to prevent warping of the build sheets or the printed part.

## EXTRUDER

The extruder is used to deposit material in the printing process. The extruder has controlled heating zones to process the material before extrusion. See the extruder manual for additional specifications, operations, safety, and maintenance requirements.

### EXTRUDER TEMPERATURE

The extruder has multiple heating zones. The extruder temperature can be adjusted to the optimal extrusion print temperature. The extruder zone temperatures are set through the heating software. The extruder will need to be preheated to the recommended settings by the material datasheet or supplier. The extruder should be given time to reach the desired temperature and time to stabilize before continuing. When turning off the Extruder temperature or not using the heated extruder for an extended time, it is recommended to purge the material from the extruder.

### LOAD MATERIAL INTO EXTRUDER

When the extruder is at its desired temperatures and the material is loaded in the receiver hopper, then the material can be purged through the extruder.

1. Select Manual Mode for the machine mode.
2. Jog the axes to put the extruder over the purge collection container.
3. Press "Setup/Test" button on BAAM HMI application. The Setup/Test window will pop-up. In the window, there will be extruder controls.
4. Set the extruder speed to zero RPMs.
5. Press the "Extruder" button to turn on the extruder.
6. Slowly increase the extruder RPMs, allowing the material to begin to flow down the extruder.
7. Once the material begins to steadily flow out the nozzle, then raise the RPMs to the desired print speed. Verify the quality of the bead and adjust the RPMs or extruder temperatures as needed.
8. Press the "Extruder" button to turn off the extruder.

### PURGING MATERIAL FROM THE EXTRUDER

When shutting down the extruder, material that is loaded in the receiver hopper should be purged from the extruder.

1. Set the material delivery system to stop sending the material up to the receiver hopper.
2. Select Manual Mode for the machine mode.
3. Jog the axes to put the extruder over the purge collection container.
4. Press “Setup/Test” button. The Setup/Test window will pop-up. In the window there will be extruder controls.
5. Set the extruder speed to zero RPMs.
6. Press the “Extruder” button to turn on the extruder.
7. Slowly increase the extruder RPMs, allowing the material to begin to purge from the extruder.
8. Once the material stops flowing from the extruder, the extruder is now purged and can be turn off.
9. Press the “Extruder” button to turn off the extruder.

## MATERIAL

Material to be used for printing should be stored by the recommended supplier specifications. Material dryer is used to preheat and dry the material to supplier specifications or datasheets. Material is delivered from the material dryer to the hopper at the extruder.

## MATERIAL DRYER

The material will need to be preheated and dried to the recommended settings by the material datasheet or supplier. Use the dryer controls to set the drying temperature. Some dryers have the possibility to program a ON/OFF time to have the dryer to automatically turn on, to reduce the start-up time. Some materials will require minimal dry time of a couple of hours. This will need to be done before printing can be started. The pellet dryer has vacuum load to fill the dryer hopper. See the material dryer manual for addition specifications, operations, safety, and maintenance requirements

## MATERIAL DELIVERY

When the material in the material dryer has reached the desired temperature and dry time then the material is ready for delivery. Set the material delivery system to send the material up to the receiver hopper attached to the extruder. Adjust the proximity switch at the receiver hopper to set the level of the material in the hopper. The level should be set so the extruder is not starved of material and at the same time to limit the exposure time of the material being outside of the pellet dryer.

## STARTING UP THE BAAM SYSTEM

### START UP OF THE BAAM SYSTEM

1. Perform the steps in the **SAFETY MAINTENANCE CHECK** portion of **SECTION 3 – SAFETY**, and any steps in the **DAILY MACHINE INSPECTION** portion of **SECTION 9 – MAINTENANCE AND ADJUSTMENTS** of the **System Operation, Safety, and Maintenance Manual** that do not require operating the machine.
2. Turn on Main disconnect, to supply power to the BAAM system.
3. Verify that the chiller is on and set to ‘REMOTE’ mode. Follow chiller warm up procedure to turn on the chiller.
4. Verify that the material dryer is on. The material is preheated and dried to the recommended settings by the material datasheet or supplier. Some dryers have the possibility to program an ON/OFF time to have the dryer to automatically turn on, to reduce the start-up time.
5. To operate the System, log on to the Microsoft Windows® - based PC control to start the System **CINCINNATI BAAM HMI** application. If the previous user did not log off, then the **CINCINNATI BAAM HMI** program should be running. If the screen saver is displayed on the control station monitor, then move the trackball or press any keyboard key to restore the display. If the CNC/HMI user interface is not visible, then proceed with the following instructions to log on.

When the control is first powered-up, the Windows Logon screen will be displayed on the control station monitor. To log on, click a user name and enter the corresponding password. There are different user logon levels, starting with the Operator user.

6. Turn on the Main Drives. When the **CINCINNATI BAAM HMI** application begins running, the *Alarms and Messages* window will display: “Main drives are off”, “Axes have not been homed” and any other fault messages. Make sure all personnel and equipment remain clear of the moving gantry.

Turn main drives on by:

- Press the “RESET” button to clear any other fault messages. Any fault message that did not clear will need to be corrected. See **ALARMS and MESSAGES** section in HMI operation Section of the manual.
- Turn the “DRIVES” selector keyswitch on the Operator



Control Station Panel to the “ENABLED” position, press the “DRIVES ON” pushbutton.

- The “Drives On” indicator on the Control Station Panel should illuminate and the Main drives are off message should disappear from the Alarms and Messages window.
- 7. Home the machine axes. The Alarms and Messages window will display: “Axes have not been homed”. Make sure all personnel and equipment remain clear of the moving gantry.

Home the machine axes by:

- Selecting the “Home Axes” button.
  - Then pressing the “CYCLE START” pushbutton. When the homing operation starts, the “Home Axes” button text changes to “Homing” and the color changes to amber.
  - When all axes have moved to their reference positions, all axis motion stops, the Axes Home function ends, and the Home Axes” button will be illuminated green.
8. When Jogging the machine axes, the machine mode must be in Manual. Press the button for desired motion, hold the button down for continued motion. Release the button to stop motion. Each axis also has a rapid traverse button, which can be toggled on or off. When rapid button is off the speed of the desired axis is reduced. When rapid button is on the speed of the desired axis is increased.
  9. Perform the steps in the **SAFETY MAINTENANCE CHECK** portion of **SECTION 3 – SAFETY**, and in the **DAILY MACHINE INSPECTION** portion of **SECTION 9 – MAINTENANCE AND ADJUSTMENTS** of the System **Operation, Safety, and Maintenance Manual** that require operating the machine control.
  10. The build surface should be clean and debris free. Use build sheets as needed, based on material to be printed. Build sheets should be attached to the build plates to keep the sheet from warping. The build table also has vacuum to help hold down the build sheet. There is a “VACUUM” button on the HMI, press the vacuum button to turn on the vacuum to the table. The button will be green when the vacuum is on. To turn off the vacuum, press the button when green, a message window will pop up asking if you want to turn off the vacuum. Press Ok to turn off the vacuum, this prevents accidentally turning off the vacuum. If the vacuum is used it is recommended to leave the vacuum on the entire

print time and cooling time to prevent warping of the build sheets or the printed part.

11. Heat the table zones. The table temperature can be adjusted to the optimal build surface print temperature. The table zone temperature are set through the heating software. The table temperature is typically set to near the glass transition temperature of the material be printed to help with the adhesion of the first layer and to help prevent part warping.
12. Heat the extruder zones. The extruder temperature can be adjusted to the optimal extrusion print temperature. The extruder zone temperatures are set through the heating software. The extruder will need to be preheated to the recommended settings by the material datasheet or supplier. The extruder should be given time to reach the desired temperature and time to stabilize before continuing.
13. When the material in the pellet dryer has reached the desired temperature and dry time then the pellet are ready for delivery. Set the dryer to send the pellets up to the receiver hopper attached to the extruder. Adjust the proximity switch at the receiver hopper to set the level of the pellets in the hopper. The level should be set so the extruder is not starved of material and at the same time to limit the exposure time of the material being outside of the pellet dryer.
14. When the extruder is at its desired temperatures and the material is loaded in the receiver hopper, then the material can be purged through the extruder.
  - Select Manual Mode for the machine mode.
  - Jog the axes to put the extruder over the purge collection container.
  - Press “Setup/Test” button. The Setup/Test window will pop-up. In the window there will be extruder controls.
  - Set the extruder speed to zero RPMs.
  - Press the “Extruder” button to turn on the extruder. The “Extruder” button will lite green when the extruder is running.
  - Slowly increase the extruder RPMs, allowing the material to begin to flow down the extruder.
  - Once the material begins to steadily flow out the nozzle, then raise the RPMs to the desired print speed. Verify the quality of the bead and adjust the RPMs or extruder temperatures as needed.
  - Press the “Extruder” button to turn off the extruder.

15. Once the machine has been homed, the table temperature is reached and the material has been loaded in the extruder the machine is ready to print. Follow the above procedures to Open and Load a program. The program will be checked, correct any program errors as needed.
16. When the machine is ready to print and the file to be printed is loaded, start the print.
  - Select Auto mode for the machine mode.
  - Verify the program to be printed.
  - Press the “Cycle Start” button to start the machine. You maybe be asked to verify operation and be required to hit the “Cycle Start” button multiple time to get the printing started.

## SHUTTING DOWN THE BAAM SYSTEM

1. When shutting down the extruder, material that is loaded in the receiver hopper should be purged from the extruder.
  - Set the dryer to stop sending the pellets up to the receiver hopper.
  - Select Manual Mode for the machine mode.
  - Jog the axes to put the extruder over the purge collection container.
  - Press “Setup/Test” button. The Setup/Test window will pop-up. In the window there will be extruder controls.
  - Set the extruder speed to zero RPMs.
  - Press the “Extruder” button to turn on the extruder.
  - Slowly increase the extruder RPMs, allowing the material to begin to purge from the extruder.
  - Once the material stops flowing from the extruder, the extruder is now purged and can be turn off.
  - Press the “Extruder” button to turn off the extruder.
2. Turn off the extruder zone through the heating software.
3. Turn off the table zone temperature through the heating software. To prevent the warping of the build sheet it recommend to leave the vacuum on until the table temperature is room temperature.
4. The vacuum can be turned off. To turn off the vacuum, press the button when green, a message window will pop up asking if you want to turn off the vacuum. Press Ok to turn off the vacuum, this prevents accidentally

turning off the vacuum. If the vacuum is used it is recommended to leave the vacuum on the entire print time and cooling time to prevent warping of the build sheets or the printed part.

5. Turn off the main drives by rotating “DRIVES” keyswitch on the Control Station Side Panel to the “LOCK/OFF” position.
6. With the main drives off, the chiller will shut down automatically if the chiller switch is in the “REMOTE” position. If the chiller is in Local mode, switch it to “STANDBY”.

### CAUTION

**If chiller power disconnect has been off for more than 30 minutes, see the chiller manual for recommended startup. Failure to follow this procedure can damage the chiller. CINCINNATI INCORPORATED recommends leaving the chiller power disconnect ON at all times, unless maintenance or repair procedures require turning off chiller power.**

7. Terminate the application using any of the application **Exit** commands.
 

***Note:** CINCINNATI INCORPORATED recommends leaving the machine disconnect on at all times unless maintenance or repair procedures require turning off power to the machine. If no such maintenance or repairs are required, the above steps complete a normal shutdown. If machine disconnect must be turned off, proceed to the next step.*
8. If the main power disconnect is turned off, be sure to wait for the Operator Control Station screen to go completely blank before servicing the System computer. IF equipped the computer is powered by an uninterruptible power supply (UPS), power to the computer will remain on for several minutes after the disconnect is turned off. After the main power disconnect is turned off, the operating system will begin the automatic shutdown procedure. When automatic shutdown is complete, the Operator Control Station screen will be blank, indicating the UPS has turned off power to the computer.

## **DANGER**

The system computer has a UPS (Uninterruptible Power Supply) for power protection. After main power shutdown, the power to the computer will remain on for up to 10 minutes before shutting down.

9. To prevent unauthorized machine operation, remove keys from all key-operated control switches.

*Note: Some keys can operate more than one switch.*





**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, 6-4 and 6-5 for actual component locations.

**Touchscreen:** The touchscreen is a device for monitoring various conditions of the BAAM 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.



**FIGURE 6-2 Screen**

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

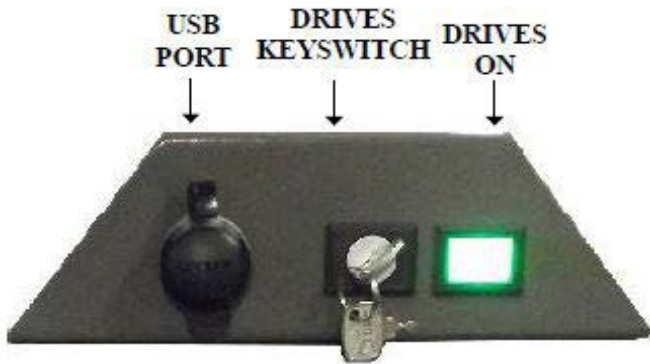


**FIGURE 6-3 Keyboard Control**

**Trackball:** The trackball assembly, or trackball located in the upper right on keyboard, 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 6-4 Trackball**



**FIGURE 6-5** panel Controls

## MACHINE OPERATOR

The panel pushbutton/indicators can be categorized into Drive Controls and Emergency Stop. See Figure 6-1 and 6-5.

### PANEL CONTROLS

On the Operator Control Station is a panel with keyswitches and one pushbutton/indicator. These controls are described in detail below. See Figure 6-4.

### DRIVES KEYSWITCH

**DRIVES keyswitch:** Turning this keyswitch to the LOCK/OFF (Left) position or removing the key disables the motor drives in the BAAM System. Turn this keyswitch to LOCK/OFF before entering any area where the gantry 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.

### DRIVES ON PUSHBUTTON

**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 BAAM System. The indicator is illuminated when the drives are enabled. To turn the drives off, turn the DRIVES selector switch to LOCK/OFF.

### USB CONNECTOR

**USB Connector:** On 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.

## EMERGENCY STOP

The Emergency Stop pushbutton is located on the Operator Control Station. Pressing the Emergency Stop pushbutton stops all axis motion. When this pushbutton is pressed during automatic operation, axis motion decelerates to a stop. To indicate Emergency Stop status, the System Alarms dialog box displays the message “Emergency Stop Pressed”.



**FIGURE 6-6** Key Control

The Emergency Stop pushbutton is locked inward when depressed. The method to unlock the pushbutton by is to rotate it 1/4 turn clockwise.

### WARNING

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

**SEE SUPPLEMENT MANUAL EM-572  
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-572, SECTION 7, OPERATION** – A SUPPLEMENT TO THE OPERATION MANUAL FOR THE CINCINNATI BAAM 100.





NO OPTIONS ARE AVAILABLE AT THIS TIME.



# 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 2000 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 four 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.

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

### ⚠ 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 280 mm.
- ◆ Anti-fretting and corrosion

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

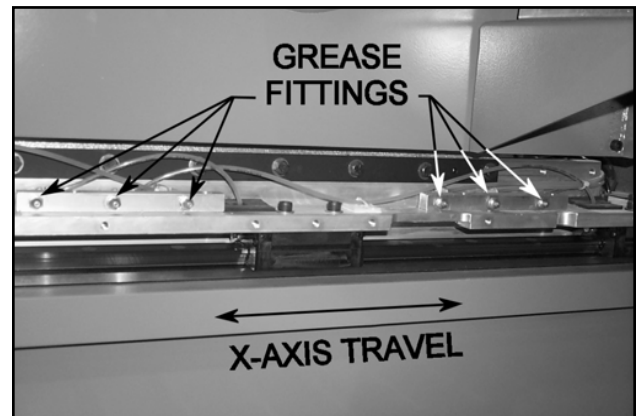
The Maintenance / Statistics window includes parameters to display the accumulated time and distance since the bearings were lubricated. After lubricating the bearings, edit the parameters labeled, “Program Run Time”, “Total X Axis Travel”, “Total Y Axis Travel” and “Total Z Axis Travel” to zero.

### Z-AXIS LUBRICATION

The Z-Axis ballscrew requires manual lubrication every 2000 hours of operation. Figure 9-4 shows the Z-axis ballscrew bearing lube point.

### Z Table Lubrication

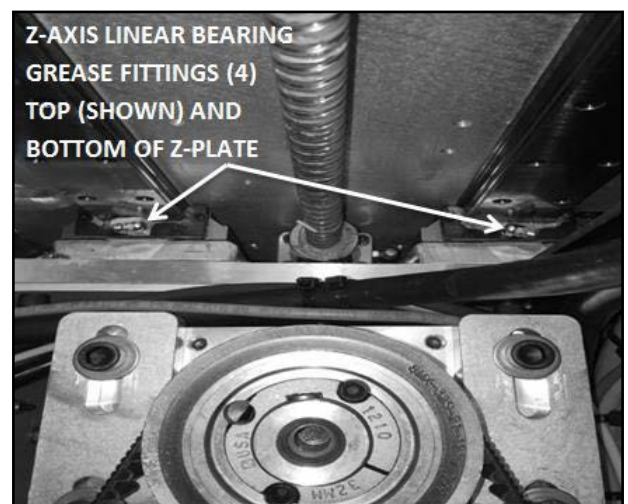
The Z-table jackscrews require a thin layer of lubrication at all times.



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



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



**FIGURE 9-3: Z-Axis Linear Bearing Grease fittings, Top Bearings Shown. (Do not over-grease.)**



FIGURE 9-4: Ballscrew Lube Point

## 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 way covers 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.

## ENCODER MAINTENANCE

The BAAM system X and Y-axes have "open style" linear encoders covered by flexible Way covers. The encoder scales require periodic inspection and cleaning to maintain reliable operation.

### ENCODER CLEANING

The integrated scales are insensitive to contamination (oil, coolant, dust, etc.). Cleaning the scales is only necessary if the X or Y axis motion is unstable. Clean the scales with a soft, dry, lint-free cloth. To remove stubborn contamination, **lightly wet** the cloth with Isopropyl alcohol.

***Note:** Do not use aggressive mechanical cleaning techniques to clean the X or Y-axis liner scale tape.*

*If the liner scale cleaning does not correct motion instability, it may be necessary to clean the X or Y encoder read head. Cleaning the encoder read head requires disassembly. Consult CINCINNATI BAAM Service before removing the encoder read head.*

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

## AIR DRYER

The BAAM system is equipped with a compressed air dryer. Near the dryer entry, there are two coalescing pre-filters. Each filter has a differential pressure indicator, which monitors the pressure drop across the pre-filter. The cartridge should be changed when the indicator approaches the red zone (or annually, whichever is earlier). A filter kit is available; see assembly drawing C.I. #916660

### ⚠ WARNING

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

## INPUT AIR REQUIREMENTS

- 100 PSI Minimum, 125 PSI Maximum. ( 690 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.

## MATERIAL DRYER

See the material pellet dryer manual for maintenance requirements.

### CAUTION

The Material Dryer power is supplied from a different source than the main machine.

## EXTRUDER

See the extruder manual for maintenance requirements.

## MATERIAL DRYER PREVENTIVE MAINTENANCE

### DAILY MACHINE INSPECTION

1. Note any machine problems that might require additional attention. Contact CINCINNATI BAAM Service for assistance in resolving those problems.
2. 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 plastic in and around the printing area that may affect machine operation. Clean any oil or grease films that might trap dirt or other contaminants. Inspect the Z-table rails and

lift screws. Clean as necessary.

2. Remove any debris collected on or near the X and Y-axis encoder scales. Refer to “Encoder Cleaning” in this section.
3. Clean the air filters on the chiller. Dirty filters will reduce the chiller efficiency.
4. 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.
5. Verify that machine operation is prevented when the Emergency Stop button has been pushed.
6. 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. After lubrication, reset the distance traveled to zero.
7. Note any machine problems that might require additional attention. Contact CINCINNATI BAAM Service for assistance in resolving those problems.

## SEMI-ANNUAL (2000 HOURS) MACHINE INSPECTION

Complete the steps in this procedure semi-annually or at 2000 run-time hours, whichever comes first.

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

<u>Component</u>	<u>Fittings</u>	<u>Figure</u>
<b>X-axis linear bearings</b>	6	9-1
<b>Y-axis linear bearings</b>	4	9-2
<b>Z-axis linear bearings</b>	4	9-3
<b>Z-axis ballscrew</b>	1	9-4

### Table

### Extruder

2. 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.

3. Lubricate the Z-axis linear bearings and ballscrew as described in “DRIVES LUBRICATION”.
4. Lubricate the Z-Table linear bearings and lift screws.
5. Replace the filter element (C.I. #921929) for the chiller water input.
6. Clean the chiller condenser.
7. Inspect the machine for coolant leaks and oil leaks. Correct as necessary.
8. Replace all missing or damaged safety signs.
9. Test all machine motion and safety interlocks for proper operation.
10. Remove the way covers to expose the magnet tracks of the X1 and X2 axis linear motors. Dampen a cloth with isopropyl alcohol and clean the tape that covers the magnet tracks. Re-lubricate the tape surface with a bonded dry Teflon spray (C.I. #921916), then re-install the way covers.
11. Note any machine problems that might require additional attention. Contact CINCINNATI BAAM Service for assistance in resolving those problems.

## **ANNUAL MACHINE INSPECTION**

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

1. 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.

## ORDERING REPAIR PARTS

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

1. Serial number of the BAAM-100 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 or from the CD included with your machine.
3. As complete a description of the part as possible.
4. Required delivery date.

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

## RETURNING PARTS FOR CREDIT

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

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

2. The Returned Material 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-based service for prompt service assistance. Factory trained servicemen are available to assist with any service problems. This includes service ranging from minor repairs and adjustments to major reconditioning jobs.
2. Planned Maintenance Service (PMS). This is a program designed to give comprehensive inspections and recommendations concerning the condition of the equipment. PMS is specifically tailored to the machine's specific needs for timely inspections, qualified recommendations, and expert field assistance with repairs to the equipment.

## TECHNICAL TRAINING

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

Additional training and consultation services for specific customer applications are available at additional cost. Please contact our customer Technical Training Department for further information.

## CUSTOMER INFORMATION CENTER

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

### MACHINE DOCUMENTATION

View documentation, such as manuals, related to your CINCINNATI INCORPORATED machines.

### SOFTWARE

View and download available software updates and files.



**CI**ONLINESTORE.COM

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