



MODEL 285/287/295 ELECTRON BEAM SOURCE

INSTRUCTION MANUAL

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Current version of this manual can be found at
<https://telemark.com/electron-beam-sources/high-capacity-multi-pocket-sources/>

SAFETY WARNING

HIGH (POTENTIALLY LETHAL) VOLTAGES ARE PRESENT WITHIN EVAPORATION SYSTEM. GREAT CARE MUST BE EXERCISED WHEN PERFORMING MAINTENANCE.

HUMAN CONTACT WITH THE VOLTAGES CAN BE FATAL.

SHORT ALL HV FEEDTHRU CONNECTIONS WITH A GROUNDING HOOK.

DANGER – HIGH VOLTAGE

WARRANTY

This Electron Beam Source is guaranteed against faulty materials, function, and workmanship for a period of 12 months after delivery from Telemark.

This warranty is valid only for normal use where regular maintenance is performed as instructed. This warranty shall not apply if repair has been performed or an alteration made by anyone other than an authorized Telemark representative or if a malfunction occurs through abuse, misuse, negligence, or accident. No charge will be made for repairs made under warranty at Telemark's facilities. Defective parts will be repaired or replaced at Telemark's option. Customer will be responsible for freight charges to Telemark's facility.

For the safety of the Telemark technician's customers are requested to supply a list of materials which have been evaporated in the crucible when the electron beam source is returned for repair.

USER RESPONSIBILITY

The user is responsible for proper operation and ordinary maintenance of the equipment, following procedures described in this manual, including reference documents. Proper operation includes timely replacement of parts that are missing, broken, or plainly worn. If the user has a reasonable doubt about understanding the use or installation of a component, Telemark or your local representative should be called.

It is vitally important that the user properly install the equipment as described in Chapter 3 (Installation) of this manual, with particular attention to the correct grounding methods described.

The Warranty will be void if the equipment is improperly installed and/or properly grounded.

TABLE OF CONTENTS

| | |
|---|-----------|
| 1 UNPACKING | 1 |
| 2 DESCRIPTION | 1 |
| 3 SPECIFICATIONS | 3 |
| 4 INSTALLATION | 5 |
| 4.1 Required Components | 5 |
| 4.2 Setting Up | 6 |
| 4.3 Grounding | 7 |
| 4.4 High Voltage..... | 8 |
| 4.5 Ground Connections | 8 |
| 4.6 Two Source Installation | 9 |
| 5 OPERATION | 11 |
| 5.1 General Operation – Startup | 11 |
| 5.2 General Operation – Shutdown..... | 12 |
| 5.3 Adjusting the Electromagnetic Field | 12 |
| 6 SERVICING | 13 |

| | | |
|----------|--|-----------|
| 6.1 | Crucible Removal..... | 13 |
| 6.2 | Crucible Replacement..... | 13 |
| 6.3 | Source Base Plate Assembly..... | 14 |
| 6.4 | Emitter Removal..... | 19 |
| 6.5 | Emitter Disassembly and Cleaning | 20 |
| 6.6 | Filament Replacement | 20 |
| 6.7 | Emitter Rebuilding/Reassembly | 20 |
| 6.8 | Source Disassembly | 22 |
| 6.9 | Crucible Rotation Assembly | 24 |
| 6.10 | Coil Assembly | 24 |
| 6.11 | Side Drive Assembly | 24 |
| 6.12 | Bottom Drive Assembly | 25 |
| 6.13 | Main Body Reassembly | 26 |
| 6.14 | Quick Check..... | 27 |
| 7 | KITS AND ACCESSORIES | 28 |
| 7.1 | Installation Kits..... | 28 |
| 7.2 | Accessories..... | 29 |
| 7.3 | Replacement Crucibles | 31 |
| 7.4 | Rebuild Kits..... | 32 |
| 7.5 | Change Over Kit..... | 33 |
| 8 | TROUBLESHOOTING | 34 |
| 8.1 | Power Problems..... | 34 |
| 8.2 | Beam Problems..... | 35 |
| 8.3 | Rotation Problems..... | 36 |

1

UNPACKING

Your electron beam source is packed into a specially designed double strength box and surrounded with two and a half inches of rigid foam padding. Since packaging the source for safe shipment is otherwise difficult, please save the box in the event that the source ever needs to be returned for servicing. Telemark cannot be held liable for sources which are damaged in transit as a result of improper packaging.

Inside the box are the source and installation kit. The installation kit includes: a set of tools, a spare seal kit and an emitter rebuild kit. Please check the packaging list to make sure no damage has occurred in transit. Inspect the emitter assembly for alignment of the filament, anode plate and beam former. The source is ruggedly built and packaged tightly to prevent damage. In the event of any deficiencies, please report them to your vendor immediately. Also take care to read the warranty regarding the limits of Telemark's liabilities.

The finish on the metal parts of the source is the highest available. The source is assembled under clean conditions and sealed in a polyethylene bag for shipment. A set of white gloves is included for your use in unpacking and setting up the source to help minimize contamination.

2 DESCRIPTION

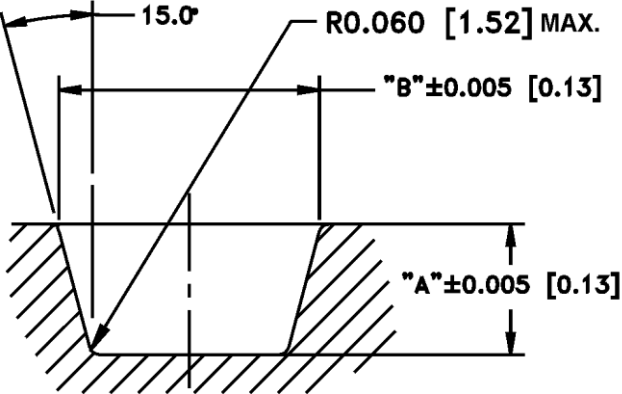
The electron beam source's most notable features:

Some models have crucibles that can be removed from above by simply removing the screws that hold them in place. This feature allows the crucible to be cleaned or replaced without removing the source from the vacuum chamber or disassembling the entire source. This process is described in the Servicing Manual.

The emitter assembly is a critical component in the operation of the electron beam source. The parts that make up the emitter assembly are manufactured to exacting standards. Telemark has developed several innovative changes to the emitter assembly which make it more reliable and easier to assemble.

The sweep coils are sealed in a water-cooled solid copper block or are sealed in a stainless steel can that is attached to a water-cooled solid copper block. This virtually eliminates the possibility of damaging the coils thermally or mechanically during normal production or handling. As long as proper water flow is maintained in the EB source and care is taken not to drop it, the coils should last indefinitely.

Other features, such as heavy-duty screws with Helicoil® inserts in the copper in all important fastening locations, reliable vacuum connections, and heavy-duty construction in general, are designed to make the source serviceable for years of production.



Standard Crucible

Figure 2-A Crucible Dimensions

| Size | "A" | | "B" | |
|----------------|-------|-------|-------|-------|
| | Inch | mm | Inch | Mm |
| 15cc | .670 | 17.02 | 1.485 | 37.72 |
| 25cc (Shallow) | .680 | 17.27 | 1.855 | 47.12 |
| 25cc (Deep) | .920 | 23.37 | 1.633 | 41.48 |
| 40cc | 1.020 | 25.91 | 2.030 | 51.56 |
| 100cc | 1.470 | 37.34 | 2.700 | 68.58 |

3 SPECIFICATIONS

| Specifications | 285 EB Source | 287 EB Source | 295 EB Source |
|---|---|---|---|
| Electron Beam Deflection | 270° | 270° | 270° |
| Power Rating | 10 kW | 10 kW | 10 kW or 15kW |
| High Voltage Range | -6 kV to -10 kV | -6 kV to -10 kV | -6 kV to -10 kV |
| Lateral Coil Resistance | 3.0 ohms | 3.0 ohms | 3.0 ohms |
| Longitudinal Coil Resistance | 9.6 ohms | 9.6 ohms | 9.6 ohms |
| Emission Current | Up to 1 amp @ 10kV (Dielectric only) Up to 1.5 amp @ 10kV | Up to 1 amp @ 10kV (Dielectric only) Up to 1.5 amp @ 10kV | Up to 1 amp @ 10kV (Dielectric only) Up to 1.5 amp @ 10kV |
| Filament Power | 600 watts maximum (50 Amps at 12 VAC max). | 600 watts maximum (50 Amps at 12 VAC max). | 600 watts maximum (50 Amps at 12 VAC max). |
| Sweep Lateral Coil | +/-1.5 amps | +/-1.5 amps | +/-1.5 amps |
| Sweep Longitudinal Coil | +/-1.5 amps | +/-1.5 amps | +/-1.5 amps |
| Water Requirements | 5 gpm (minimum) @ maximum power rating (crucible only) 3 gpm @ maximum power rating (electromagnetics only) Input water temperature should be 60-70 F (15-21C) at a pressure of 60 psi (4.2 kg/cm ²), using a 3/8" (10mm) line. | 5 gpm (minimum) @ maximum power rating (crucible only) 3 gpm @ maximum power rating (electromagnetics only) Input water temperature should be 60-70 F (15-21C) at a pressure of 60 psi (4.2 kg/cm ²), using a 3/8" (10mm) line. | 5 gpm (minimum) @ maximum power rating (crucible only) 3 gpm @ maximum power rating (electromagnetics only) Input water temperature should be 60-70 F (15-21C) at a pressure of 60 psi (4.2 kg/cm ²), using a 3/8" (10mm) line. |
| Weight (less feedthrough, indexer and water union.) | 69 Lb (31.3 kg) | 89 Lb (40.4 kg) | With 12 pocket 40cc crucible: 116 Lb (52.6 kg) |
| Crucible Volume | Many options available | Many options available | Many options available |

4 INSTALLATION

4.1 Required Components

See figure 3-B

The following is the minimum list of components required for setting up the source for safe operation.

- 1 High-voltage Feedthroughs** – Two high-voltage feedthroughs rated at 15 kV @ 70 amps. Bare copper straps are provided for use inside the chamber. Outside the chamber use #6 AWG copper wire with lugs for attaching feedthrough to transformer.
- 2 Tank Ground** – Use a solid copper strap or copper wire (#6 AWG or greater and up to seven strands, not copper braid) between tank and an 8 foot long copper clad steel grounding rod. Connections must be free of oxide and extremely tight.
- 3 Transformer Cover** – Mount filament (source) transformer as close to high-voltage feedthroughs as possible in the transformer box provided with the Telemark power supply.
- 4 Sweep Coil Feedthrough** – All sources, except models 221, 508 and 528, have an electromagnetic X-Y sweep coil and need a minimum of a four (4) pin low-voltage feedthrough. Kapton® coated wire is supplied on the standard coil connector Telemark #271-0125-1. Bare OFHC wire is used in the UHV assembly

Telemark #271-0125-3. Coil connector assemblies come with two feet of wire standard, optional lengths are available. See figure 3-A for reference code of marked wires when shipped from the factory.

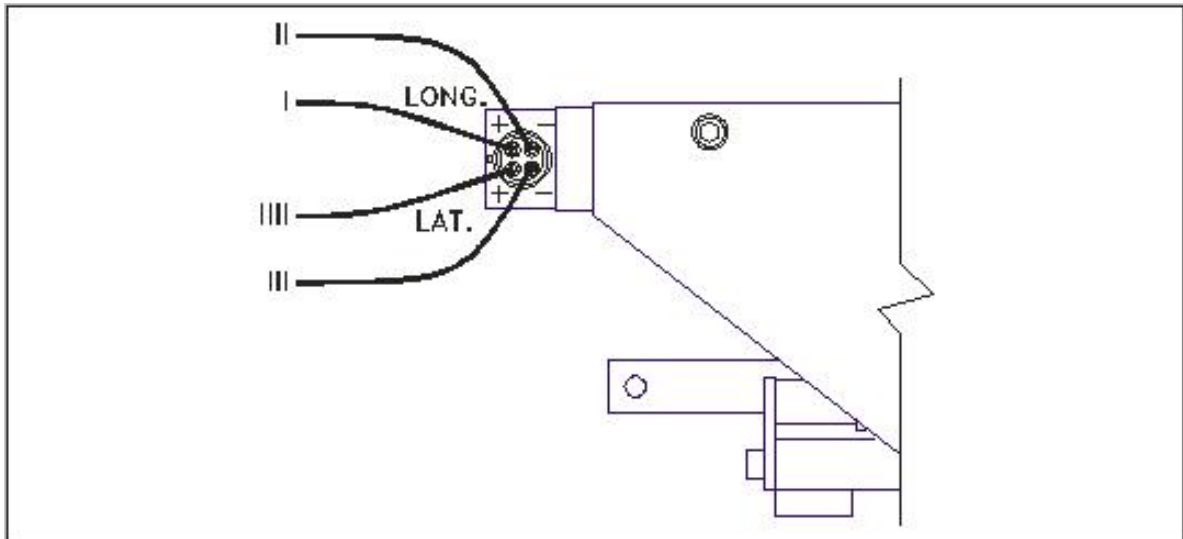


Figure 3-A Coil Wire Reference Code

- 5 Water Feedthrough** – For sources that do not come from the factory installed on flanges a water feedthrough is required. Use 3/8" O.D. x 1/16" wall 304 Stainless tubing and weld into fittings provided with source and butt-weld to tubing dual water feedthrough. We do not recommend the use of bellows inside the chamber. Attach feedthrough tubing to 3/8" copper tubing outside chamber, use compression fittings or other means to make this connection.
- 6 Water Filter** – Use standard removable water filter on inlet. Position away from chamber so that it is completely accessible for servicing.
- 7 Blowout Valve** – Use three-way valve attached to air or nitrogen supply for blowout.
- 8 Flowmeter** – Use a flowmeter with an interlock switch on water outflow.
- 9 Interlocks** – Install interlocks for Vacuum, Tank, High Vacuum, and Water. Other interlocks should be installed using the Aux interlock input.

4.2 Setting Up

Note that it is important to never use mild steel for electron beam source mounting. This includes mounting plates, standoffs or source shutter hardware. Mild steel could affect

the magnetic properties of the electron beam source resulting in poor performance or a deformed electron beam. The best material to use is non-magnetic 304 stainless steel.

Set the source level with the required offset from chamber centerline. The source is easiest to operate and observe in operation if placed facing forward and in front of the chamber centerline. The source may be mounted directly on a vacuum chamber baseplate, on stainless steel standoffs, a flange depending on the model and installation requirements. Custom designed mounting plates are available from the factory.

Good contact between the base of the electron beam source and the baseplate of the vacuum chamber is important to earth ground the source through the chamber baseplate.

A shutter should be mounted above and slightly behind the pocket. The shutter should obscure at least a one-hundred-degree cone above the pocket. A stainless disc makes a good, enduring shutter, provided it can be mounted ruggedly and detached easily for cleaning.

8 or 10 AWG copper wire is provided for the high voltage leads. These should be shortened to the smallest distance between source emitter and the feedthroughs, with a slight curve to allow for thermal expansion and contraction.

Interlocks should be installed, so that the breaking of any interlock turns off the source. See the note on high voltages below as to why this is important.

4.3 Grounding

Proper grounding is the single most important aspect of the installation of the E-beam. During arcing events, RF noise is generated that must be properly driven to ground to avoid interference/damage. For this reason, the E-beam ground must be separate from the electronics rack ground and ideally as short as possible. Improper grounding can lead to poor performance, interference with other equipment, damage to E-beam electronics or other equipment, or even shock potential.

Do not depend on water pipes for the system ground connection. Because of multiple joints and sealing compounds, water pipes typically do not make an earth ground. Keep in mind this is a high frequency as well as a DC ground.

Regardless of the method of grounding, the first point of connection for the ground cable/strap is always the E-beam chamber. There should be a specially designed ground bar welded to the chamber for this purpose. The strap, if used, should be "sandwiched" between two bars to ensure a broad area connection.

Connecting to Building Steel

The best method known for grounding the E-beam is to tie the ground bar to building steel as close as possible using the appropriate grounding strap (varies based on the distance - see details below). One must verify that the building steel has a good connection to ground for this to be a viable solution. Be sure to remove any paint, rust, etc from under the connection point to the building steel.

Because the connection is for an RF ground, surface area is more important than cross-sectional area. It is critical to have a wide surface area of connection between the grounding strap and the building steel.

| Distance Between E-Beam Chamber and Grounding Point | Minimum Recommended Strap/Cable |
|--|--|
| < 10 Feet « 3 meters) | #6 Gauge or larger gauge copper cable |
| 10-20 Feet (3-6 meters) | #4 Gauge or larger gauge copper cable |
| 20-60 Feet (6-18 meters) | 2 inch by .035 inch thick copper strap |
| > 60 Feet (> 18 meters) | Contact Telemark for recommendations |

Table 4-1: Ground Strap Size

When in doubt, always go with the larger ground connection. You can never have too good of a connection!

Do not use braided wire. Be sure that the connection is made to clean metal.

The power supply is connected to ground using the HV cable's shield connection. The power supply may sustain major damage if power is applied before the ground is connected.

4.4 High Voltage

Use decals or other warning labels on the high voltage shield, at the front of the E-beam chamber and on the door to the room to provide warning that lethal voltages are present. Do not put any part of the body under a chamber while a source is running. Always use a grounding hook as a matter of habit before touching any potentially high voltage area, even when power supply is off. Always keep one hand in a pocket. Always maintain a respectful fear of high voltages: familiarity does not make high voltages safe.

4.5 Ground Connections

In addition to the critical building (earth) ground described above, there are 6 other ground leads that will be attached to the ground bar on the E-beam chamber:

1. Source Transformer Box - connected using 6 AWG gauge wire

2. E-beam power supply - connected using 6 AWG wire
3. Safety cover over high voltage feedthroughs - connected using 12 AWG gauge wire
4. Sweep controller - connected using 12 AWG gauge wire
5. TT-Controller - connected using 12 AWG gauge wire
6. Sweep cable ground connection - connected using 12 AWG gauge wire

There is not a required order for the above; simply connect each ground lead securely to an open ground lug location on the ground bar. Ensure connections are secure prior to turning on the power to the E-beam. Operating without one or more grounds properly connected may cause damage to equipment or even harm to the operator.

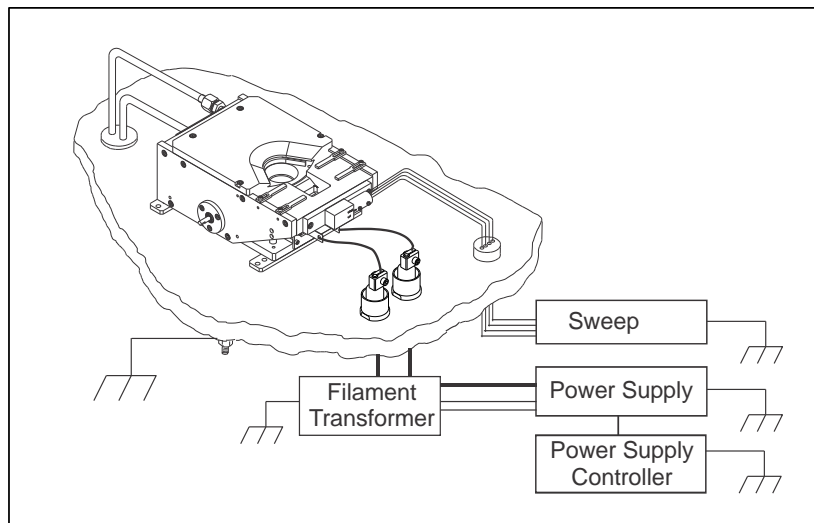


Figure 4-B Suggested Ground Installation

4.6 Two Source Installation

See Fig 3-C

To have a two-source installation work properly, a magnetic shunt bar must be placed between the two sources so that the magnetics of the sources do not interfere with the movement of positions of the dual electron beams. The shunt is usually a sandwich alternating between magnetic and non-magnetic metal with an air gap between each piece. Magnetic metals used are Mew metal or a mild steel .020 to .030 inch (0.50 to 0.75mm). Non-magnetic metals are non-magnetic stainless steel or copper .020 to .030 inch thick (0.50 to .75mm). One way of mounting the shunt to the magnet arms is with 304 stainless steel straps; other fastening methods may need to be used.

Sources must oppose each other for the sweep coils to work properly.

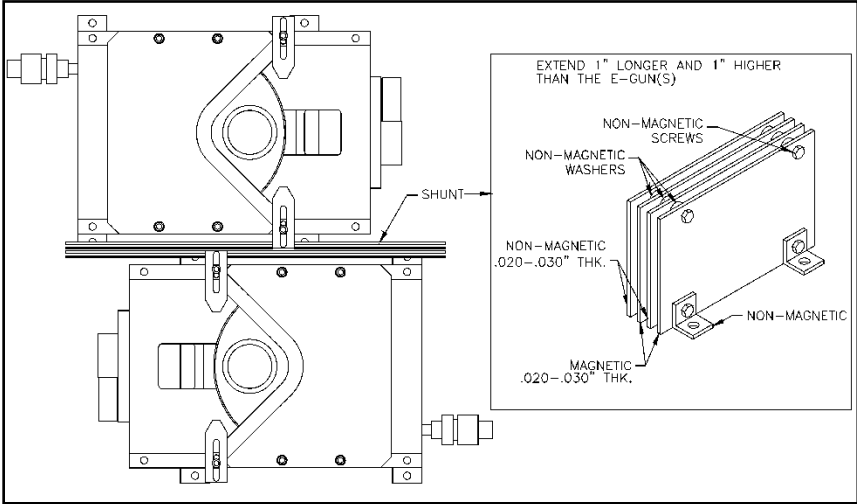


Figure 3-C Multi-Source Installation

5 OPERATION

5.1 General Operation – Startup

Load the crucible up to first rim with vacuum grade material. Make sure the view of the crucible is unobstructed from the view port when the chamber is closed. Welding glass (T9H is a convenient density) should be used when the beam intensity becomes too bright for direct viewing. (It is always a good idea to put a clean, removable piece of glass on the inside the chamber to prevent the port from being coated.) When the chamber is in operating range on the order of 1×10^{-5} torr or better, set the operation voltage, set the beam position to neutral, set the emission to zero, and reset the sweeps amplitude to zero.

When you are satisfied that conditions are optimal, turn on the power supply high voltage. Keeping an eye on the evaporant, very slowly turn up filament current. At around 100mA the beam should become apparent on the melt. If not, see the following paragraph. The beam should always be in the center of the crucible. As the emission is increased, the sweep pattern can be enlarged to cover the melt. After the ion gauge has stabilized and the material has stopped out-gassing and spitting, the shutter can be opened. After the required thickness level is reached, close the shutter, and reduce the emission to zero.

If the beam is not visible at 100mA of emission current, then adjust the beam position all the way in and then all the way out and from left to right. If the beam does not become visible at this time, do not under any circumstances try to increase the emission. Instead, turn off the source emission current and the high voltage. Check the longitudinal focus coil leads, be sure that they are not reversed, and go through the checklist under the section on troubleshooting.

5.2 General Operation – Shutdown

After terminating the final layer of the run sequence, turn down the filament current, turn off the high voltage, and allow the filament to cool for a few minutes before opening the chamber. The emitter assembly is surrounded by water-cooled components, so through radiation the filament will cool quickly. (A yellow oxide forms around the filament cavity if the vent is too fast.) Always use a grounding hook before working around high voltages.

Before removing the crucible for cleaning, make sure the water lines are blown out.

5.3 Adjusting the Electromagnetic Field

Position – The beam can be pulled towards the front of the crucible by:

- Reducing the high voltage (which also reduces beam intensity).
- Increasing the longitudinal coil current.
- Removing the shunt bar.
- Bringing the pole pieces farther in.

The beam can also be moved laterally by applying current to the lateral sweep coils.

Shape – As in the discussion above, the shape of the beam can be concentrated by bringing the pole pieces all the way in. In general, the beam shape is optimal for dielectrics if the pole pieces are two thirds of the way in, the shunt bar is added, and the accelerating voltage is around 6kV.

Intensity – The intensity of the beam is maximized by having the filament, beam former and anode plate aligned properly: see the service manual for your model electron beam source. If the intensity seems limited, the filament alignment should be checked – it may be warped, too far up, or even in backwards. The beam intensity is increased by turning up the filament current.

6 **SERVICING**

You should be particularly familiar with the removal and replacement of the crucible and the emitter, as these are the components most commonly removed for servicing.

6.1 Crucible Removal

Turn off the water and use the blowout valve to purge as much water from the source as possible. Undo the four #10-32 Allen Head screws, holding down the cover plate and remove the plate carefully, setting down on clean lint-free tissue to avoid contaminating or losing the O-ring seals. Undo the twelve #10-32 crucible screws. Screw the two lift handles provided, one into each side of the crucible, and lift the crucible out. Take care when bead blasting or cleaning not to damage the O-ring surface.

6.2 Crucible Replacement

Examine the crucible O-ring seating surface. If any major gouges are noticed, they should be fine sanded smooth. Make sure that no flakes have fallen onto the O-ring during general system cleaning. Also, make sure no flakes fall onto the O-ring while lowering the crucible back onto the EB source. Remove the two lift handles from the crucible. Tighten the crucible screws. Lower the cover plate gently onto arms and tighten the four holding screws. It is not necessary to lube any of these screw threads if some lubricant remains from previous use. Turn on water, observing the sides of the cover plate and the base of the crucible for any leaks.

6.3 Source Base Plate Assembly

Step 1



Step 2

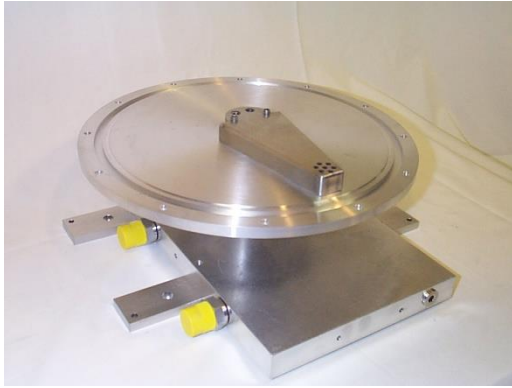


Step 3



Figure 1 Source Base Plate Assembly

Step 1



Step 2



Step 3



Step 4

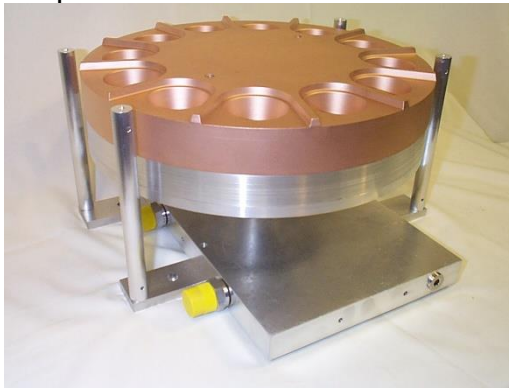


Figure 2 Crucible Base Plate Assembly

Step 1



Step 2



Step 3



Step 4



Step 5



Step 6



Step 7



Step 8



Step 9



Step 10



Step 11



Step 12



Step 13



Step 14

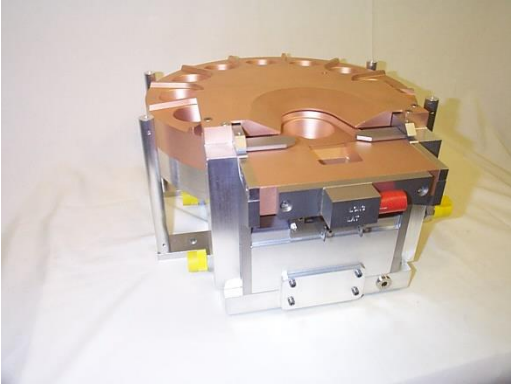


Figure 3 Base Plate/Pivot Shaft Assembly

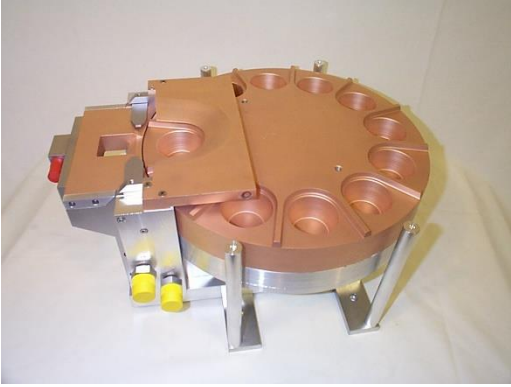
Step 1



Step 2



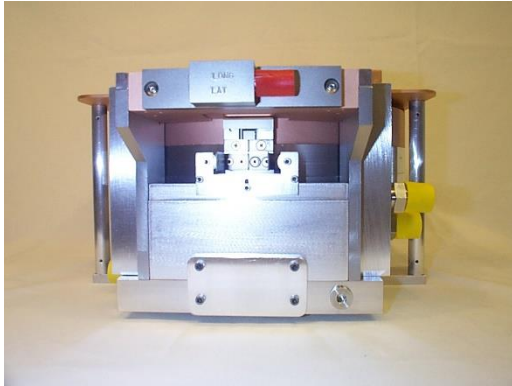
Step 3



Step 4



Step 5



Step 6

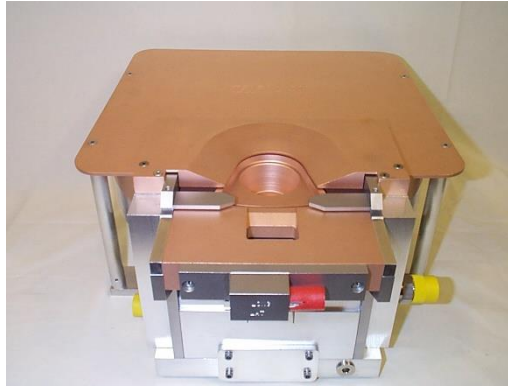


Figure 4 Source Assembly

CAUTION: MAKE SURE THAT A GROUNDING HOOK IS USED TO SHORT ALL HV CONNECTION BEFORE ANY WORK IS PERFORMED ON THE EMITTER ASSEMBLY.

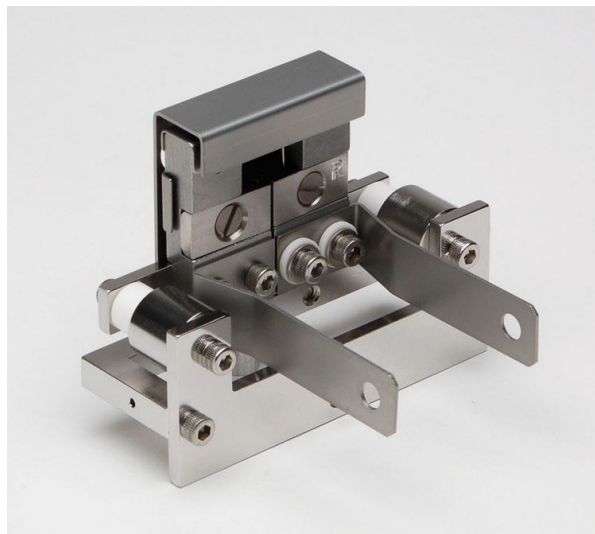


Figure 5 Emitter Assembly

6.4 Emitter Removal

Remove the two nuts and bolts holding the filament buss bars to the HV. leads. The emitter is attached to the base with a single #6-32 x 1/4" Allen screw. The most convenient way to detach the emitter assembly is with a long handled Allen wrench (12"

long is fine) since in normal practice the emitter is extremely hot at this time. Then pull the emitter assembly straight out the front.

6.5 Emitter Disassembly and Cleaning

You will need several things for the disassembly/cleaning process:

- Alcohol to help free the tight screws.
- Wire to string the metal parts of your emitter for cleaning.
- A bead-blaster to clean the parts.
- Gloves to handle the parts while cleaning them using either alcohol or acetone.

Clean and vapor dry the parts after bead-blasting. Some of your ceramics can also be cleaned in this fashion. Discard any cracked or broken ceramics.

6.6 Filament Replacement

To replace the filament in the emitter assembly it is necessary to locate and remove the two filament clamp screws. CAUTION: IF the screws seem tight, you can use alcohol to keep them from seizing. (See step 5 below).

6.7 Emitter Rebuilding/Reassembly

See supplied drawings

If the emitter is disassembled, refer to 273-0150-1 pdf drawing and figure 6. Ninety percent of system problems during production relate to the EB-source emitter, so pay close attention to its assembly, it is of the utmost importance to trouble free runs.

In particular, pay meticulous attention to the following:

- 1** Length of screws. All screws must be clean and of correct length. (Refer to Figure 5-A) Tighten screws so that they are just snug. Do not overtighten screws going into or through ceramics. The ceramics will break, the resulting loss of ceramics can be both frustrating and expensive.
- 2** Relative position of anode plate, beam former and filament must be precise to .005". (Refer to Figure 2-A) The filament (coils forward!) normally projects 1/2 of its diameter or slightly more (2/3) below beam former. Clearance between these three elements should be judged, based on performance, with a well calibrated,

experienced eye. The source will only work properly if these clearances are properly maintained.

- 3** Leads to filament. The voltage through the filament is only 12 volts so filament clamps, leads and high voltage feedthroughs must all be snugged firmly, but not overtighten, to reduce resistance.
- 4** High voltage leads. Make sure high voltage leads clear all objects inside chamber, especially leads to focus coil and aluminum foil or other shielding, by at least one inch.

The following is the recommend step-by-step method to assemble an emitter. Note that you should not tighten the screws all the way down until instructed to do so.

- 5** Assemble the mounting bracket (273-0017-1), the left hand cathode block (273-0031-1), and the left hand buss bar (273-0035-1) using two #6 x 3/8" screws (271-6050-1).
- 6** Add to the assembly the L insulator (273-0008-1), the right hand cathode block (273-0032-1) and the right hand buss bar (273-0036-1), using two #6 washers (273-0009-1), two collar insulators (273-0006-1), and two #6 x 1/2" screws (271-6060-1).
- 7** Next mount the cross insulator (273-0005-1) and the beam former (273-0004-2) using one #6 x 1/4" (271-6030-1).
- 8** Now, stand this assembly up on a flat surface with the buss bars facing away from you. Gently tap the beam former into place, and snug the screw down. Turn the assembly so the buss bars are facing you. Press down gently on the beam former and gently snug the screws on the right hand buss bar. Check the gap between the two cathode blocks making sure that they are parallel. Snug the left hand buss bar screws.
- 9** Install the new filament making sure that the filament orientation is correct (see figure 2-A). Use new #6 x 1/4" screws, loosely mount the filament clamps in place. Gently tap the emitter assembly on a flat surface to settle the filament into place. Slide the filament clamp on the right cathode block until it is flush with the right side of the block. Snug the right #6 x 1/4" screws. Gently push the left hand clamp into place. NOTE: Sliding this clamp can cause the filament to warp or bow. Snug the left #6 x 1/4" screws. Now check the alignment of the filament to the beam former.

- 10** Loosely mount two HV Insulators (273-0010-1) and two HV Shields (273-0011-1) to the emitter support bracket (273-0018-1) with two #6 x 3/8 screws.
- 11** Mount the Anode (273-0003-1) to the U Bracket (273-0019-1) using two #6 x 1/4 screws.
- 12** Attach the emitter support bracket assembly to the mounting bracket assembly, using two #6 x 1/4 screws. Place this assembly on a flat surface with the emitter support hanging over an edge, gently push down on the support bracket and tighten the two #6 x 3/8 screws into the HV insulators. Next, carefully reach around and tighten the two #6 x 1/4 screws into the HV insulators. Now mount the U bracket assembly to support bracket using two #6 x 1/4 screws. Gently push down on the mounting bracket, and tighten the two screws #6 x 1/4.
- 13** Push down on the Anode, tighten the last two #6 x 1/4 screws. Now check the alignment of the Anode to the beam former (see figure 2-A). The rebuilt emitter assembly is now ready to be installed back in the EB-source.

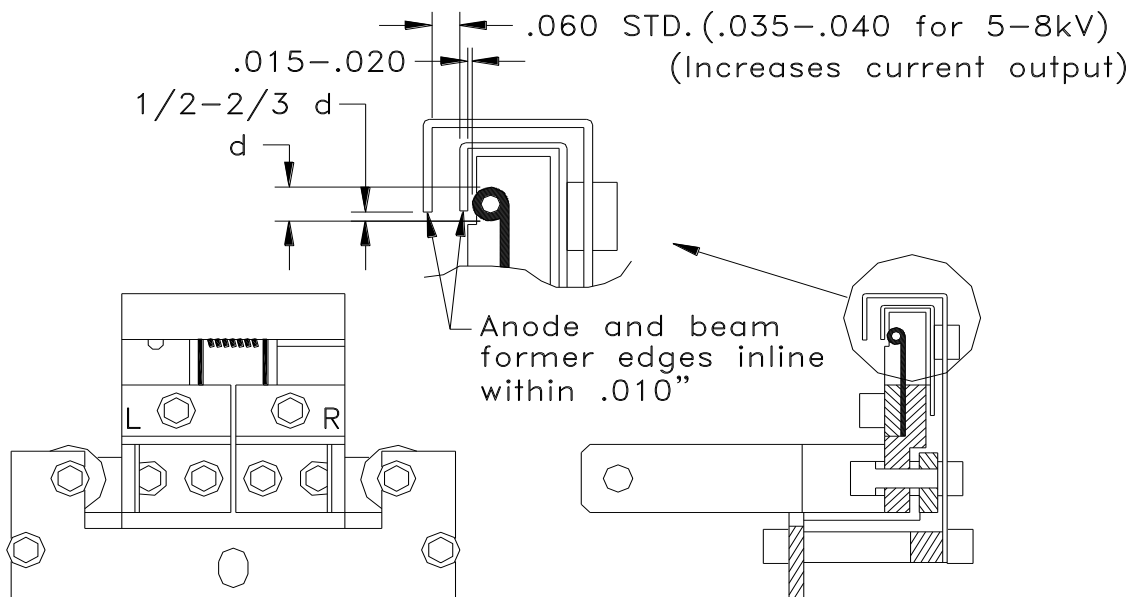


Figure 6 Filament Location

6.8 Source Disassembly

When disassembling the source, the following steps help to maintain maximum gauss.

- 1** Turn off the water and blow out the water lines.

- 2 Remove one #6-32x3/8" SST SHCS and remove the source emitter.
- 3 Remove the four #8-32 flat head screws from the cover plate.
- 4 Remove the screws from the crucible, use the lift handles to separate the crucible from the source body.
- 5 Remove three #8-32x1 1/8" SHCS (271-6136-1).
- 6 Pull the left cooling block (295-0084-1) straight out.
- 7 Repeat steps 4 and 5 to remove the right cooling block (295-0085-1).

NOTE: Steps 8 and 9 are not recommended by Telemark. This procedure may decrease the magnetic field intensity in the assembly and it may need to be re-magnetized to operate at the desired high voltage.

- 8 Remove three #10-32x1/2" SST SHCS and pull the left magnet arm (295-0058-1) straight out.
- 9 Repeat step 8 to remove the right magnet arm (295-0059-1).
- 10 Clean front shield, crucible, emitter, and cover plate.
- 11 Check the O-rings in the cooling blocks. Remove and replace them as necessary.
- 12 Reverse the previous steps to reassemble the front coil and emitter assembly.
- 13 Turn the baseplate upside down.
- 14 Remove the four screws that hold the crucible rotation assembly to the baseplate.
- 15 Inspect the O-rings. Remove and replace them as necessary.
- 16 Reverse the previous to assemble the baseplate and crucible rotation assembly.
- 17 Replace the crucible and tighten the screws.

- 18** Replace the cover plate and tighten the screws..

6.9 Crucible Rotation Assembly

Check the free turning ability on the bearings and make sure there is no vacuum grease in them. If there is, clean thoroughly and allow to vapor dry.

- 1** Remove four #10-32x1" SST SHCS from the bearing housing (295-0038-1). Separate the bearing housing from the crucible base (295-0442-2).
- 2** Remove the SST External Retaining Ring (295-0036-1).
- 3** Pull the bearing housing straight up to remove.
- 4** Inspect the bearings for free turning ability and make sure there is no vacuum grease in them. Remove and replace the bearings.
- 5** Reverse the previous steps to assemble the crucible rotation assembly.

6.10 Coil Assembly

The coil assembly is not intended to be separated from the front copper of the main body, partly because the magnetics are tested with the coils in place, and could change if the coils are reassembled.

6.11 Side Drive Assembly

See supplied drawings

Reassemble the side drive assembly by referring to figure 18. The pinion gear can be adjusted or tightened away from the main body.

To reattach the side drive assembly to the side are, drop in three #10-32x5/16" screws and secure in the housing. Check engagement of teeth. The teeth should line up and engage smoothly with about .015" play to allow for thermal expansion. If any adjustment is needed, remove the entire assembly and slide the pinion gear either out or in, as required.

Step 1



Step 2



Step 3



Step 4



Step 5



Step 6



Figure 6 Side Drive Assembly

6.12 Bottom Drive Assembly

See supplied drawings

The bottom drive assembly must be assembled on the base before the crucible rotation assembly is installed on the base of the source. It is designed with the proper alignment of the gears, there are no adjustments.

6.13 Main Body Reassembly

See supplied drawings

When completely disassembled, after the components are cleaned, the main body of the source should be reassembled in the following order:

- 6** Install mounting straps.
- 7** Install bottom drive assembly.
- 8** Attach the crucible rotation assembly.
- 9** Mount the crucible base.
- 10** Install the water-cooling duct.
- 11** Mount crucible with appropriate screws.
- 12** Install the emitter/front shield assembly.
- 13** Install the drive, either side or bottom.
- 14** Install the emitter assembly.
- 15** Install the crucible and top cover plate.
- 16** Leak-check the entire assembly.
- 17** Assembly is completed.

6.14 Quick Check

If necessary use following check list which is used on final Q.A. to make sure everything is in place.

| | | |
|---|---|----------------------|
| Emitter Assembly | Filament location | |
| | Anode, beam former and filament parallel | |
| | #6-32 screws snugged | |
| | Resistance check | Filament continuity |
| | | Emitter to ground |
| | Fastened to baseplate | |
| Tightened firmly to HV leads | | |
| Main Body Assembly | Screws tightened | Crucible |
| | | Emitter |
| | | Magnet arms |
| | | Magnet shield |
| | | Crucible cover plate |
| | | Straps |
| | Stem | |
| Check magnet orientation! (From Rear of source, North on left, Top up) | | |
| Magnetic Field | Checked directly Above filament: No current, 1 Amp applied | Longitudinal |
| | | Lateral |
| Leak check | To 2×10^{-10} Std. ccs of helium | |
| Cleanliness | Beadblasting Flakes, dust, coating Fingerprints | |
| Waterline Fittings | Tight | |

7 KITS AND ACCESSORIES

7.1 Installation Kits

The one of the following Installation Kits is shipped with the EB Source

285-0723-1 Installation Kit, 285

| No. | Description | Quantity |
|------------|-------------------------------|----------|
| 271-0090-1 | Shunt Bar | 2 |
| 271-4004-1 | Four-In-One Screwdriver | 1 |
| 271-4020-1 | Wrench Kit | 1 |
| 271-6154-9 | Screw, #10-32 X 1/2" SST FHSC | 4 |
| 272-0125-2 | Coil Connector Assembly | 1 |
| 273-0038-1 | HV Lead Kit | 2 |
| 273-0700-1 | Emitter Parts Kit | 1 |
| 295-2000-1 | O-Ring Kit, 295, 10kW | 1 |
| 295-4020-1 | Wrench Kit | 1 |
| 295-5006-1 | Lift Handle, Crucible | 2 |
| 295-5007-1 | Lift Handle, Source | 2 |

287-0723-1 Installation Kit, 287

| No. | Description | Quantity |
|------------|-------------------------------|----------|
| 271-0090-1 | Shunt Bar | 2 |
| 271-4004-1 | Four-In-One Screwdriver | 1 |
| 271-4020-1 | Wrench Kit | 1 |
| 271-6154-9 | Screw, #10-32 X 1/2" SST FHSC | 4 |
| 272-0125-2 | Coil Connector Assembly | 1 |
| 273-0038-1 | HV Lead Kit | 2 |
| 273-0700-1 | Emitter Parts Kit | 1 |
| 295-2000-1 | O-Ring Kit, 295, 10kW | 1 |
| 295-5006-1 | Lift Handle, Crucible | 2 |

| | | |
|------------|---------------------|---|
| 295-5007-1 | Lift Handle, Source | 2 |
|------------|---------------------|---|

295-0723-1 Installation Kit, 295, 10kW

| No. | Description | Quantity |
|------------|-------------------------------|----------|
| 271-0090-1 | Shunt Bar | 2 |
| 271-4004-1 | Four-In-One Screwdriver | 1 |
| 271-4020-1 | Wrench Kit | 1 |
| 271-6154-9 | Screw, #10-32 X 1/2" SST FHSC | 4 |
| 272-0125-2 | Coil Connector Assembly | 1 |
| 273-0038-1 | HV Lead Kit | 2 |
| 273-0700-1 | Emitter Parts Kit | 1 |
| 295-2000-1 | O-Ring Kit, 295, 10kW | 1 |
| 295-4020-1 | Wrench Kit | 1 |
| 295-5006-1 | Lift Handle, Crucible | 2 |
| 295-5007-1 | Lift Handle, Source | 2 |

295-0723-2 Installation Kit, 295, 15kW

| No. | Description | Quantity |
|------------|-------------------------------|----------|
| 271-0090-1 | Shunt Bar | 2 |
| 271-4004-1 | Four-In-One Screwdriver | 1 |
| 271-4020-1 | Wrench Kit | 1 |
| 271-6154-9 | Screw, #10-32 X 1/2" SST FHSC | 4 |
| 272-0125-2 | Coil Connector Assembly | 1 |
| 273-0038-1 | HV Lead Kit | 2 |
| 273-0700-1 | Emitter Parts Kit | 1 |
| 295-2000-2 | O-Ring Kit, 295, 15kW | 1 |
| 295-5006-1 | Lift Handle, Crucible | 2 |
| 295-5007-1 | Lift Handle, Source | 2 |

7.2 Accessories

Recommended parts:

1 Power Supply: We recommend the ST or TT power supplies from Telemark. However, this source will work well with all available power supplies that meet the operating specifications of the electron beam source.

2 High Voltage Covers: Install 2 HV covers for each EB source.

| No. | Description |
|------------|----------------------------------|
| 275-0210-1 | HV Cover Assy. Single Pass 1" |
| 275-0210-2 | HV Cover Assy. Single Pass 1.25" |
| 275-0211-1 | HV Cover Assy. Single Pass CFF |

3 Indexer: Install one multi-pocket indexer for each EB source.

| No. | Description |
|------------|--|
| 396-9901-1 | Crucible Indexer, 1" Bolt |
| 396-9901-2 | Crucible Indexer, 1.25" Bolt |
| 396-9901-3 | Crucible Indexer, 4/6/Con. 2.75" CF Flange |

4 Flowmeter. Telemark part number 271-0831-1. This Model uses ¼" NPT fittings and is rated at 1-6 gpm adjustable.

5 Shutter: For applications requiring a shutter install one of the following

| No. | Description |
|------------|---|
| 275-0888-1 | Shutter/Controller, 1" feedthrough |
| 275-0888-2 | Shutter/Controller, 1-1/4" feedthrough |
| 275-0888-3 | Shutter/Controller, CFF 2.75" feedthrough |

6 Feedthrough Kit. Install one of the following for each EB source.

275-0706-1 Feedthru Kit, 295 Bottom Drive, 1"

| No. | Description | Quantity |
|------------|--------------------------------------|----------|
| 275-0001-1 | HV Feedthru, 1" | 2 |
| 275-0002-1 | Rotary 1/4 Feedthru, 1" | 1 |
| 275-0003-1 | Water Feedthru Assembly, 1" | 2 |
| 275-0008-1 | 8 Pin Instrument Feedthru, Octal, 1" | 1 |

275-0706-2 Feedthru Kit, 295 Bottom Drive, 15kw, 1"

| No. | Description | Quantity |
|------------|--------------------------------------|----------|
| 275-0001-1 | HV Feedthru, 1" | 2 |
| 275-0002-1 | Rotary 1/4 Feedthru, 1" | 1 |
| 275-0003-1 | Water Feedthru Assembly, 1" | 2 |
| 275-0004-1 | 1/2" Water Feedthru Assy., 1" | 2 |
| 275-0008-1 | 8 Pin Instrument Feedthru, Octal, 1" | 1 |

275-0706-3 Feedthru Kit, 295 Bottom Drive, 1.25"

| No. | Description | Quantity |
|------------|---|----------|
| 275-0001-2 | HV Feedthru, 1.25" | 2 |
| 275-0002-2 | Rotary 1/4 Feedthru, 1.25" | 1 |
| 275-0003-2 | Water Feedthru Assembly, 1.25" | 2 |
| 275-0008-2 | 8 Pin Instrument Feedthru, Octal, 1.25" | 1 |

275-0706-4 Feedthru Kit, 295 Bottom Drive, 15kw, 1.25"

| No. | Description | Quantity |
|------------|---|----------|
| 275-0001-2 | HV Feedthru, 1.25" | 2 |
| 275-0002-2 | Rotary 1/4 Feedthru, 1.25" | 1 |
| 275-0003-2 | Water Feedthru Assembly, 1.25" | 1 |
| 275-0008-2 | 8 Pin Instrument Feedthru, Octal, 1.25" | 1 |

275-0707-1 Feedthru Kit, 295, Side Drive, 1"

| No. | Description | Quantity |
|-----|-------------|----------|
|-----|-------------|----------|

| | | |
|------------|--------------------------------------|---|
| 275-0001-1 | HV Feedthru, 1" | 2 |
| 275-0003-1 | Water Feedthru Assembly, 1" | 2 |
| 275-0006-7 | Rt. Angle Rotary Feedthru, 1", 295 | 1 |
| 275-0008-1 | 8 Pin Instrument Feedthru, Octal, 1" | 1 |

275-0707-2 Feedthru Kit, 295, Side Drive, 15kw, 1"

| No. | Description | Quantity |
|------------|--------------------------------------|----------|
| 275-0001-1 | HV Feedthru, 1" | 2 |
| 275-0003-1 | Water Feedthru Assembly, 1" | 1 |
| 275-0004-1 | 1/2" Water Feedthru Assy., 1" | 2 |
| 275-0006-7 | Rt. Angle Rotary Feedthru, 1", 295 | 1 |
| 275-0008-1 | 8 Pin Instrument Feedthru, Octal, 1" | 1 |

275-0707-3 Feedthru Kit, 295, Side Drive, 1.25"

| No. | Description | Quantity |
|------------|---|----------|
| 275-0001-2 | HV Feedthru, 1.25" | 2 |
| 275-0003-2 | Water Feedthru Assembly, 1.25" | 2 |
| 275-0006-2 | Rt. Angle Rotary Feedthru, 1.25" | 1 |
| 275-0008-2 | 8 Pin Instrument Feedthru, Octal, 1.25" | 1 |

275-0707-4 Feedthru Kit, 295, Side Drive, 15kw, 1.25"

| No. | Description | Quantity |
|------------|---|----------|
| 275-0001-2 | HV Feedthru, 1.25" | 2 |
| 275-0003-2 | Water Feedthru Assembly, 1.25" | 1 |
| 275-0006-2 | Rt. Angle Rotary Feedthru, 1.25" | 1 |
| 275-0008-2 | 8 Pin Instrument Feedthru, Octal, 1.25" | 1 |

7.3 Replacement Crucibles

Replacement crucibles are available to replace the crucible or to change number and size of the pockets. When changing number of pockets a new cover is required. In addition to standard crucibles, custom combinations of pocket sizes are available, please contact the factory.

Model 285 Crucibles

| No. | Description |
|------------|-------------------------|
| 285-0234-1 | Crucible, 12x 25cc |
| 285-0238-1 | Crucible, 14x 15cc |
| 285-0250-1 | Crucible, 1512cc Trough |

Model 287 Crucibles

| No. | Description |
|------------|-----------------------|
| 287-0207-1 | Crucible, 8x 75cc |
| 287-0222-1 | Crucible, 9x 60cc |
| 287-0232-1 | Crucible, 10x 40cc |
| 287-0234-1 | Crucible, 15x 15cc |
| 287-0235-1 | Crucible, 12x 25cc |
| 287-0275-1 | Crucible, Pan, 1810cc |

Model 295 Crucibles

| No. | Description |
|------------|---------------------------------|
| 295-0205-1 | Crucible, 6x 100cc, (10kW) |
| 295-0232-1 | Crucible, 10x 40cc (10kW) |
| 295-0233-1 | Crucible, 12x 40cc (10kW) |
| 295-0240-1 | Crucible, 1486cc Trough, (10kW) |
| 295-0245-1 | Crucible, 1420cc Pan, (10kW) |
| 295-0250-1 | Crucible, 6x 100cc |

7.4 Rebuild Kits

Seal Kits

295-2000-1 O-Ring Kit, 295, 10kW

| No. | Description | Quantity |
|------------|--------------------------------------|----------|
| 271-2109-1 | O-Ring, Viton, ID 5/16", W 3/32" | 2 |
| 271-2111-1 | O-Ring, Viton, ID 7/16", W 3/32" | 4 |
| 271-2204-1 | O-Ring, Viton, ID 3/8", W 1/8" | 2 |
| 271-2226-1 | O-Ring, Viton, ID 2", W 1/8" | 1 |
| 271-2452-1 | O-Ring, Viton, ID 11-1/2", W 1/4" | 2 |
| 271-3906-1 | O-Ring, Viton, Tube OD 3/8" | 7 |
| 271-3908-1 | O-Ring, Viton, Tube OD 1/2" | 2 |
| 271-4328-1 | Quad Ring, Viton, ID 1-7/8", W 3/16" | 1 |

295-2000-2 O-Ring Kit, 295, 15kW

| No. | Description | Quantity |
|------------|-----------------------------------|----------|
| 271-2109-1 | O-Ring, Viton, ID 5/16", W 3/32" | 2 |
| 271-2111-1 | O-Ring, Viton, ID 7/16", W 3/32" | 4 |
| 271-2204-1 | O-Ring, Viton, ID 3/8", W 1/8" | 2 |
| 271-2226-1 | O-Ring, Viton, ID 2", W 1/8" | 1 |
| 271-2452-1 | O-Ring, Viton, ID 11-1/2", W 1/4" | 2 |
| 271-3906-1 | O-Ring, Viton, Tube OD 3/8" | 7 |
| 271-3908-1 | O-Ring, Viton, Tube OD 1/2" | 2 |
| 271-4329-1 | Quad Ring, Viton, ID 2", W 3/16" | 1 |

Emitter Parts Kit

273-0700-1 Emitter Parts Kit

| No. | Description | Quantity |
|------------|--|----------|
| 271-5003-1 | White Gloves, Nylon, Large, pr. | 1 |
| 271-6010-5 | Screw, #6-32 X 1/4" Slot Flat Head, Ti | 2 |
| 271-6020-5 | Screw, #6-32 X 3/16" Ti SHCS | 1 |
| 271-6030-1 | Vented Screw, #6-32 X 1/4" SST SHCS | 4 |
| 271-6050-1 | Vented Screw, #6-32 X 3/8" SST SHCS | 6 |
| 271-6060-1 | Vented Screw, #6-32 X 1/2" SST SHCS | 2 |
| 271-6242-1 | Flat Washer, #6 | 2 |
| 273-0001-1 | Filament, 7-1/2 Turn | 5 |
| 273-0003-1 | Anode Plate | 1 |
| 273-0004-2 | Beam Former | 1 |

| | | |
|------------|-------------------|---|
| 273-0005-1 | Insulator, Cross | 1 |
| 273-0006-1 | Insulator, Collar | 2 |
| 273-0008-1 | Insulator, L | 1 |
| 273-0010-1 | Insulator, HV | 2 |
| 273-0011-1 | HV Shield | 2 |

HV Lead Kit

273-0038-1

HV Lead Kit

| No. | Description | Quantity |
|------------|--|----------|
| 119-0010-4 | Copper Rod, OFHC, 8awg (0.125") | 2 FT. |
| 110-8404-1 | Lug, Crimp Terminal, Ring, 8 Ga., 1/4 | 2 |
| 275-0119-6 | Lug, Tin Pltd Copper 8awg #10 Non-Insulated Ring | 2 |
| 271-6150-9 | Screw, #10-32 X 1/2" SST SHCS | 2 |
| 271-6255-1 | Nut, #10-32, SST | 2 |
| 271-6245-1 | Flat Washer, #10, SST | 4 |

7.5 Change Over Kit

When it is necessary to change the drive orientation of an existing EB source, one of the following kit supplies all the necessary parts.

| No. | Description |
|------------|--|
| 295-0726-1 | Change Over Kit, Bottom to Side Drive, 295 |
| 295-0728-1 | Change Over Kit, Side to Bottom Drive, 295 |

8

TROUBLESHOOTING

This section should be read in conjunction with the section on assembling the emitter. Experience demonstrates that the emitter assembly causes ninety percent of system problems in production.

8.1 Power Problems

Problem: EMISSION CURRENT MUST BE TURNED TO HIGHER THAN NORMAL TO EVAPORATE.

Cause: Filament is badly warped or was put in backwards.

Correction: *Remove emitter assembly and replace filament.*

Problem: EMISSION GOES TO MAXIMUM WHEN THE HIGH VOLTAGE IS TURNED ON.

Cause: A flake of material (sometimes extremely small) may be shorting the filament block to the anode plate. This happens occasionally when heating brittle materials too fast.

Correction: *Remove emitter, and try to locate and remove flake.*

Problem: NO EMISSION CURRENT.

Cause 1: Filament is broken or leads need tightening

Correction: Replace filament or tighten connections.

Cause 2: Power supply filament control circuit is faulty. parallel

Correction: Fix power supply.

Problem: NO VOLTAGE.

Cause: System or source has high resistance ground

Correction: Check emitter, filament, and feedthroughs for shorts.

8.2 Beam Problems

Problem: NO BEAM VISIBLE IN CRUCIBLE AS CURRENT IS INCREASED.

Cause 1: The magnet was reversed when reassembling the source (this can have damaging affects on the EB source and chamber walls if emission current is increased too far while searching for beam).

Correction: Close down the system and reassemble the source with the magnet properly oriented.

Cause 2: The sweep unit may have a problem.

Correction: Check sweep for proper setup.

Problem: THE BEAM IS CENTERED TO THE FRONT OF THE CRUCIBLE, WITH NO COIL CURRENT.

Cause 1: The high voltage is below what the source was gaussed for.

Correction: Adjust the voltage so the beam is centered.

Cause 2: The magnet is too strong.

Correction: Place a shunt just behind the cover plate on the magnet arms to weaken the magnet.

Problem: THE BEAM CENTERED TO THE BACK OF THE CRUCIBLE, WITH NO COIL CURRENT.

Cause 1: The high voltage is above what the source was gaussed for.

Correction: Adjust the voltage so the beam is centered.

Cause 2: The magnet is too weak.

Correction: Remove shunts. If still out of position, contact factory to have the source regaussed.

Problem: THE BEAM DOES NOT HAVE THE DESIRED SHAPE.

Cause 1: The filament is warped or misaligned.

Correction: Replace the filament.

Cause 2: The pole pieces are either in or out too far.

Correction: Adjust the pole pieces.

Cause 3: The voltage is not set correctly causing the beam to spread out.

Correction: Adjust the voltage.

Problem: ARCING AND BLUE FLUORESCENCE OCCUR WHERE THE BEAM SHOULD BE.

Cause: The pressure is too high. There may be a water leak, the bleed valve may be wide open, or chamber seal may be broken.

Correction: Shut off the bleed valve, check the source or water fittings for leaks, check the most recently opened chamber seals (such as the door) for clean surfaces. Mentally and, if necessary, physically leak check chamber.

8.3 Rotation Problems

Possible problems with Quad-ring sealed Multi-Pocket Sources.

Problem: LOSS OF VACUUM WHEN THE CRUCIBLE IS ROTATED.

Cause: Water seal is letting water through.

Correction: Install a new Quad-ring.

Problem: THE CRUCIBLE IS DIFFICULT TO ROTATE.

Cause 1: The water seal is in need of lubrication.

Correction: Install a new Quad-ring.

Cause 2: The drive bearing is bad.

Correction: Check and replace bearing if needed.