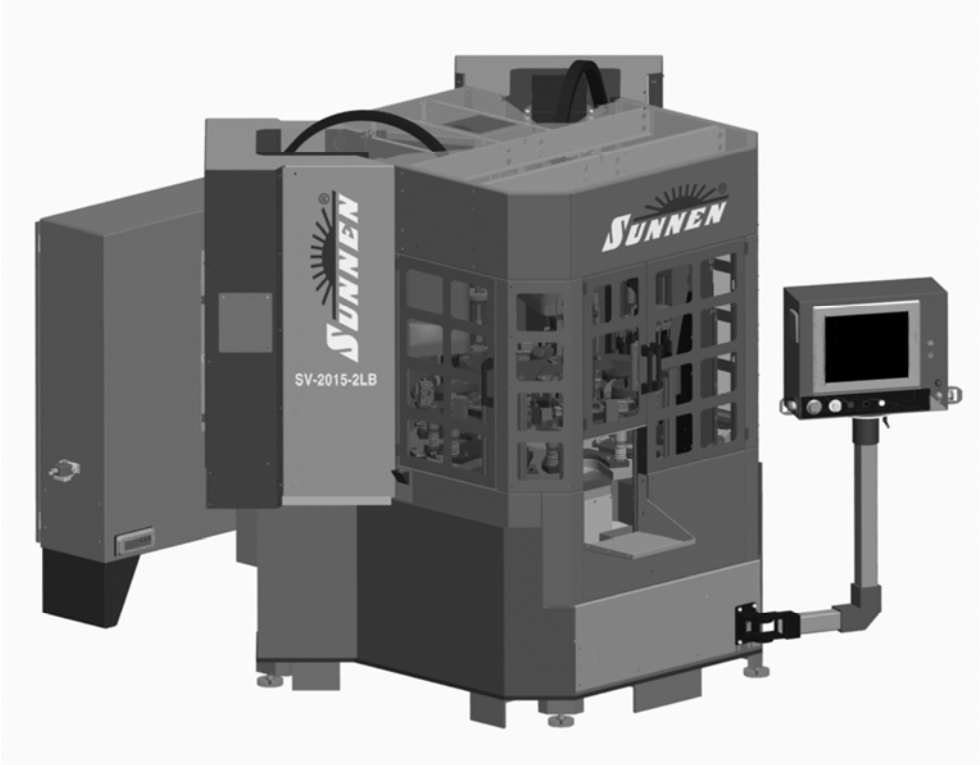
Installation, Setup and Operation

INSTRUCTIONS



FOR

SUNNEN® 2-COLUMN VERTICAL HONING MACHINE

MODEL: SV-2015-2LB

READ THE FOLLOWING INSTRUCTIONS THOROUGHLY AND CAREFULLY BEFORE UNPACKING, INSPECTING, OR INSTALLING THE SUNNEN® SV20152LB 2-COLUMN VERTICAL HONING MACHINES.

SUNNEN® PRODUCTS COMPANY • 7910 MANCHESTER ROAD • ST. LOUIS, MO 63143, U.S.A. • PHONE: 314-781-2100

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READ THE FOLLOWING INSTRUCTIONS CAREFULLY AND THOROUGHLY BEFORE UNPACKING, INSPECTING, OR INSTALLING THE EQUIPMENT.

IMPORTANT: READ ANY SUPPLEMENTAL INSTRUCTIONS BEFORE INSTALLING THIS EQUIPMENT. THESE SUPPLEMENTAL INSTRUCTIONS GIVE YOU IMPORTANT INFORMATION TO ASSIST YOU WITH THE PLANNING AND INSTALLATION OF YOUR SUNNEN EQUIPMENT.

SUNNEN TECHNICAL SERVICE DEPARTMENT IS AVAILABLE TO PROVIDE TELEPHONE ASSISTANCE FOR INSTALLATION, PROGRAMMING, & TROUBLESHOOTING OF YOUR SUNNEN EQUIPMENT. ALL SUPPORT IS AVAILABLE DURING NORMAL BUSINESS HOURS, 8:00 AM TO 4:30 PM CENTRAL TIME.

REVIEW ALL LITERATURE PROVIDED WITH YOUR SUNNEN EQUIPMENT. THIS LITERATURE PROVIDES VALUABLE INFORMATION FOR PROPER INSTALLATION, OPERATION, AND MAINTENANCE OF YOUR EQUIPMENT. TROUBLESHOOTING INFORMATION CAN ALSO BE FOUND WITHIN THE INSTRUCTIONS. IF YOU CANNOT FIND WHAT YOU NEED, CALL FOR TECHNICAL SUPPORT.

WHERE APPLICABLE, PROGRAMMING INFORMATION FOR YOUR SUNNEN EQUIPMENT IS ALSO INCLUDED. MOST ANSWERS CAN BE FOUND IN THE LITERATURE PACKAGED WITH YOUR EQUIPMENT.

HELP US HELP YOU. WHEN ORDERING PARTS, REQUESTING INFORMATION, OR TECHNICAL ASSISTANCE ABOUT YOUR EQUIPMENT, PLEASE HAVE THE FOLLOWING INFORMATION AVAILABLE:

- HAVE ALL MANUALS ON HAND. THE CUSTOMER SERVICES REPRESENTATIVE OR TECHNICIAN WILL REFER TO IT.
- HAVE MODEL NUMBER AND SERIAL NUMBER PRINTED ON YOUR EQUIPMENT SPECIFICATION NAMEPLATE.
- WHERE APPLICABLE: HAVE DRIVE MODEL AND ALL NAMEPLATE DATA. MOTOR TYPE, BRAND, AND ALL NAMEPLATE DATA.

FOR TROUBLESHOOTING, ADDITIONAL INFORMATION MAY BE REQUIRED:

- POWER DISTRIBUTION INFORMATION (TYPE - DELTA, WYE, POWER FACTOR CORRECTION; OTHER MAJOR SWITCHING DEVICES USED, VOLTAGE FLUCTUATIONS)
- INSTALLATION WIRING (SEPARATION OF POWER & CONTROL WIRE; WIRE TYPE/CLASS USED, DISTANCE BETWEEN DRIVE AND MOTOR, GROUNDING).
- USE OF ANY OPTIONAL DEVICES/EQUIPMENT BETWEEN THE DRIVE & MOTOR (OUTPUT CHOKES, ETC.).

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SUNNEN AUTOMOTIVE CUSTOMER SERVICE TOLL FREE AT: 1-800-772-2878

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ESD PREVENTION REVIEW

LET'S REVIEW THE BASICS OF A SOUND STATIC CONTROL SYSTEM AND ITS EFFECTIVE IMPLEMENTATION. FIRST, IN THE THREE STEP PLAN:

1. ALWAYS GROUND YOURSELF WHEN HANDLING SENSITIVE COMPONENTS OR ASSEMBLIES.
2. ALWAYS USE A CONDUCTIVE OR SHIELDED CONTAINER DURING STORAGE OR TRANSPORTATION. THESE MATERIALS CREATE A FARADAY CAGE, WHICH WILL ISOLATE THE CONTENTS FROM STATIC CHARGES.
3. OPEN ESD SAFE CONTAINERS ONLY AT A STATIC SAFE WORK STATION.

AT THE STATIC SAFE WORK STATION, FOLLOW THESE PROCEDURES BEFORE BEGINNING ANY WORK:

A. PUT ON YOUR WRIST STRAP OR FOOT GROUNDING DEVICES.

B. CHECK ALL GROUNDING CORDS TO MAKE SURE THEY ARE PROPERLY CONNECTED TO GROUND, ENSURING THE EFFECTIVE DISSIPATION OF STATIC CHARGES.

C. MAKE SURE THAT YOUR WORK SURFACE IS CLEAN AND CLEAR OF UNNECESSARY MATERIALS, PARTICULARLY COMMON PLASTICS.

D. ANTI-STATIC BUBBLE WRAP HAS BEEN INCLUDED FOR USE AT THE MACHINE WHEN AN ESD SAFE WORKSTATION IS NOT AVAILABLE.

YOU ARE NOW PROPERLY GROUNDED AND READY TO BEGIN WORK. FOLLOWING THESE FEW SIMPLE RULES AND USING A LITTLE COMMON SENSE WILL GO A LONG WAY TOWARD HELPING YOU AND YOUR COMPANY IN THE BATTLE AGAINST THE HAZARDS OF STATIC ELECTRICITY. WHEN YOU ARE WORKING WITH ESD SENSITIVE DEVICES, MAKE SURE YOU:

GROUND

ISOLATE

NEUTRALIZE

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  - › SHIPMENT TO THE CUSTOMER (FOR ITEMS DELIVERED TO CUSTOMER OR CUSTOMER'S AGENT F.O.B., SHIPPING POINT)
  - › INCORRECT INSTALLATION INCLUDING IMPROPER LIFTING, DROPPING AND/OR PLACEMENT
  - › INCORRECT ELECTRIC POWER (BEYOND +/- 10% OF RATED VOLTAGE) INCLUDING INTERMITTENT OR RANDOM VOLTAGE SPIKES OR DROPS
  - › INCORRECT AIR SUPPLY VOLUME AND/OR PRESSURE AND/OR CONTAMINATED AIR SUPPLY
  - › ELECTROMAGNETIC OR RADIO FREQUENCY INTERFERENCE FROM SURROUNDING EQUIPMENT (EMI, RFI)
  - › STORM, LIGHTNING, FLOOD, OR FIRE DAMAGE
  - › FAILURE TO PERFORM REGULAR MAINTENANCE AS OUTLINED IN SPC MANUALS
  - › IMPROPER MACHINE SETUP OR OPERATION CAUSING A CRASH TO OCCUR
  - › MISAPPLICATION OF THE EQUIPMENT
  - › USE OF NON-SPC MACHINES, TOOLING, ABRASIVE, FIXTURING, COOLANT, REPAIR PARTS, OR FILTRATION
  - › INCORRECT SOFTWARE INSTALLATION AND/OR MISUSE
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SAFETY INSTRUCTIONS

READ FIRST

This machine, like any equipment, may be dangerous if used improperly. Please read all warnings and instructions before attempting to use this machine.

Always disconnect power at main enclosure before servicing machine.1

Always wear eye protection when operating this machine.

NEVER open or remove any machine cover or protective guard with power "ON." Always disconnect power at main enclosure before servicing this equipment.1

DO NOT attempt any repair or maintenance procedure beyond those described in this book. Contact your Sunnen® Field Service Engineer or Technical Services Representative for repairs not covered in these instructions.

Due to the wide variety of machine configurations, all possibilities cannot be described in these instructions. Instructions for safe use and maintenance of optional equipment ordered through Sunnen, will be provided through separate documentation and/or training provided by your Sunnen Field Service Engineer or Technical Services Representative.

DO NOT attempt to defeat any safety device on this machine or on any of the optional equipment.

If specially built automation components are added to this system, be sure that safety is not compromised. If necessary, obtain special enlarged work area safety system from Sunnen Products Co.

[1] DO NOT TOUCH ELECTRICAL COMPONENTS UNTIL MAIN INPUT POWER HAS BEEN TURNED OFF AND *CHARGE* LAMPS ARE EXTINGUISHED. WARNING: THE CAPACITORS ARE STILL CHARGED AND CAN BE QUITE DANGEROUS.

IMPORTANT NOTE

The temperature requirements of the Sunnen® SV20152LB 2-Column Vertical Honing Machines have been established as 35 degrees C (95 degrees F). Above this temperature, an optional cooler will be available to handle temperatures from 35º to 46º C (95º to 115º F). IT IS NOT recommended that the SV machine be operated at temperatures above 46º C (115º F). Sunnen Products Company warrants the SV machine for operating environments up to 35ºC (95º F). For operating environments of 35º to 46º C (95º to 115º F) the warranty only applies if the optional cooler is installed on the machine. No warranty coverage is offered for operating environments above 46º C (115º F).

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INTRODUCTION

This Instruction Manual provides information required to install, operate, and maintain Sunnen® Vertical Honing Machine.

When ordering parts for, or requesting information about your machine, include model and serial numbers, located on electrical enclosure of your machine.

The Sunnen® Vertical Honing Machine is to be used for finishing bores in small workpieces. In finishing bores, this machine can achieve any or all of following results: fast stock removal, consistent final size, a high degree of cylindrically, fine surface finish. To achieve best results and ensure safe operation, ONLY Sunnen tools and abrasives are to be used in the SV machines.

GENERAL INFORMATION & SPECIFICATIONS

SUNNEN® SV-2015-2LB SERIES 2-COLUMN VERTICAL HONING MACHINES

	COLUMN A	COLUMN B
Diameter Range (ID)[1]:	3 - 65 mm (0.12 - 2.56 in.)	3 - 65 mm (0.12 - 2.56 in.)
Workpiece Length [1]:	250 mm (9.8 in)	250 mm (9.8 in)
Work Area Envelope (Table) [3]:	175 x 175 x 150 mm (7 x 7 x 6 in.)	175 x 175 x 150 mm (7 x 7 x 6 in.)
Carriage Travel:	630 mm (24.8 in.)	630 mm (24.8 in.)
Carriage Speed:	0,001 to 0,800 mps (2 to 2000 ipm)	0,001 to 0,800 mps (2 to 2000 ipm)
Reciprocation Speed (Stroke):	30-400 spm	30-400 spm
Column Motor:	7,5 kW (10 hp)	7,5 kW (10 hp)
Spindle Speeds:	100 to 4000 rpm	100 to 4000 rpm
Spindle Motor:	7,5 kW (10 hp)	7,5 kW (10 hp)
Feed Force:	Up to 3800 newtons (850 lbs.) force	Up to 3800 newtons (850 lbs.) force
Sump Pump [2]:	Centrifugal Pump	
Sump Pump Motor [2]:	0,67 kW (.5 hp)	
Sump Pump Rate [2]:	208 LPM @ 4 m (55 GPM @ 15 feet)	
Coolant System:	Optional	
Coolant Requirements:	Sunnen Industrial Honing Fluids	
Floor Space: (Doors Open & Column at Top of Travel)	3200 W x 4956 D x 2946 H mm (126 x 195 x 116 in.)	
Floor Weight (Dry):	6668 kg (14700 lbs.)	
Floor Load:	2050 kg/sq. meter (415 lbs./sq. ft.)	
Pneumatic Requirements:	5,5 to 6,9 Bar (80 to 100 psi)	
Electrical Requirements:	460V, 60Hz, 3Ph; 400V, 50Hz, 3Ph	
Color:	Black/Stainless Steel	
Noise Emission:	Less than 76 dB(A) continuous: Less than 78 dB(A) peak: Load (max. noise) condition in a typical	

1 Diameter range, length range, and workpiece weight are contingent on workpiece and application.
2 The SV Machines DO NOT come with a Coolant System. The Coolant System is an option and MUST be ordered separately.
3 Work Area may vary with machine configurations and options ordered.

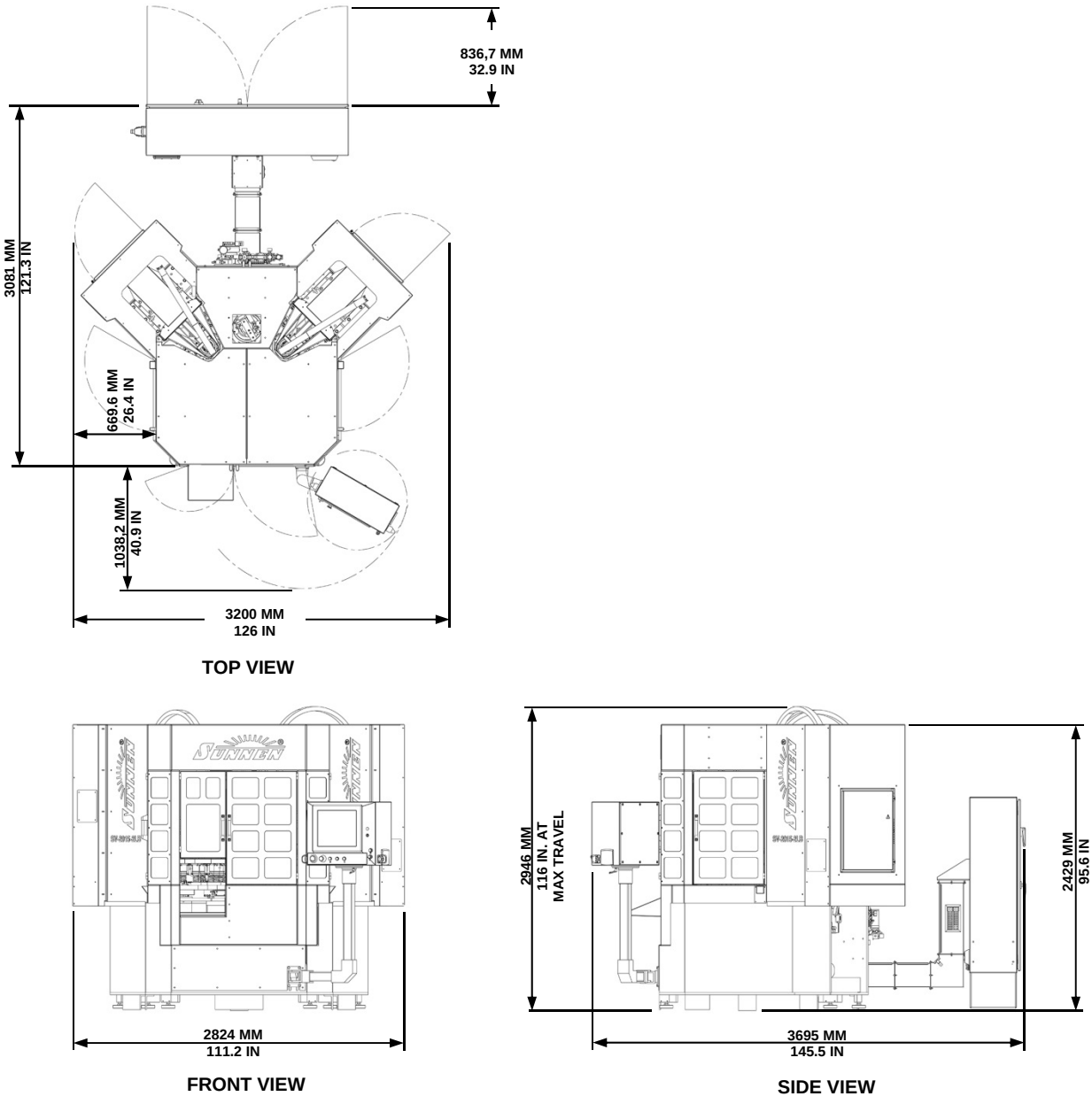

Figure 1-A, Floor Plan Layout

SECTION 1
INSTALLATION

PURPOSE

Consult this section when unpacking, inspecting, and installing Sunnen® 2-Column Vertical Honing Machine, hereafter referred to as the machine.

SAFETY SYMBOLS

For a description of safety symbols that may be used on this machine, *refer to Table 1-1, Safety Symbols.*

TABLE 1-1, Safety Symbols

SYMBOL	DESCRIPTION	FUNCTION
	Warning Label	Warns that an electrical hazard exists.
	Warning Label	Warns that safety glasses should be worn at all times when operating this machine.
	Label	Designates this machine is “CE” compliant.
	Warning Label	Warns that a *hazard from objects falling off work table* exists and that proper precautions should be taken.
	Warning Label	Warns that an arc flash hazard exists.

TOOLS & MATERIALS

The following tools and materials are required for unpacking and installing of your machine:

Knife	Hex Wrenches
Hammer	Open End Wrench
Crow Bar	Cleaning Solvent
Tin Snips	

MAJOR COMPONENTS

For location and function of major components on this machine, *refer to the following list and Figure 1-1, Major Components.*

1a. The *machine base* is equipped with

1b. *Leveling bolts* for stabilizing machine and

1c. *Stainless steel guard doors.*

2a. *Column electrical enclosure*.

2b. *Machine electrical enclosure*.

3a. The *operator station* houses all electronic hardware and software for hone control. It is also main operator interface with machine.

3b. The *carriage controls*. *(Not Shown)*

4a. A *ball screw stroker assembly*, which provides stroking power to *(Not Shown)*

4b. the *spindle carriage*, which is mounted on *(Not Shown)*

4c. the *column assembly*, which houses *(Not Shown)*

4d. the *spindle motor*, which by way of a belt drives *(Not Shown)*

4e. the *spindle nose*, which imparts stroking and rotational motion from spindle to honing tool. *(Not Shown)*

5a. An *indexing table* (optional) allows the *(Not Shown)*

5b. *Workholding fixture* (optional) to be indexed and aligned with tool. *(Not Shown)*

6a. The *adjustable coolant lines* allow manual regulation of honing fluid flow. *(Not Shown)*

7a. The *sump pump* pumps coolant from the machine base reservoir. *(Not Shown)*

7b. A *coolant interface* allows an optional coolant system to be attached to the machine. *(Not Shown)*

8a. A *coolant system* (optional) can be added to ensure debris is removed from coolant. *(Not Shown)*

8b. *Coolant maintenance kit* (optional). *(Not Shown)*

9a. *Gaging system* (optional). *(Not Shown)*

9b. *Air gage feedback interface* (optional). *(Not Shown)*

10. An *automatic lubricator* provides grease to the major components of the machine. *(Not Shown)*

11a. *Tooling* (optional). *(Not Shown)*

11b. *Tool alignment stand* (optional). *(Not Shown)*

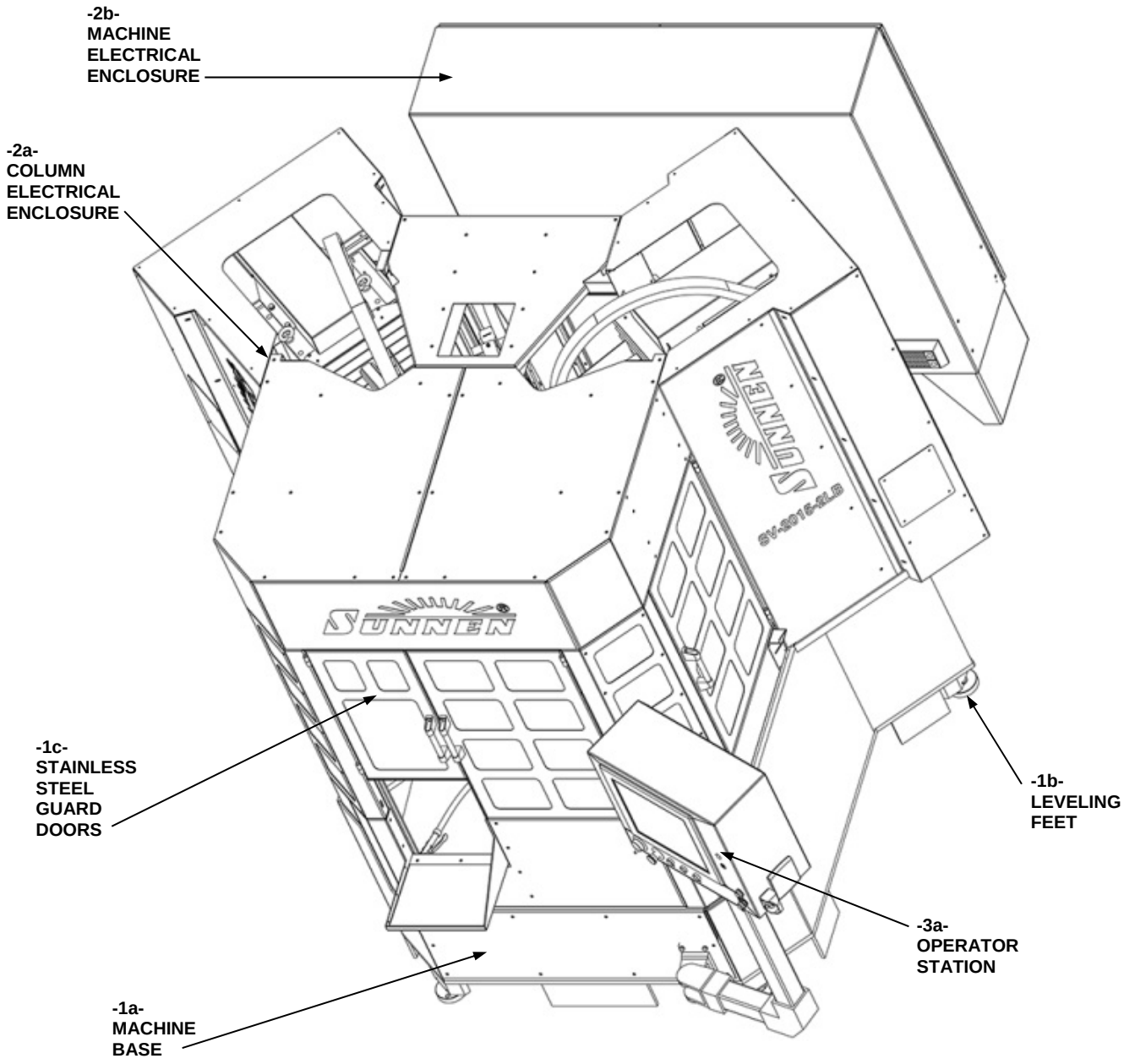

Figure 1-1, Major Components

INSTALLATION

Read the following instructions carefully and thoroughly before unpacking, inspecting, and installing your machine. All references to right and left in these instructions are, unless otherwise noted, as seen by operator as one looks at machine or assembly being described. *Refer to Figure 1-2, Vertical Honing Machine.*

NOTE: When ordering parts for, or requesting information about your machine, include model number and serial numbers that are printed on the nameplate.

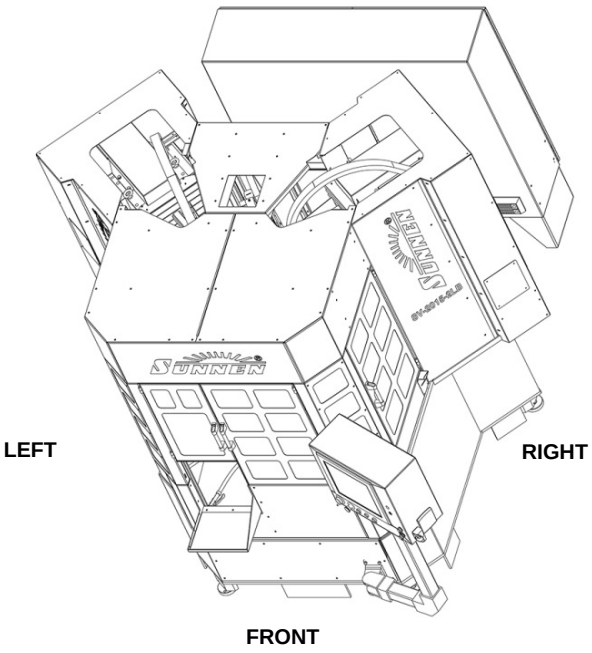

Figure 1-2, Vertical Honing Machine

1. Move machine to staging/unpacking area.
2. Remove carton and plastic wrap. Cut, remove, and discard shipping bands.
3. Remove all loose components from carton.
4. Check all components against items ordered.
5. Inspect machine and components for dents, scratches, or damage resulting from improper handling, by carrier. If damage is evident, immediately file a claim with carrier.

CAUTION

Weight is approx. 5756 kg (12,690lb).

6. Remove bolts securing machine to skid.
7. Using a forklift, slide forks (minimum 7 feet long) under machine as shown. *Refer to Figure 1-3, Fork Lift.* Lift machine and install leveling feet. *Refer to Figure 1-5, Leveling Foot.*
8. Using a forklift, remove machine from skid and move to desired location and lower into place.

NOTE: Machine should be located on a leveled concrete floor away from heavy traffic. Allow at least 1 meter (38 inches) around enclosure to any adjacent equipment and walls. *Refer to Figure 1-A, Floor Plan Layout.*

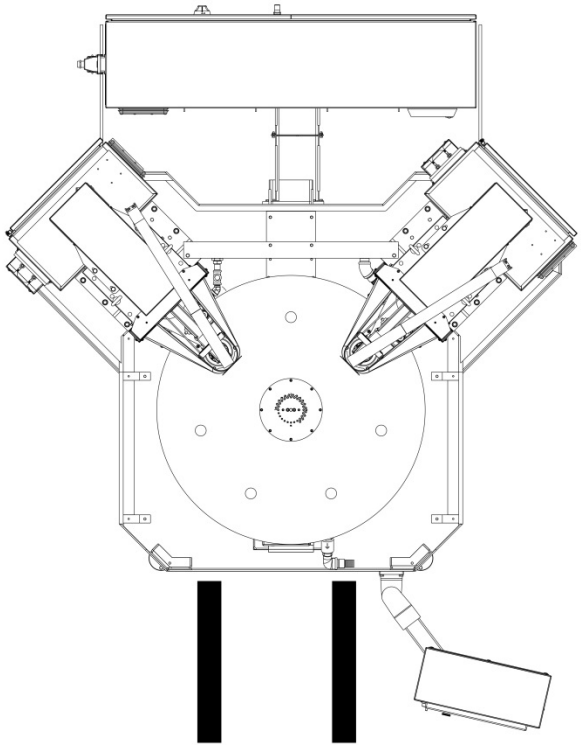

Figure 1-3, Fork Lift

9. Once machine is in desired location; move main electrical enclosure away from machine base and reinstall straight section of wire way removed for shipping. *Refer to Figure 1-4, Electrical Wireway.*

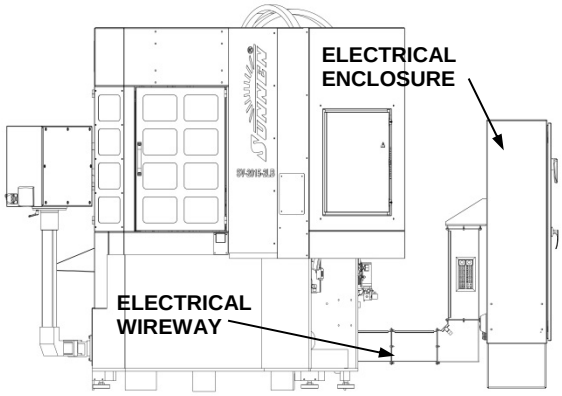

Figure 1-4, Electrical Wireway

10. Place a machinist's level on machine table and level machine by adjusting leveling bolts on the leveling feet, using a 24mm open-end wrench. Adjust leveling bolt in six leveling feet as required. Tighten jam nuts to lock bolt in place. *Refer to Figure 1-5, Leveling Foot.* Machine does not need to be bolted to floor, but should be set on a solid concrete floor of six inch minimum thickness.

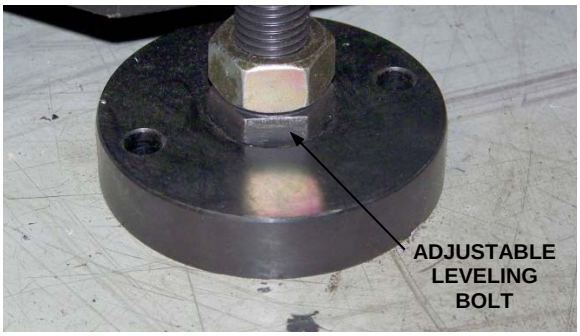

Figure 1-5, Leveling Foot

NOTE: The cable track has been disconnected from column for shipping purposes.

11. Reattach cable track to top of column using bolt and washer supplied. *Refer to Figure 1-6, Cable Track.*

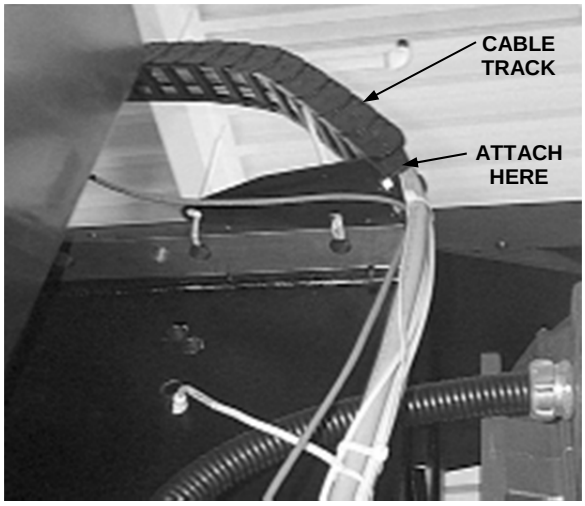

Figure 1-6, Cable Track

12. Wipe all protective shipping oil and grease from machine.

PNEUMATICS

Refer to Figure 1-7, Air Line Routing and connect pneumatic line (air line) as follows:

NOTE: The factory air supply line is not supplied. A minimum of 0,55 MPa (80 psi) clean, dry compressed air is required for proper operation.

1. Connect factory air supply to air line port on filter/regulator.

NOTE: Air line port is 1/2 Rc (BSPT).

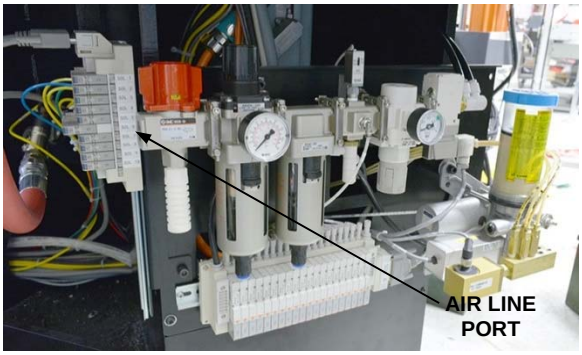

Figure 1-7, Air Line Routing

CAUTION

Do not connect machine to any air supply with a pressure greater than 1,4 MPa (200 psi).

2. Filter/regulator has been factory set to .55 MPa (80 psi). Air supply to machine must be at least this or machine's special fixturing and accessories will not operate properly. With air supply connected, check regulator gage for .55 MPa (80 psi). If not set correctly, lift knob on top of regulator and turn to adjust. After setting correct regulated pressure, push knob down to lock.

LUBRICATING SYSTEM

The machine is equipped with an automatic grease lubricating system.

Grease reservoir is filled at the factory with Kluberplex #BEM 34-132 or its equivalent. System is equipped with a pressure switch, which flashes a warning on the operator display screen when the level/pressure drops below minimum requirement.

ELECTRICAL

All wiring is to be performed by a competent, licensed electrician in accordance with all local, state, and federal codes and regulations; along with any special information provided on machine nameplate or electrical specification plate.

CAUTION

This machine was wired for 460VAC. If it is to be run at 400VAC, the taps on the control transformer must be changed. All wiring is to be performed by a competent, licensed electrician in accordance with all local, state and federal codes and regulations. FAILURE TO COMPLY CAN RESULT IN PERSONAL INJURY AND DAMAGE TO THE MACHINE.

WARNING

All wiring and electrical equipment service should be performed by authorized personnel ONLY.

CAUTION

Do not attempt to connect machine if supply voltage is not within following acceptable limits as noted on nameplate or electrical specification plate. If supply voltage is not within these limits MACHINE WILL BE DAMAGED.

Verify supply voltage is the same as voltage on machine nameplate or electrical specifications plate, located on front of enclosure.

Electrical Connection

A pre-drilled hole has been provided in the electrical enclosure for electrical supply cord (not supplied). *Refer to Figure 1-8, Electrical Connection* and connect cord as follows:

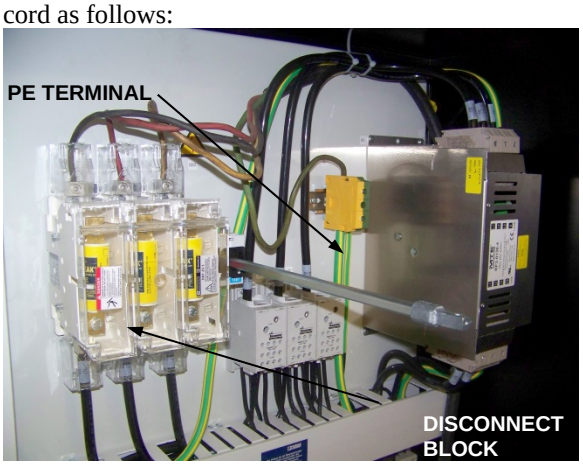

Figure 1-8, Electrical Connection

1. Unlock door to electrical control enclosure using key supplied with machine
2. Turn disconnect ON/OFF switch to OFF position and open door. Door WILL NOT open unless disconnect ON/OFF switch is in OFF position.
3. Open door to enclosure.

WARNING

You must use the hole provided. Drilling any new holes in the electrical enclosure may void the warranty.

CAUTION

Door is equipped with lockable safety door latch. Door should be closed and latched during operation to prevent accidental interruption of operation from doors being opened. Door latch should be locked-out and tagged-out during servicing to prevent machine from being powered up.

4. Remove hole plug located on top, right side of the enclosure. Then install an oil tight fitting.
5. Insert electrical supply through oil tight fitting and route to electrical disconnect block. Allow for approximately 305 mm of cable from where it enters enclosure; then cut off excess. Electrical supply must include a proper earth ground.
6. Strip 254 mm (10 in) off cable's outer jacket.
7. Strip 6 mm (1/4 in) of insulation off each wire.
8. Connect green wire (earth ground) to terminal PE on electrical disconnect switch (earth ground).
9. Connect other three wires to disconnect block (1DISC) as noted on block (1L1, 3L2, 5L3).
10. Route and secure cord inside of enclosure.
11. Tighten oil tight fitting.
12. Close and secure/lock door(s) to enclosure.
13. Remove lock-out/tag-out device. Turn disconnect ON/OFF switch ON.

COOLANT SYSTEM

The machine comes with a sump pump within the base of the machine for return of dirty coolant. Because of the numerous application possibilities, the machine is not supplied with a coolant system, however optional coolant systems are available.

Placement and system requirements will vary with coolant system used. Sunnen provides several optional coolant systems.

Check with your local Sunnen Products Company representative, or authorized distributor, for available systems or before installing another manufacturer's system.

NOTE: Operating Instructions and Repair Parts Manuals for the optional coolant systems are supplied by the systems manufacturer.

Fill coolant reservoir with either Sunnen Industrial Honing Oil or Sunnen Water-Based Coolant. *Refer to coolant systems manufacturer's instructions.*

Coolant System Connection

CAUTION

Supply coolant pressure should not exceed 20 psi (0,14 MPa).

The machine comes with a sump pump within the machine base. Intake and outlet connections are located near the bottom of the back of the machine base. A flow sensor is installed inline with the supply line connection on the right side of the machine base when viewed from the machine's back. A return line (without flow sensor) connects on the left side of the machine base when viewed from the machine's back.

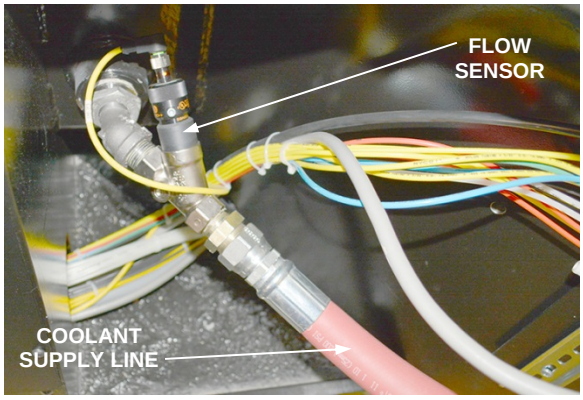

Figure 1-9, Coolant System Connection

MAGNETIC SEPARATOR (OPTIONAL)

Like the coolant system, the machine is not supplied with a magnetic separator. If your application produces large amounts of metal residue, it is recommended that you employ a magnetic separator or filter system (or both). Check with your local Sunnen Products Company representative, or authorized distributor, for available options or before installing another manufacturer's system.

FIXTURE (OPTIONAL)

Because of the numerous applications possibilities the machine is not supplied with any fixturing, however optional fixtures are available. Check with your local Sunnen Products Company representative, or authorized distributor.

OPERATIONAL CHECK

Read Sections 1, 2 and 3 thoroughly and carefully before performing the operational check.

NOTE: Power up and start machine to check for proper operation.

1. Release E-STOP and press power ON button.
2. Power-up machine and check rotation of sump pump motor. Rotation of shaft should be as shown on motor cover.
3. If rotation is incorrect, turn power to machine OFF and reverse any two wires (red, white, or black) of electrical supply cord, where they connect to disconnect block.
4. Operate machine and check rotation of optional equipment according to installation instruction package with optional equipment.
5. Set up and test all machine functions. *Refer to Section 3, Safety and Shutdown.*
6. After unpacking and installing machine, clean and lubricate. *Refer to Section: 4, Routine Maintenance.*

SECTION 2
PREPARING FOR OPERATION

GENERAL

Consult this section when preparing machine for operation.

OPERATOR CONTROL PANEL

For location and function of operator controls, *refer to Figure 2-1, Operator Control Panel and Table 2-1, Operator Control Panel.*

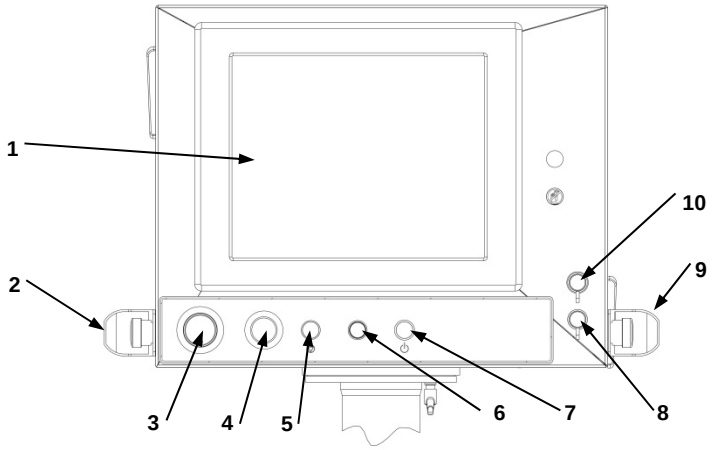

Figure 2-1, Operator Control Panel

TABLE 2-1, Operator Control Panel

LOCATION	DESCRIPTION	FUNCTION
1	LCD Display and Touch Screen Operator Panel	Operation of the machine can generally be done via the touch screen, which means that a function may be started by touching the corresponding key on the screen.
2	Left Palm Button	Press both palm buttons (left and right simultaneously) to start cycle.
3	Stroker/Tool Positioning Handwheel	Select either Tool Position or Tool Feed Mode on Operator Touch Screen, then Tool Position Mode: Dial can be used to position tool vertically in bore (up or down). Tool Feed Mode: Dial can be used to expand or retract stones in bore.
4	Emergency STOP (E-Stop) Button	Shuts all power to the machine functions OFF. Button must be released before power ON button can be pushed.
5	Cycle STOP Button	Brings the machine to a controlled stop at the first available opportunity when any axis is in motion.
6	Manual Dwell Button	Switch is used to make stroker dwell while machine is honing. (**NOTE**: Under Run screen, Run Settings, Control Tab, Column A Bore Profile, there are five marks in middle of screen that represent five locations in bore. Use the up or down arrow keys, to move this marker to desired location of dwell. When dwell button is pressed, stroker will dwell in that location for two seconds.) For continuous dwell, hold the Dwell Button for the desired length of time.
7	Power ON Button/Light	Turns control power to the machine ON. Light illuminates when power is ON.
8	USB Port	Allows for connection of a USB device.
9	Right Palm Button	Press both palm buttons (left and right simultaneously) to start cycle.
10	Ethernet Port (Optional)	Allows Sunnen Service personnel to connect to Simotion for diagnostics purposes or to the Internet.

SECTION 3
SETUP & OPERATION

GENERAL

This section gives step-by-step setup and operating Procedures for Sunnen® 2-Column Vertical Honing Machine.

SAFETY PRECAUTIONS

The following precautions should be observed to ensure maximum safety while working on or around the machine.

- Wear proper safety items (such as safety glasses and other personal safety equipment as necessary or required).
- DO NOT wear loose fitting clothes or jewelry while working on or around machine.
- Keep area around machine free of paper, oil, water and other debris at all times.
- Keep machine and area around machine cleaned of excessive lubricant and lubricant spills.
- Keep tools and other foreign objects clear of machine while in operation.
- Keep tools clean and in their proper storage compartments to maintain them in proper working condition and to prolong tool life.
- Inspect Tools before using. Check for cracks, burrs, or bent parts that might affect operation.
- DO NOT force tools when operating. Tools will do a better and safer job when operated at the rate for which they were designed.
- Turn OFF electrical power when performing service on your machine, which does not require power.
- Disconnect machine from main power supply and allow drives to drain before any work is performed inside of electrical enclosure.
- Ensure all Guards are in place and are in proper working order.
- DO NOT override safety switches or lockouts. Where interlocking systems rely on special actuators or keys, DO NOT keep spare/master actuators or keys on, around or near machine.
- Use proper lifting procedures when loading and unloading the machine.
- Keep all non-essential persons clear of work area. Visitors, especially children, should not be permitted near the work area.
- DO NOT use machine for other than its intended use. Using these machines for other purposes could result in damage to machine and loss of warranty.
- Be sure to work in a well-lit area
- Use ONLY factory authorized or recommended parts or replacement accessories. Using parts or accessories other than those approved by Sunnen could result in damage to machine and loss of warranty.
- Electrostatic discharge can damage the circuitry of the electronic components used in this machine. Use proper electrostatic controls when working with or around electronic components. Ground machine and use wrist strap to reduce the chances of static discharge.
- Residual Voltage exists for 2-3 minutes after master ON/OFF switch is turned OFF. Before working inside enclosure, wait for all fans to stop running to allow drives to drain. Machines equipped with uninterrupted power supply (UPS) please wait 3 minutes before restarting the system after power has been shut off at main power supply.

SETUP - INITIAL

To set up your machine for operation select SETUP from main menu. The machine's operating system software will walk you through the setup procedure step-by-step on the display screen. Follow all instructions carefully.

SETUP - INDEXING TABLE

Machines Equipped with a Rotary Indexing Table

On top of the table is a round tooling plate. This plate is the mounting surface for the work piece holding fixtures. If your fixtures were purchased as part of a complete Honing System, it is likely that the tooling plate was machined specially to mount the unique fixtures for your application. If you are making your own fixtures, you will probably have to machine the tooling plate to accept the fixtures you provide.

If your Sunnen fixtures arrive assembled to the tooling plate, then they have also been accurately aligned to the spindles for best honing performance. No other alignment should be necessary, but be sure to read any special instructions that come with your unique fixtures. If you are providing the fixtures or if they are taken off the tooling plate for any reason, they must be aligned to the spindles when they are reinstalled.

The tooling plate is bolted and pinned to the rotary indexing table. The roll pin provides precise repeatability of location if the tooling plate is ever removed.

The rotary indexing table can be made to index only through simultaneously touching palm buttons on the side of the operator control panel. *Refer to Figure 2-1, Operator Control Panel.*

The control program will only allow this indexing motion at points in the Setup or in Diagnostics Modes where it is safe and pertinent to the instructions displayed on the operator control console screen.

CAUTION

Never attempt to activate the palm buttons without first reading the display screen. .

At some points during the setup and operation, the indexing table will only move one station at a time; the table may continue to move until the required position is reached.

SETUP - FIXTURE INSTALLATION

This procedure is provided as an overview to align fixture base with spindle. For detailed instructions; refer to instructions packaged with your fixture. To initially align Spindle and Fixture, proceed as follows:

1. Install Fixture bases at each station on table. Roughly align fixtures with hole in table and secure with mounting bolts. Snug, DO NOT tighten bolts at this time.

2. On spindle column mount a dial indicator.

3. Close all Guards.

4. Turn ON power at Master ON/OFF Switch, located on Electrical Enclosure.

5. Release Emergency STOP Button on Operator Control Console.

6. Press POWER-ON Button.

7. Press Palm Buttons to HOME the machine.

8. Go to Main Menu. System Settings and click on Indexing Settings Tab.

9. Press Index Positions and select number of positions (fixture) and press OK.

10. Go to Diagnostics, Machine and click on Index Table Tab.

11. Verify that tooling is out of way of fixtures.

12. Press and hold Palm Buttons to position fixture #1 under spindle.

13. Open Guards.

14. Position indicator so it can sweep a hole or other cylindrical surface on your fixture.

15. Turn the spindle by hand (with Power OFF) and read the indicator. Adjust fixture location until precise alignment is achieved. The allowable amount of misalignment depends on your application and the type of fixturing used.

16. Then, tighten mounting bolts.

NOTE: An alternate method is to mount a special close fitting alignment bar in the spindle, adjust its run out to nearly zero (see run out adjustment), and then use this bar to locate fixture on tooling plate.

17. When first fixture is aligned, advance table to next fixture and align next fixture.

18. Repeat with each fixture in turn, until all fixture bases are aligned.

19. Route and attach airlines to fixtures as needed.

20. Attach and position coolant lines at column.

SETUP - TOOL INSTALLATION

To set up your machine for operation select SETUP from main menu. The machine's control software will walk you through the setup procedure step by step on the display screen. Follow all instructions carefully. If additional information is needed at any time during set up, refer to the related setup overview, which follows.

Consult the Operating Display Screen manual I-SV-124(-SE) for more detailed Explanation of feature with definitions. (Machine's control software will walk you through the setup procedure step-by-step on the view screen. Follow all instructions carefully.)

1. Install Workpiece.

2. Release E-stop by turning clockwise.

3. Press Power ON button.

NOTE: After E-Stop Button is pushed; Power ON button must be pushed once to reset E-Stop relay and again to turn ON control power.

4. Once Main Menu display screen appears, press F1, Setup Menu.

5. Then press F2, New Setup.

6. Follow direction on display screen for entering a new setup:

START DIAMETER:

Key in desired value using key pad - Press OK to accept.

FINAL DIAMETER:

Key in desired value using key pad - Press OK to accept.

BORE LENGTH:

Key in desired length - Press OK to accept.

MATERIAL:

Select material - Press OK to accept.

HARDNESS:

Select hardness - Press OK to accept.

SELECT BLIND BORE OPTION:

Enter blind bore amount - Press OK to accept

7. Press NEXT and continue to Diameters page:

- Change start and finish diameter for Column A
- Change Start and finish Diameter for Column B.

8. Press NEXT and continue to follow direction on display screen for Index Table. (Check all required boxes for table position part status.).

- This screen allows for the setting of the various airlines.
- Active Airlines by clicking in boxes.

9. Press NEXT and continue to follow direction on display screen:

- This screen allows for the setting of the Fixture Interlocks.
- These settings are calculated based on preprogrammed information. Do Not change these settings at this time.

COLUMN A AND B SETUP (SPECIFIC TO HUSQVARNA APPLICATION)

- Column A Tool Selection –This will display your tool selection options.
- Select Tool Adapter.

(Husqvarna)

Select Tool Family.

(User)

Select Tool.

(TC xxxx-xx)

10. Press NEXT and continue to follow direction on display screen for Column A Setup:

- Column B Tool Selection –This will display your tool selection options.
- Select Tool Adapter.

(Husqvarna)

- Select Tool Family.

(User)

- Select Tool.

(TC xxxx-xx)

11. Press NEXT and continue to follow direction on display screen for Column B Setup.

12. Press NEXT and select Install New Tool.

13. Press NEXT and follow direction on display screen for installing tool

---

NOTE: Refer to instructions for Tool Installation.

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14. Once tool is installed; press NEXT and then press YES.

15. Set tool SNUG: Automatic snug is the preferred method used with a multiple spindle machine. With manual snug moving tool around in bore, while using hand wheel, expand tool (CW) or retract tool (CCW), until tool feels snug in bore.

16. Press TEACH to set Snug Diameter. Box to right will turn green and display “the snug size is set.”

17. Press NEXT and continue the follow direction on display screen to set spindle speeds feed rates on each tab. Helpful hint: Use file SAVE AS (Windows) make changes to new set ups without affecting the current setup

18. Press NEXT and continue the follow direction on display screen for setting stroke use manual stroker function set up found on the honing tab page.

19. With Manual stroker function you must also set limits it is also important that you check the lock out bottom of stroke button (This will keep the operator from making adjustments to the bottom stroke position due to a blind bore)

20. Press NEXT when stroke is set and follow directions on display screen for setting load position.

21. Press FINISH when stroke is set.

22. Repeat steps 17-21 for Column B following the directions on the screen.

23. Press FINISH when stroke is set.

24. Press Yes to save setup.

25. Select location to save file. Name the File. Then Press Save.

26. Press F1 to return to Main Menu.

27. Press F2 to access Run Menu.

28. Install work piece in fixture.

29. Press F2, Run Settings.

30. Click on Machine Tab.

31. Toggle ON Coolant (Green light) to check flow and position.

32. Under Cycle Mode click Single.

33. Press APPLY and then press OK.

34. Press check parts button and set part status on index table.

35. Close all Guards.

36. Press CYCLE START button and run a honing cycle.

37. Open Guards.

38. Remove and check (gage) work piece(s).

- To edit: Press F4 Edit Setup. Then press F4 to edit Part Specifications or F5 to edit Column Setup (Machine).

38. Press OK when finished.

39. Press F1 to return to Main Menu.

40. Press F2 to return to Run Menu.

41. Load parts.

42. Continue Honing.

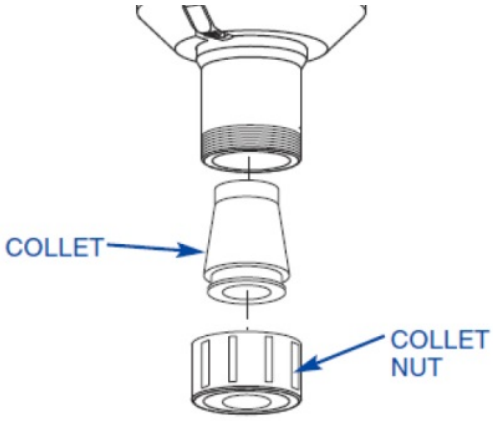

Figure 3-1, Collet

TC TOOLS®

Consult the following procedure when installing TC-Series Tools:

1. Go to Setup Menu. Click on Column A Setup and select Tool. Then follow directions on screens.

2. Install collet and collet nut on spindle shaft. *Refer to Figure 3-1, Collet.*

3. *Refer to Figure 3-2, Install Tool* and install tool as follows:

- Insert tool into collet; until bottom flange of tool is seated firmly against the bottom of the collet nut, making sure there is no gap. If the tool is not in the correct position, the tool could be positioned down too far and could make contact with the bottom of the bore (mounting flange on tool is flush with face of collet).
- Push mandrel up against collet while tightening collet nut until hand tight.
- Tighten collet nut to 68 N/m (50 ft/lbs), using spanner wrench.

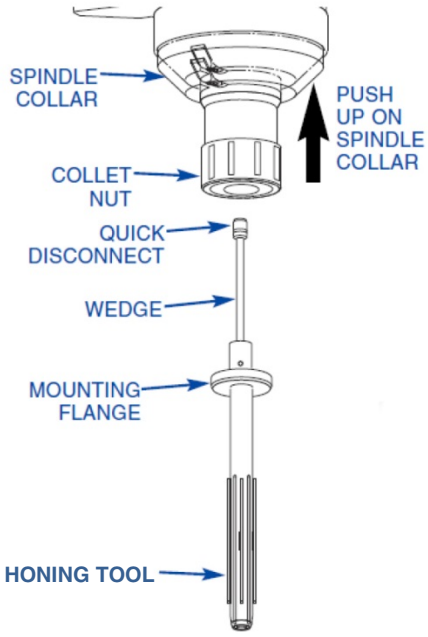

Figure 3-2, Install Tool

SAFE SHUTDOWN (TURNING MACHINE OFF)

NOTE: To turn the machine OFF properly, DO NOT just turn off the disconnect switch. Please follow the following steps:

1. Press the SAFE SHUTDOWN button.
2. Then press YES. This will allow the machine to prepare for shut down.
3. After a few moments, the screen will go blank. At this time, you can turn the disconnect switch OFF.

BASIC SETUP IS COMPLETE

For a complete list of screen functions and more detailed setup instructions, *refer to Sunnen SV-124(-SE) Series Screen Manual shipped with your machine*.

SECTION 4
ROUTINE MAINTENANCE

GENERAL

The following procedures are given as guides only and are not to be construed as absolute or invariable. Each machine must be maintained individually according to its particular requirements.

WARNING

ALWAYS have power OFF when hoods are open or performing service not requiring power.

CLEANING

Daily, after use, wipe exterior of the machine with a clean, dry cloth to remove any coolant, dust, and grime.

Monthly, wipe with a clean dry cloth. Then clean the exterior of machine with warm water and a mild detergent or mild industrial solvent. Rinse thoroughly with clean hot water and wipe dry. Lightly lubricate following lubrication instructions.

LUBRICATION

Inspect grease lines and fittings monthly for leaks or damaged parts. Replace parts as required.

Grease Lubricating System

Fill grease reservoir with Kluberplex #BEM34-132 or its equivalent. *Refer to Figure 4-1, Lubrication System.*

Fill grease reservoir through grease fitting with grease gun equipped with air relief valve. It is important to the operation of the grease pump that no air is in the grease reservoir. System is equipped with a pressure switch, which flashes a warning on the operator display screen when the level and/or pressure drops below the minimum requirement.

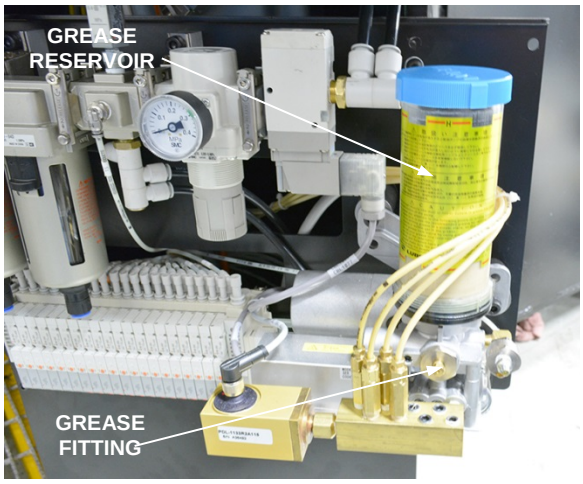

Figure 4-1, Lubrication System

ROUTINE MAINTENANCE SCHEDULE

The following procedures and suggested maintenance periods are given as guides only, and are not to be construed as absolute or invariable. Local conditions must always be considered. Each machine must be maintained individually, according to its particular requirements.

Daily:

- Check coolant level of attached coolant system, and add coolant as necessary.
- If using Sunnen Coolant Concentrate, check concentration and add water or concentrate as necessary.

Every 1000 Hours:

- Remove the large plastic cover and the sheet metal covers that are attached to the carriage.
- Examine the way covers for breaks or tears. If the way covers fall down rather than stay in place on the ways, then they must be replaced. The replacement way cover assembly number is Sunnen # SV-32820A.

NOTE: When installing a replacement way cover assembly, it is important to note that it is shipped with two screws, one in each end, to hold all the spring-loaded components together. Once the new cover is installed on the ways, these two screws must be removed to assure proper operation.

- Verify the operation of the lubrication system as follows: Wipe all excess grease from the ball screw and the ball spline. Under the diagnostics section of the software, set the lube system to cycle 100 times. After this is complete, move the carriage up and down once by hand. Verify that new grease rings have been left on the ball screw and ball spline. The presence of this excess grease indicates adequate lubrication is being delivered.
- Inspect the ball spline and ball screw grooves for pitting or wear. Pitting or wear in a region where the machine strokes during the honing cycle indicates that a failure is imminent; therefore, replacement should be planned for the near future.
- Check the tension of the motor and spindle belts. Belt tension should be no less than 780 N for used belts. A newly installed belt should be tensioned to 1210 N to allow for some relaxation after break-in.

CAUTION

Both belts can be tensioned with the aid of screws placed in the assembly. These screws are only to assist in belt tensioning. Care must be taken that belts are not over-tightened by attempting to tighten these screws.

PNEUMATIC LINES CHECK

Inspect pneumatic lines and fittings monthly for leaks or damaged parts. Replace parts as required.

Filter Element Replacement

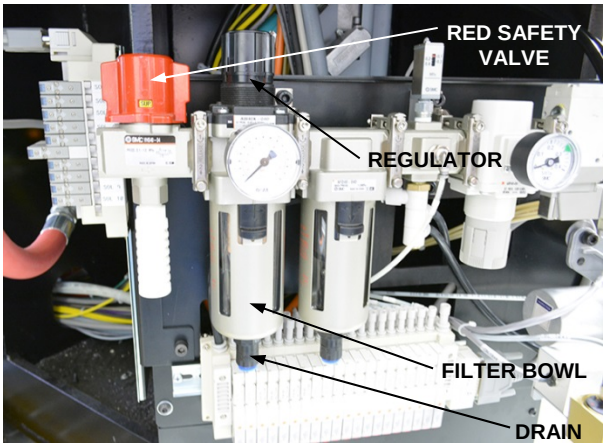

Figure 4-2, Pneumatic Line Check

The filter element in the air line regulator should be cleaned or replaced when there is a noticeable drop in air pressure. To clean or replace the filter element, *refer to Figure 4-2, Pneumatic Line Check* and proceed as follows:

1. Turn power to machine OFF at disconnect ON/OFF switch located on the electrical enclosure.

2. Turn red safety valve to OFF and disconnect incoming factory air line at quick-disconnect.

3. Bleed any trapped air from filter.

4. Remove bowl assembly from unit, by holding down on release button and rotating bowl. Lay bowl aside for reinstallation.

CAUTION

Use care during disassembly to prevent O-ring from being damaged.

5. Unthread the baffle and remove baffle and filter element from shaft.

6. Wipe bowl and internal parts clean.

7. Install new filter element on shaft. While holding filter in place, thread baffle into place.

NOTE: Replacement elements and parts are available through the unit manufacturer or your local supplier.

8. Install bowl assembly with O-ring on unit. Rotate bowl until button on side of bowl snaps into place, locking bowl into unit.

9. Connect incoming factory air line at quick-disconnect.

10. Turn red safety valve ON.

11. Turn power to the machine ON at disconnect ON/OFF switch located on the electrical enclosure.

COOLANT LINES CHECK

Inspect coolant lines and fittings monthly for leaks or damaged parts. Replace parts as required.

Sump Tank Cleaning

Periodically check and clean sump tank. Sump tank should be checked and cleaned if a “Sump overflow detected” error occurs and is displayed on the control screen.

Filter Element Replacement

Periodically check and clean air intake filter element located on the side of the column and replace as required. To clean or replace the filter element, *refer to Figure 4-3, Air Filter Access Panel and Figure 4-4, Air Filter Element* and proceed as follows:

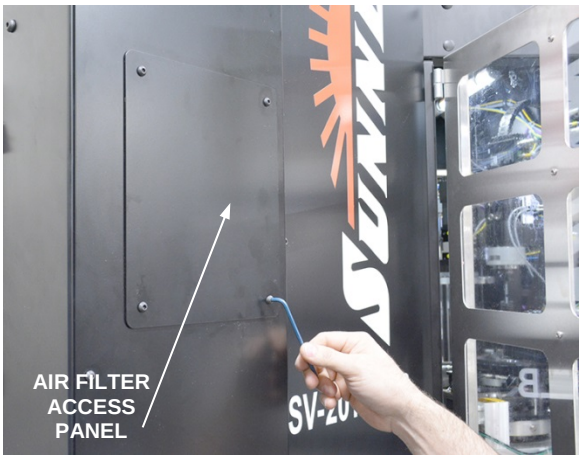

Figure 4-3, Air Filter Access Panel

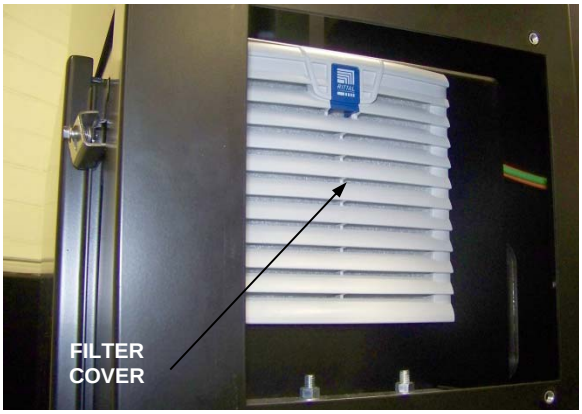

Figure 4-4, Air Filter Cover

1. Turn all power to machine OFF at disconnect ON/OFF switch.

2. Remove access panel at the rear of machine, by removing four button socket head capscrews, *refer to Figure 4-3, Air Filter Access Panel.*

3. Snap filter cover off filter, *refer to Figure 4-4, Air Filter Cover.*

4. Remove filter element.

5. Clean filter element and filter cover with warm water and a mild detergent or mild industrial solvent.

6. Rinse thoroughly with clean hot water and allow to dry.

7. Reinstall filter element.

NOTE: Replacement elements and parts are available through Sunnen or your local supplier.

8. Snap filter cover into place over filter element.

9. Reinstall access panel.

10.Repeat steps 2-9 for each honing column.

11. Turn power to the machine ON.

SECTION 5
TROUBLESHOOTING

GENERAL

This section contains troubleshooting information in table form**,** which should be used when problems occur with machine. The table lists problems encountered, possible causes, and solutions for problems along with reference to section of manual where detailed instructions may be found to correct problems.

OPERATIONAL TROUBLESHOOTING

For suggestions on correcting problems with bore conditions or with honing operation, *refer to Table 5-1, Operational Troubleshooting*.

TABLE 5-1, Operational Troubleshooting

PROBLEM	PROBABLE CAUSE	SOLUTIONS
Stone not cutting	1. Stone Glazing (Stone looks clean)	A. Dress stone B. Increase feed C. Increase stroking speed D. Use softer stone
	2. Stone Loading (Metal particles on stone surface)	A. Dress stone B. Increase stroking speed C. Use softer stone D. Use coarser stone E. Check coolant *
Slow stock removal	1. Improper spindle speed 2: Inadequate stone feed up 3. Improper stone	A. Increase spindle speed A. Increase feed A. Use softer stone B. Use coarser stone
Poor stone life	1. Excessive stone feed up 2. Inadequate spindle speed 3. Improper stone	A. Decrease feed A. Increase spindle speed A. Use harder stone B. Use coarser stone
Bellmouth	1. Improper overstroke 2. Improper stone	A. Shorten overstroke A. Use softer stone
Barrel	1. Improper overstroke 2. Improper stone	A. Increase overstroke A. Use finer stone
Taper in Blind End	1. Inadequate coolant flow 2. Part 3. Material 4. Inadequate relief in blind end	A. Adjust coolant nozzle A. Short stroke tight end A. Use hardtip stone A. Provide sufficient relief
Out-Off-Round	1. Workpiece flexing (thin wall)	A. Decrease feed B. Change method of fixturing

TABLE 5-1, Operational Troubleshooting (continued)

PROBLEM	PROBABLE CAUSE	SOLUTIONS
Rough Finish	1. Improper feed 2. Improper stone 3. Improper or Diluted coolant	A. Decrease feed A. Use finer stone B. Use softer stone A. Check coolant *
Scratches in Bore (Random)	1. Improper feed 2. Improper stone 3. Improper or diluted coolant	A. Decrease feed A. Use finer stone B. Use softer stone A. Check coolant *
***Many honing problems, such as poor cutting action, poor stone life, and rough finish are caused by wrong honing oil, insufficient honing oil, dirty honing oil, or contaminated honing oil. Use only clean, full-strength Sunnen Industrial Honing Oil. Verify that honing oil is neither diluted or "cut" with other oils. Keep solvents and cleaning fluids away from honing machine.**		

MACHINE OPERATION TROUBLESHOOTING

Error Messages:

The SV-Series machines have built in error messages that will appear on display screen to alert operator when machine has stopped due to an error, problem, or incorrect setup.

Problems/Solutions:

WARNING

Some troubleshooting procedures require examining parts inside machine enclosure. ALWAYS have power OFF when guards are open. If problem cannot be diagnosed by power OFF inspection, then consult a Sunnen Service Technician.

PROBLEM: Control system gives a message indicating that the grease system is out of grease, but grease can still be seen in the reservoir.

SOLUTIONS:

An air pocket in the grease system can cause this fault. Use the following procedure to bleed the air from the system:

1. Disconnect all grease lines from their grease injectors.

2. Remove all the grease injectors from the manifold.

3. In the diagnostics section of the control software, set the grease system to cycle 100 times.

4. Watch the open ports in the manifold. As soon as grease comes out an open port, install that injector in the open port.

NOTE: If you cannot hear the grease pump cycling, then either the pump is defective or there is a loose electrical connection.

5. When all injectors are installed, begin looking for grease to come out of the injectors. As soon as grease can be seen coming out of an injector, then connect a grease line to that injector.

6. After all grease lines have been reconnected, allow the system to finish the 100 cycles. If no faults occur in those 100 cycles, then the air has been successfully bled out of the system.

PROBLEM: Routine inspection of lubrication system shows that grease is not coming out of one or more grease lines.

SOLUTIONS:

Remove the grease lines from the tops of the grease injectors. Under the diagnostics section of the software, set the lube system to cycle 50 times.

1. If grease is seen coming out of the injectors, then the problem is with the grease line. It either is clogged or has a leak. In either case, the grease line should be replaced.

2. If grease is not seen coming out of one or more injector, then remove the injector(s) from the manifold. Is grease coming out of the manifold port(s) as the system continues to cycle? If not, then proceed to step 5.

3. If grease is coming out of the port(s), then reinstall the injector(s). Only reinstall an injector into a port where grease is present. If air is trapped below the injector, it will not work properly.

4. If grease does not come out of the reinstalled injector, then the injector is not working properly. An injector may be disassembled and cleaned to get it to resume working, if that does not work then the injector is defective and should be replaced.

5. If grease is not seen coming out of the port(s) when the injectors are removed, then air must be bled from the grease pump. Open the air bleed port just below the grease reservoir and continue cycling the system until grease can be seen coming out of the port. If this does not happen, then the pump is defective.

6. After taking the necessary corrective action and reassembling, but before reattaching the grease lines to the ball screw and ball spline, cycle the lube system 50 times and verify that grease is coming out of the lines.

APPENDIX A
TYPICAL COOLANT SYSTEM FLOW DIAGRAM

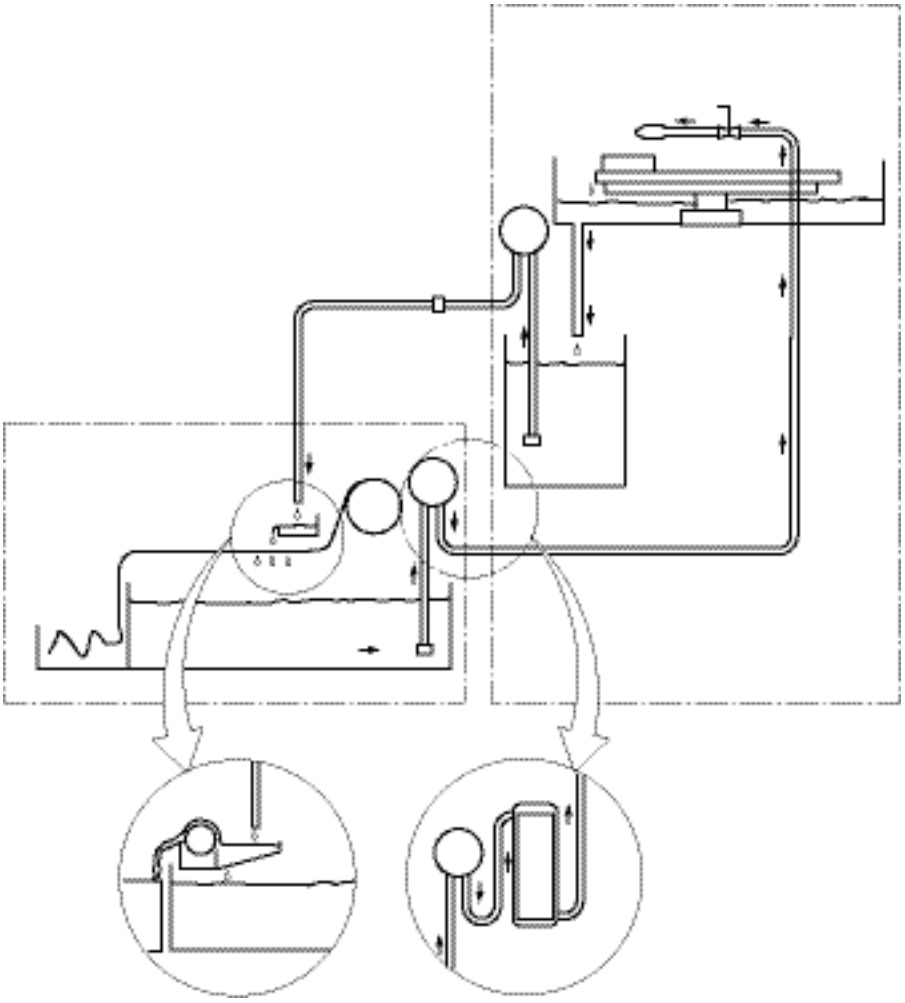

Figure A-1, Coolant System Flow Diagram

APPENDIX B
DECLARATION OF CONFORMITY (CE)

EC declaration of conformity

according to the EU Machinery Directive 2006/42/EG, Annex II, 1.A

Manufacturer:
Sunnen Products Co.,
7910 Manchester
63143 St. Louis, Missouri USA

Person residing within the Community authorised to compile the relevant technical documentation:
Julian Hooper
Sunnen Products Ltd.,
Centro 1 Maxted Rd
HP2BL Hemel Hempstead, Hertfordshire

Description and identification of the machinery:

Make:	SV-2015-2LB-298	2-Spindle Vertical Honing Machine
Serial no:	xxxx	

It is expressly declared that the machinery fulfils all relevant provisions of the following EU Directives:

2006/42/EG:2006-05-17	EU Machinery Directive 2006/42/EG
2004/108/EG:2004-12-15	Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC

Reference to the harmonised standards used, as referred to in Article 7(2):

EN 349:1993+A1:2008	Safety of machinery – Minimum gaps to avoid crushing parts of the human body
EN 574:1996+A1:2008	Safety of machinery — Two-hand control devices — Functional aspects — Principles for design
EN 614-1:2006+A1:2009	Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles
EN 614-2:2000+A1:2008	Safety of machinery — Ergonomic design principles — Part 2: Interactions between the design of machinery and work tasks
EN 626-1:1994+A1:2008	Safety of machinery — Reduction of risks to health from hazardous substances emitted by machinery — Part 1: Principles and specifications for machinery manufacturers
EN 626-2:1996+A1:2008	Safety of machinery — Reduction of risk to health from hazardous substances emitted by machinery — Part 2: Methodology leading to verification procedures
EN 894-1:1997+A1:2008	Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 1: General principles for human interactions with displays and control actuators
EN 894-2:1997+A1:2008	Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays
EN 894-3:2000+A1:2008	Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 3: Control actuators
EN 894-4:2010	Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 4: Location and arrangement of displays and control actuators

EN 953:1997+A1:2009	Safety of machinery — Guards – General requirements for the design and construction of fixed and movable guards
EN 1037:1995+A1:2008	Safety of machinery — Prevention of unexpected start-up
EN 1088:1995+A2:2008	Safety of machinery — Interlocking devices associated with guards — Principles for design and selection
EN ISO 4414:2010	Pneumatic fluid power — General rules and safety requirements for systems and their components
EN ISO 12100:2010	Safety of machinery — General principles for design — Risk assessment and risk reduction
EN ISO 13849-1:2008+AC2009	Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design
EN ISO 13849-2:2008	Safety of machinery — Safety-related parts of control systems — Part 2: Validation
EN ISO 13850:2008	Safety of machinery — Emergency stop — Principles for design
EN ISO 13855:2010	Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body
EN ISO 13857:2008	Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs
EN 60204-1:2006+A1:2009	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
EN 61310-1:2008	Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals IEC 61310-1:2007
EN 61310-2:2008	Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking
EN 61310-3:2008	Safety of machinery — Indication, marking and actuation — Part 3: Requirements for the location and operation of actuators

St. Louis, Missouri USA, 2015.02.06

Place, date

Signature
Michael C. Haughey
Chief Operating Officer

Like any machinery, this equipment may be dangerous if used improperly. Be sure to read and follow instructions for operation of equipment.

WARNING

An Arc Flash Hazard Exists. Follow safe work practices and wear appropriate Personal Protective Equipment. Follow proper lockout/tagout procedures. Failure to comply can result in death or injury.

FRACTION / DECIMAL / MILLIMETER EQUIVALENTS CHART

INCH		MILLIMETER	INCH		MILLIMETER	INCH		MILLIMETER
FRACTION	DECIMAL		FRACTION	DECIMAL		FRACTION	DECIMAL	
…	.003937	0,1000	9/32	.281250	7,1438	21/32	.656250	16,6688
…	.007874	0,2000	19/64	.296875	7,5406	…	.669291	17,0000
…	.011811	0,3000	5/16	.312500	7,9375	43/64	.671875	17,0656
1/64	.015625	0,3969	…	.314961	8,000	11/16	.687500	17,4625
…	.015748	0,4000	21/64	.328125	8,3344	45/64	.703125	17,8594
…	.019685	0,5000	11/32	.343750	8,7313	…	.708661	18,0000
…	.023622	0,6000	…	.354331	9,0000	23/32	.718750	18,2563
…	.027559	0,7000	23/64	.359375	9,1281	47/64	.734375	18,6531
1/32	.031250	0,7938	3/8	.375000	9,5250	…	.748031	19,0000
…	.031496	0,8000	25/64	.390625	9,9219	3/4	.750000	19,0500
…	.035433	0,9000	…	.393701	10,0000	49/64	.765625	19,4469
…	.039370	1,0000	13/32	.406250	10,3188	25/32	.781250	19,8438
3/64	.046875	1,1906	27/64	.421875	10,7156	…	.787402	20,0000
1/16	.062500	1,5875	…	.433071	11,000	51/64	.796875	20,2406
5/64	.078125	1,9844	7/16	.437500	11,1125	13/16	.812500	20,6375
…	.078740	2,0000	29/64	.453125	11,5094	…	.826772	21,0000
3/32	.093750	2,3813	15/32	.468750	11,9063	53/64	.828125	21,0344
7/64	.109375	2,7781	…	.472441	12,0000	27/32	.843750	21,4313
…	.118110	3,0000	31/64	.484375	12,3031	55/64	.859375	21,8281
1/8	.125000	3,1750	1/2	.500000	12,7000	…	.866142	22,0000
9/64	.140625	3,5719	…	.511811	13,0000	7/8	.875000	22,2250
5/32	.156250	3,9688	33/64	.515625	13,0969	57/64	.890625	22,6219
…	.157480	4,0000	17/32	.531250	13,4938	…	.905512	23,0000
11/64	.171875	4,3656	35/64	.546875	13,8906	29/32	.906250	23,0188
3/16	.187500	4,7625	…	.551181	14,0000	59/64	.921875	23,4156
…	.196850	5,0000	9/16	.562500	14,2875	15/16	.937500	23,8125
13/64	.203125	5,1594	37/64	.578125	14,6844	…	.944882	24,0000
7/32	.218750	55563	…	.590551	15,0000	61/64	.953125	24,2094
15/64	.234375	5,9531	19/32	.593750	15,0813	31/32	.968750	24,6063
…	.236220	6,0000	39/64	.609375	15,4781	…	.984252	25,0000
1/4	.250000	6,3500	5/8	.625000	15,8750	63/64	.984375	25,0031
17/64	.265625	6,7469	…	.629921	16,0000	1	1.000000	25,4000
…	.275591	7,0000	41/64	.640625	16,2719	1-1/16	1.062500	26,9880

FORMULAS:

MULTIPLY		BY		TO GET	MULTIPLY		BY		TO GET
INCHES (in)	x	25.4	=	MILLIMETERS (mm)	MILLIMETERS (mm)	x	0.03937	=	INCHES (in)
FEET (ft)	x	0.30.48	=	METERS (m)	METERS (m)	x	3.281	=	FEET (ft)

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