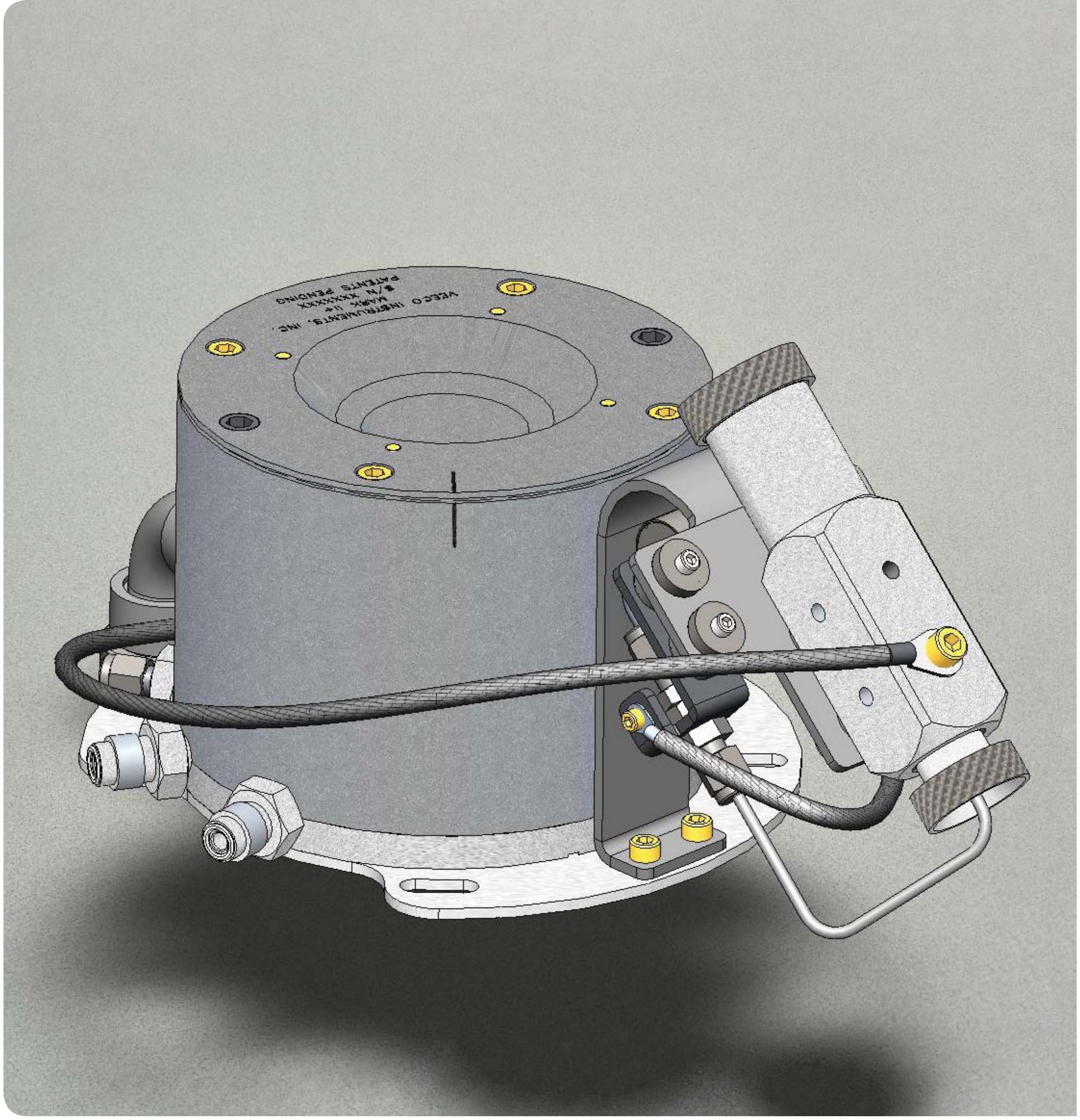

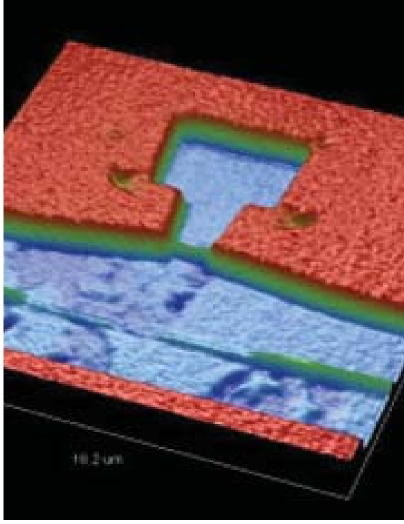

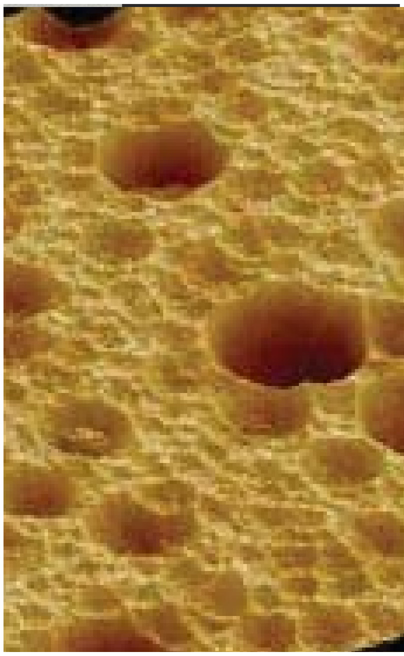

Mark II⊕ Fluid Cooled Ion Source with HCES

Technical Manual
427361

Veeco

Solutions for a nanoscale world.™

Mark II®

Fluid Cooled Ion Source

with HCES

Technical Manual

Veeco

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Manual # 427361 Rev. D

Table of Contents

Chapter 1: Safety

Understanding the correct installation, operation, and maintenance procedure is necessary for safe and successful operation. This symbol precedes safety messages in this manual, along with one of the three signal words explained below. Obey the messages that follow these words to avoid possible injury or death.

⚠ DANGER

This symbol marks an imminent hazard which will kill or injure if ignored.

⚠ WARNING

This symbol marks a potential hazard which may kill or injure if ignored.

⚠ CAUTION

This symbol marks a potential hazard which may cause minor injury if ignored.

CAUTION

This symbol marks a potential hazard which may cause damage if ignored.

Please read the following before continuing:

⚠ WARNING

To avoid electrical shock, keep clear of “live” circuits. Follow all local lock-out/tag-out procedures before repairing or replacing any electrical devices.

It is recommended that only trained, qualified persons using established safety procedures perform any work related to the installation, start-up, operation or maintenance of this system.

⚠ CAUTION

Ion source surfaces may exceed 300°C (570°F) after use and venting. Avoid burns during servicing by using appropriate personal protective equipment and allowing for a sufficient cool down interval.

Obtain, read and understand the Material Safety Data Sheet (MSDS) for any chemicals and materials referenced in this technical manual. Follow all local procedures in the safe handling and use of these materials, including the use of any required personal protective equipment.

⚠WARNING

To avoid electrical shock, check that all hardware interlocks are working. Keep all guards and panels in place during routine system operation.

Complete ion beam systems from Veeco Instruments Inc. are supplied with hardware interlocks and software safeguards at various points in the system. Whenever components or retrofits are added to existing systems, a local review of system safety is recommended.

Chapter 2: Overview

Congratulations on your purchase of the Veeco Mark™II⊕ fluid cooled ion source with hollow cathode electron source. The gridless end-Hall design offers operational flexibility and reduced sensitivity to contamination from the surrounding environment. This ion source's high-current density, total beam current and low energy beam characteristics facilitate a variety of property enhancement and reactive processes. It is particularly well suited to industrial vacuum applications involving:

- **Precleaning** – Low energy ion beam precleaning removes surface contaminants (water vapor, hydrocarbons, native oxides and absorbed materials), to improve film/substrate adhesion.
- **Ion assisted deposition** – Ion bombardment of the substrate assists film growth, adhesion and hardness while reducing absorbed residual gas contaminants and film stress.

The ion's accelerating potential difference is generated with a magnetic field and a substantial electron current. The source generates a maximum beam current of approximately 2 to 3A (for argon and oxygen) with a mean ion beam current energy that can range from 40 to 200eV, depending upon the source's input settings. Typical operating gases include argon, krypton, xenon, nitrogen and oxygen. For reference, basic operating characteristics have been included for argon and oxygen. Refer to the "Specifications" chapter for details.

The source consists of the following basic elements:

- stainless steel anode and exterior shell
- magnet
- input gas distributor
- gas and electrical feedthroughs and connections
- hollow cathode electron source (HCES)
- fluid cooling and fittings
- gold plated fasteners.

The source and feedthroughs have been engineered for straightforward installation and ease of use. If you do need help, Veeco's "Service Support" team is available to assist you.

Chapter 3: Theory of Operation

The Mark ⊕ series gridless ion source operates by producing a low pressure gas discharge or plasma (typically 0.13 to 1.33×10^{-1} Pa/0.1 to 1.0 $\times 10^{-3}$ Torr) near a cusped magnetic field that lies between an electron emitter (either a filament or a hollow cathode) and an angled anode. FIGURE 3.1 illustrates this ion source's basic operating principles. A DC magnetic field is formed by a permanent magnet and the source's open-ended magnetic stainless steel shell. Primary electrons, emitted from the cathode, are drawn to the cone-shaped anode by means of an applied DC potential, through which a working gas is injected. The accelerated electrons strike and ionize the input gas's neutral atoms or molecules to form a gas discharge or plasma. As the electrons drift toward the anode, the magnetic field impedes their mobility or flow. This resistance to electron flow results in a space charge (or potential field) within the plasma near the anode. It is this spatially varying potential field that ultimately accelerates ions away from the source anode (both axially and radially), to form the source's gridless ion beam. Since ions can be produced at various locations along the plasma space-charge, the output beam current's energy distribution and angular spread is broadly distributed. The mean ion beam current energy is typically 60 to 80% of the anode potential. In the absence of electrostatic grids to separate electrons from ions, a near equal number of electrons in the plasma are electrostatically drawn along with the ions, essentially neutralizing the ion beam. It is often necessary for many applications to inject additional electrons from the cathode into the ion beam; this further enhances neutralization and decreases positive charging of electrically isolated surfaces or work-pieces.

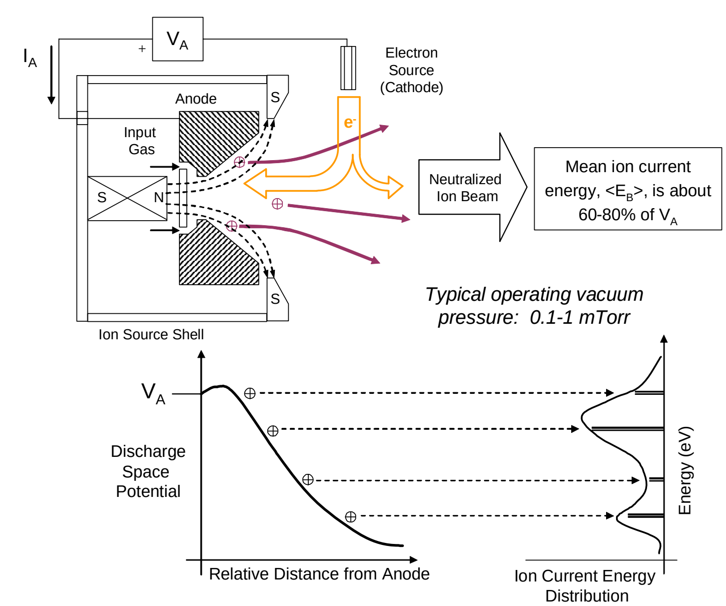


FIGURE 3.1 Schematic Diagram of Ion Source Operation.

"FIGURE 3.1" on page 4 shows the Mark ⊕ series ion source's fundamental operating principles; FIGURE 3.2 illustrates fluid cooled source operation, together with its HCES, the Veeco Mark ⊕ series Controller and both input mass flow controllers (MFC). The ion source and HCES require separate MFCs. These components are all provided when this model is ordered as a package.

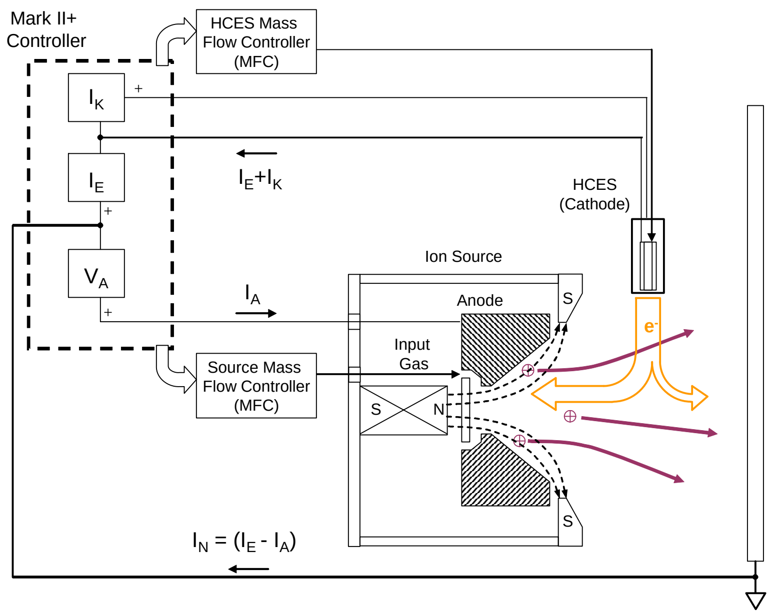


FIGURE 3.2 Ion Source-HCES-Controller Operation with MFCs.

First, an argon plasma is ignited in the HCES and sustained with current, I_K, provided by the controller's keeper supply. This supply maintains the HCES's thermionic emission temperature, to produce the primary electrons. Second, a gas flow is introduced into the source; the unit applies a voltage-regulated anode potential, V_A, to drive the ion source discharge and produce the ion beam. The controller is able to then automatically regulate the gas flow to the anode, since the electrical impedance of the plasma between the anode and cathode depends on input gas conditions. This provides an anode discharge current I_A, approximating the operator requested set point as closely as possible.

The power supply uses a third current-regulated emission supply (positioned between the cathode and the anode supply return) to provide additional electrons from the HCES to enhance ion beam neutralization. This emission supply regulates a portion of the cathode return current, I_E, most of which is the anode supply return current, I_A, and any additional neutralization current, I_N, returning through the chamber system ground. By regulating I_E, the controller allows the operator to inject an excess electron neutralization current, I_N. The recommended value for I_N is +10 to +20% of the anode current, I_A. Refer to the Mark ⊕ series Controller technical manual for detailed information.

Recall that the mean ion beam current energy is typically 60 to 80% of the anode voltage setting. Total output ion beam currents are similarly 20 to 30% of the anode current; this beam current is generally less at low gas flows (high anode voltages) and greater at high gas flows (low anode voltages). The output performance depends upon a particular vacuum system's actual pumping capacity, because of the interaction between the source output and the process chamber's background gases. Stable operation is generally possible for V_A typically ranging between 50 to 300V and for I_A between 1 to 15A, depending on gas chemistry and the local process chamber's vacuum pressure.

NOTE

Mark ⊕ series Controller output is limited to 3kW. Refer to “Specifications” on page 63**.**

Additional information and reference performance curves for routine operation appear in “Source Performance” on page 65.

Low vacuum pressures (less than 1.33 x10^{-1} Pa/1.0 x10^{-3} Torr) are generally necessary for stable source operation at high anode voltages (greater than 200V); as a result, vacuum systems with marginal pumping capacity may not support high voltage operation. A pumping capacity greater than or equal to roughly 700ℓ/s should be adequate for most applications; this assumes there are no additional gas flows into the process chamber other than those of the ion source and HCES.

Chapter 4: Installation

Inspection

Unpack the Mark ⊕ series fluid cooled ion source and inspect it carefully for any visible damage. If damage is found, notify the shipping company and contact "Service Support" on page 62 immediately. Check that all accessories and options have been included with the source package.

NOTE

The Mark ⊕ anode assembly is shipped separately from the source body. The anode assembly must be mounted in the base assembly before operating the source in the process chamber. Refer to "FIGURE 6.16" on page 44 and Step "6." on page 44 for detailed instructions.

General

Install and furnish utilities to the ion source. Where appropriate, refer to "Drawings" on page 73 and "Specifications" on page 63.

NOTE

It is the customer/installer's responsibility to install this equipment in accordance with current local electrical and mechanical code requirements, in addition to any applicable national regulations.

This chapter is divided into the following sections:

- Verify Facilities
- Source Mounting
- Feedthrough Installation
- Vacuum Side Connections
- HCES Installation
- Atmosphere Side Connections
- Electrical Continuity
- Controller Interlocks
- Post Installation.

Verify Facilities

The following is a check list of recommended facilities and components required to install and operate the ion source with the HCES.

- **Vacuum System** – The process chamber's low pressure vacuum system must be capable of base-pressures of 1.33 x 10^{-2} Pa (1.0 x10^{-4} Torr) or less, with sufficient vacuum pumping capacity to maintain operating pressure between 0.67 and 1.33 x10^{-1}Pa (0.5 and 1.0 x10^{-3} Torr) for the maximum gas flow listed in the "Specifications" on page 63. This corresponds to a approximate vacuum pumping capacity of at least 700ℓ/sec.
- **Gas Supply and Control** – The source has been tested for argon operation; it will operate with other inert gases, as well as oxygen and nitrogen. Refer to "Facilities Requirements" on page 64 for detailed information. Each source and HCES requires a separate MFC, which is provided by Veeco when the source is purchased as a part of a package. It is recommended that the customer install a two stage regulator upstream of the MFC and a positive shut off valve downstream for each MFC.The HCES is designed for inert gas operation only.
- **Cooling** – The ion source is fluid cooled, and the HCES is radiation cooled. Refer to "Facilities Requirements" on page 64 for additional information.

⚠ CAUTION

Ion source surfaces may exceed 300°C (570°F) after use and venting. Avoid burns during servicing by using appropriate personal protective equipment and allowing for a sufficient cool down interval.

- **Electrical** – The Veeco Mark ⊕ series Controller provides the currents, voltages and gas flow control needed for source/HCES operation, and is provided by Veeco when the source is purchased as a part of a package. Refer to the controller technical manual for installation, connection and operational information.
- **Mechanical** – These items are customer supplied unless noted:
  - a 1/8 in. OD stainless steel gas delivery tube that is clean of all contaminants and is appropriately rated for vacuum service within the intended process environment.
  - Vacuum/process suitable hardware and bracketry to make a fixture that secures the ion source base plate to the process chamber. This fixture must capably bear the ion source and HCES's weight. Refer to "Specifications" on

page 63 for weight and "Drawings" on page 73 for source envelope dimensions.

- Three process chamber penetrations (for coolant, gas and electrical) capable of holding a vacuum seal, which match the customer specified feedthroughs ordered with the source package. Veeco offers the following feedthrough styles: 1 in. O-ring seal or 2¾ in. metal seal.

Source Mounting

Verify that there is sufficient clearance at the intended location in the process chamber to install and hook up the ion source and HCES before continuing. Refer to "Drawings" on page 73 for source envelope dimensions. The ion source may be installed in any orientation. Veeco recommends positioning the source so that the operator may readily remove the anode assembly and HCES for maintenance while leaving the base assembly, with its electrical, gas and coolant connections in place. This is especially important when installing the source in large process chambers (deeper than 1m/39 in.).

⚠ CAUTION

To reduce the likelihood of repetitive stress and strain injuries when performing routine preventive maintenance, install the source in an ergonomically accessible location and position.

Follow customary clean room protocols and methods to keep all vacuum side parts free of oil, particles, fibers and other contaminants.

NOTE

Wear clean, lint free, powder free examination gloves before handling the source, its feedthroughs or any vacuum side mounting hardware.

The HCES, anode assembly and base assembly are separated for shipment. "FIGURE 4.1" on page 10 shows how these components will be reassembled during initial installation as well as routine servicing. Refer to "FIGURE 6.16" on page 44 and step "6." on page 44 for detailed instructions on anode assembly alignment and seating in the source body.

1. Attach the ion source base assembly to the process chamber, using clean hardware and bracketry (provided by others) via the four slotted bosses on the base assembly. Refer to “Drawings” on page 73.

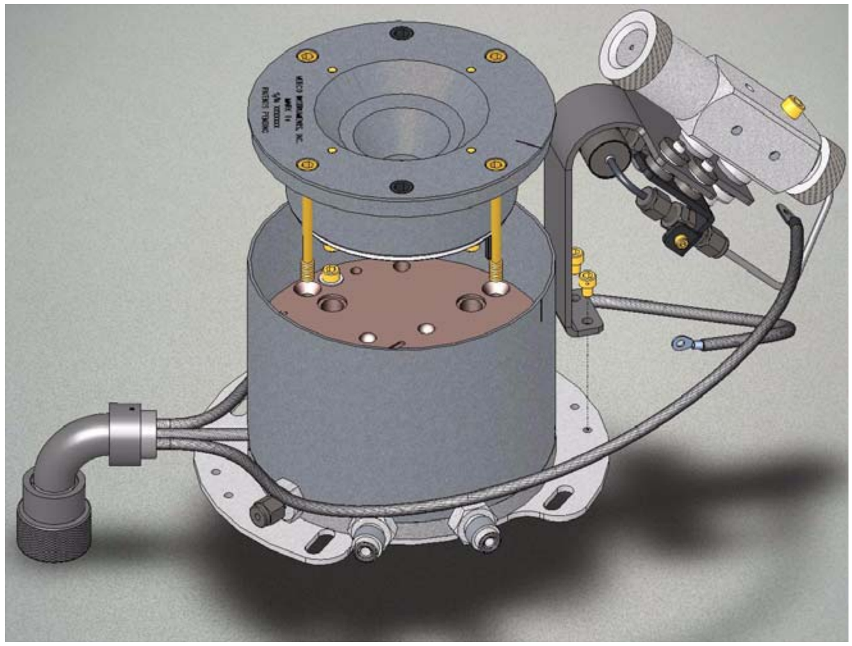


FIGURE 4.1 Mark II® Gridless Ion Source with HCES.

2. Verify the following before continuing:
   - Confirm that there is no interference between the source’s base assembly and existing vacuum and mechanical fixtures.
   - Check that the supplied connections and leads can easily reach between the source and the feedthroughs without placing undue stress on them. Refer to “Drawings” on page 73.
   - For best results, verify that any ion source beam shutter or other mechanical boundary (when used) has approximately 5cm (2 in.) of clearance from the filament cathode at the source’s output.
   - Temporarily hold the HCES in its mounting position, to confirm that the body and its 1/8 in. gas line do not come in electrical contact with any conductive surfaces in the process chamber.

NOTE

The HCES will be installed later.

If any lines and leads do not easily reach the feedthroughs, relocate the source, or contact “Service Support” on page 62 regarding the availability of other electrical lead lengths.

Feedthrough Installation

These steps describe the installation of a 1 in. O-ring feedthrough, but are also applicable for installing a feedthrough using a 2¾ in. metal seal flange. Refer to "Drawings" on page 73 when following these steps.

1. Remove any blanking plates or plugs installed in the chamber penetrations intended for feedthrough use. Confirm that the penetration size and type matches the feedthrough supplied. Contact "Service Support" on page 62 if there are any discrepancies.

NOTE

If feedthroughs using a 2¾ in. metal seal are used, confirm that the chamber penetration's flange, inner diameter and length do not interfere with making vacuum side feedthrough connections.

2. Clean all vacuum mating surfaces and seals (O-rings or gaskets) of oils, particles, fibers and other contaminants, using an alcohol moistened lint-free task wipe.

3. Secure the coolant and gas feedthroughs to the process chamber; do not complete any of the atmosphere side connections at this time.

4. Remove the following hardware from 1 in. base plate electrical feedthrough assembly:

   a. the atmosphere side electrical connector, by first removing the three pan head screws from the outside edge of the end-connector housing (atmosphere side).

   b. the retaining nut and washer.

CAUTION

To avoid possible feedthrough damage, do not bend or attempt removal of any of the electrical pins.

5. Check that the sealing surface is clean and free of scratches. Insert the base plate electrical feedthrough into the 1 in. chamber penetration from the vacuum side, placing the O-ring against the chamber interior.

6. Secure the feedthrough from the atmosphere side, using the washer and the retaining nut; hand tighten with a 1½ in. open end wrench.

CAUTION

To avoid possible feedthrough thread galling, do not overtighten.

7. Replace the atmosphere side electrical connector:

   a. Align the connector's keyway with the feedthrough's keyway. Refer to FIGURE 4.2.

FIGURE 4.2 Align the Connector and Feedthrough Keyways.

   b. Secure the connector to the feedthrough by tightening the three pan head screws. Refer to FIGURE 4.3.

FIGURE 4.3 Secure the Connector to the Feedthrough.

Vacuum Side Connections

NOTE

Swagelok® brand unions used inside the process chamber should be assembled finger tight, after initially seating the ferrules with open end wrenches. This prevents galling and makes equipment servicing easier.

1. Measure the distance between the ⅛ in. Swagelok brand gas input connection on the source's base assembly and the gas feedthrough's vacuum side; cut an appropriate length of customer supplied ⅛ in. OD stainless steel tubing for the vacuum side source gas line.

2. Join the source gas connection and the gas feedthrough using the tubing; seat each fitting using 7⁄16 and ½ in. open end wrenches.

3. Attach the flexible vacuum side coolant lines (supplied with the source package) to the female ¼ in. VCR® brand fittings on the source's base fixture. Make certain to include ¼ in. VCR brand gaskets. Compress each fitting using ⅝ and ¾ in. open ended wrenches until the connection is vacuum tight.

4. Repeat step 3. for the vacuum side coolant feedthrough connections.

NOTE

The source's internal cooling loop is symmetrical; either connection may serve as inlet or outlet.

5. Attach the source's vacuum side electrical lead assembly to the electrical feedthrough. Two lengths are available: 18 or 36 in. (0.46 or 0.91m). These leads are factory connected to the source; field disconnection is not recommended. Electrical feedthrough pin assignments are similarly factory configured, and do not require field changes or adjustment.

NOTE

The two remaining vacuum side electrical leads are for the HCES and will be connected during that device's installation. The

The source leads should remain slack and flexible after installation. Avoid tight bends (under 5cm/2 in. radius of curvature), stretching, or compression by other components.

CAUTION

To avoid lead damage and diminished source performance, keep the source leads loose and flexible.

6. The HCES, anode assembly and base assembly are separated for shipment; refer to "FIGURE 4.1" on page 10. Remove the anode assembly from the package, as well as any protective caps or covers.

7. Install the anode assembly in the source body; refer to "FIGURE 6.16" on page 44 and step "6." on page 44 for detailed instructions on anode assembly alignment and seating in the source body.

CAUTION

To avoid source damage, do not operate the ion source unless the anode assembly is installed in the base assembly.

HCES Installation

The HCES and its bracket attach to the ion source's mount plate. The HCES requires gas and electrical connections similar to the ion source. Refer to HCES 5000 technical manual for additional information.

1. Attach the HCES assembly to the ion source's mount plate, using two 10–32 screws and a 5⁄32 in. hex ball driver. There are three possible mounting locations.

2. Measure the distance between the "gas in" Swagelok® brand fitting on the HCES assembly and the gas feedthrough's vacuum side; cut an appropriate length of customer-supplied 1/8 in. OD stainless steel tubing for the vacuum side HCES gas line.

3. Join the HCES "gas in" fitting and the gas feedthrough using the tubing; seat the fittings on each end using 7/16 and ½ in. open end wrenches.

4. Check the alignment of the keeper aperture and the cathode tip's orifice by looking into the discharge end of the HCES. Adjust the alignment if necessary. Refer to HCES 5000 technical manual.

CAUTION

To avoid electrical shorts and possible HCES - controller damage, maintain at least 5cm (2 in.) clearance between the isolated gas line/ cathode and any conductive surface within the process chamber.

5. Attach each of the HCES electrical leads between the HCES and the electrical feedthrough:
   a. The keeper lead has a ¼ in. through-hole lug and attaches to the HCES body via the ¼–20 x ¼ in. long hex socket cap screw, using any of the HCES's six unused ¼–20 threaded holes.

b. The cathode lead has a #6 screw through-hole lug that attaches to the angled tab on the HCES mounting bracket with the #4–40 x 3/8 in. long hex socket cap screw.

CAUTION

To avoid possible hollow cathode tip poisoning, refrain from: cleaning the HCES or the cathode tip with isopropyl alcohol or hydrocarbon solvents, and operating the HCES using reactive gases (oxygen or nitrogen). The presence of residual solvents or oils will irreversibly damage the HCES tip and disrupt source start-up.

Atmosphere Side Connections

1. Flush any construction material (cutting oil, thread compound, PTFE tape, metal particles or other contaminants) from newly plumbed lines (gas and coolant) before attaching them to the process chamber.

2. Install the ion source and HCES mass flow controllers near the two pin gas feedthrough provided with the source. For best results, Veeco recommends locating the MFCs no more than 0.5m (19 in.) from the input gas feedthrough. Provide secure vacuum tight connections between the MFC gas outputs and the gas feedthrough at the process chamber wall.

NOTE

Shorter gas line distances ensure that the local ion source gas pressure stabilizes quickly, improving source start-up and responsiveness to changing process settings and conditions.

3. Attach the inlet and outlet coolant supply lines on the atmospheric side of the coolant feedthrough. Refer to "Specifications" on page 63 for detailed requirements. Check for and repair any leaks inside and outside the process chamber before continuing.

4. Follow the steps in the Installation chapter of the Mark ⊕ series Controller technical manual to complete the connections between the atmosphere side gas feedthrough and the facility's gas service. Refer also to "Drawings" on page 73.

NOTE

Mark the source's atmosphere side gas inlet line to avoid confusion with any other process chamber gas service.

5. Connect the source cable to the electrical feedthrough's atmosphere side. Two lengths are available: 20 or 40 ft. (6.1 or 12.2m). Perform

the steps in "Electrical Continuity" before connecting this cable to the controller's rear panel.

CAUTION

To avoid possible source and/or controller damage, perform all continuity checks after source installation, but before connecting the source cable to the controller.

After installation, the source may be serviced without the need to disconnect the base assembly from required facilities.

Electrical Continuity

For best results, check for electrical shorts and continuity between the vacuum side source/HCES electrical connections and the source cable's end before attaching it to the controller's rear panel. Connections may be checked from either the atmosphere or vacuum side. Use the pin assignments in Table 4.1 as a guide.

Table 4.1: Feedthrough Receptacle Pin Assignment

Cable Pin no.	Feedthrough Pin Letter (atmosphere side)	Connection
1	D	anode
6	C	HCES cathode tip
5	B	HCES keeper body
3/connector shield	A/connector body	ground/return

CAUTION

To avoid possible source/controller damage, do not attach the source cable to the controller or turn the controller on before confirming the following electrical checks.

1. Use a multimeter to verify continuity between the controller end of the source cable assembly to the respective vacuum side connections. Continuity should be less than 1Ω.

2. Once continuity is verified, use a multimeter to confirm that the anode, keeper, and cathode connections are isolated from one another and from ground. Isolation should be greater than 10MΩ.

NOTE

Since ion source coolant only flows through grounded source parts, coolant conductivity will have no effect on the electrical isolation of the anode or HCES assemblies.

3. If shorts or open circuits are found, find and correct them before continuing. Contact "Service Support" on page 62 for recommendations and assistance.

CAUTION

To avoid possible source-controller damage, identify and correct all shorts between leads and open circuits in individual leads before attaching the controller and operating the source.

Controller Interlocks

Veeco strongly recommends that the customer provide field interlocks to indicate when critical facilities that are required for safe operation are present. Refer to the **Installation** chapter of the Mark ⊕ series Controller technical manual for additional information. Table 4.2 shows the minimum recommended requirements. Other interlocks related to process integrity or operator safety may be added in series with these as local conditions dictate:

Table 4.2: Minimum Recommended System Interlocks

Facility	Rating or Range	Interlock State	Protection from
vacuum	1.33 to 13.3Pa (0.1 to 1.0 x10^{-1} Torr) maximum	closed	Possible source damage or process disruption from shorting or arcs caused by attempted operation at elevated pressure.
coolant	1.5ℓ/min. (0.4 gpm) minimum	closed	Source thermal damage from inadequate coolant flow.

CAUTION

To avoid possible source-controller damage, install and verify appropriate vacuum and coolant interlocks before operating the source.

Post Installation

1. After installation is complete, inspect all gas and coolant connections for leaks after pressurizing lines. Repair any leaks before continuing.

2. Make certain that the source and HCES MFCs are properly installed and connected. Refer to the **Operation** chapter of the Mark ⊕ series Controller technical manual for manual MFC operation instructions.

3. Verify that the system interlocks are functioning as intended.

4. Check that all prior installation steps were performed successfully.

CAUTION

To avoid possible source-controller damage, identify and correct all shorts between leads and open circuits in individual leads before attaching the controller and operating the source.

5. Refer to the **Installation** chapter of the Mark ⊕ series Controller technical manual for source-controller cable connection instructions.

6. Close the process chamber and pump the system down to the base pressure. The chamber pressure should reach about 1.33 x10^{-3} Pa (1.0 x10^{-5} Torr) or less.

NOTE

Attaining this base pressure is system dependent; it assumes the vacuum system has the recommended pumping capacity, and that there are positive shut off (P.S.O.) valves installed downstream of each MFC.

7. Test the process chamber/source installation with a commercial vacuum leak detector or mass spectrometer, if either one is available.

   Alternatively, if the user established baseline system performance after installation by measuring and recording the initial *leak-back rate* (rate of pressure rise with all pumping valves closed), another leak-back test may be now be run for comparison. This will confirm that no gas or coolant leaks were introduced during the source/HCES installation. Find and repair any leaks before continuing.

⚠WARNING

To avoid electrical shock, keep clear of “live” circuits. Follow all local lock-out/tag-out procedures before continuing.

8. Refer to “Operation” on page 19 to start the ion source.

Chapter 5: Operation

Follow these steps to operate the Mark ⊕ series ion source and its companion controller. The controller's touch screen offers the operator necessary controls and displays for creating initial electrical and gas flow settings, MFC configuration, source/HCES start-up and routine operation in **AUTO** mode. The source's operating conditions may then monitored, including any faults and alarms that may occur. FIGURE 5.1 depicts basic ion source operational flow. Refer to the **Operation** chapter of the Mark ⊕ series Controller technical manual for information and examples.

NOTE

The operating procedures outlined here are based on Veeco's best recommended practice. Actual source operation may differ, due to local process differences and vacuum system constraints, especially when operating the Mark ⊕ series Controller in MANUAL mode. Contact **"Service Support" on page 62** **for additional information.**

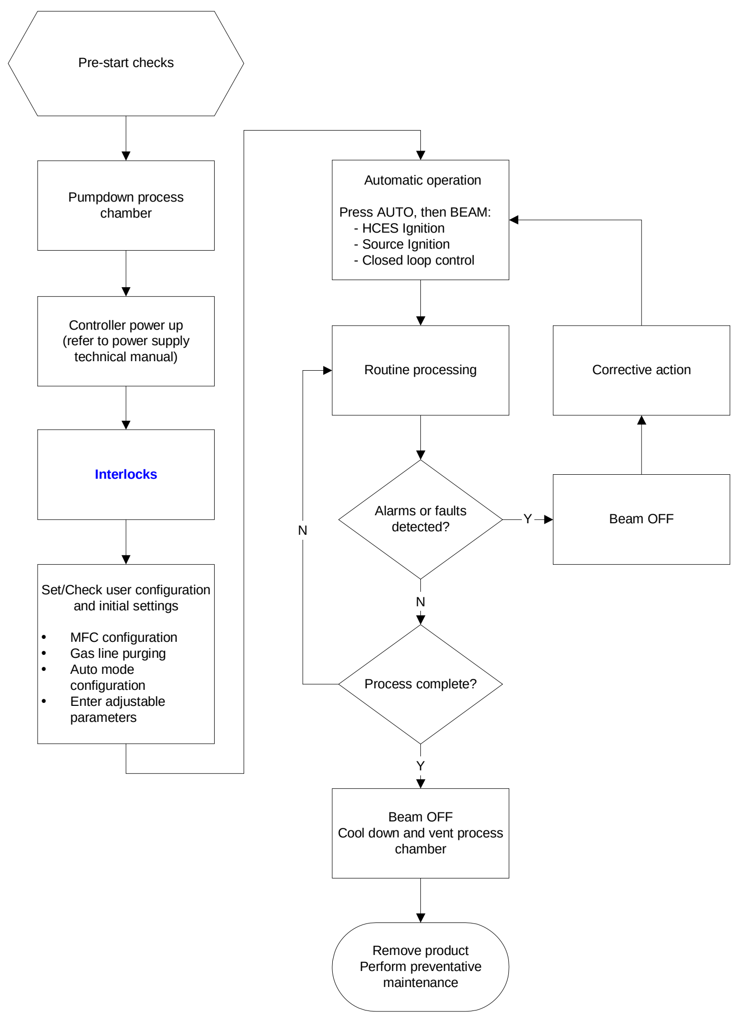


FIGURE 5.1 Source Operation.

Pre-start Checks and Chamber Pumpdown

Perform these checks to assure that the process chamber and all source package components are operating properly, before beginning routine operation.

1. Check that the all electrical connections, coolant, input gas lines, MFCs, P.S.O. valves and other facilities are operational and engaged prior to starting the source. Refer to "Verify Facilities" on page 8 and "Specifications" on page 63 for additional information.

2. Pump down the process chamber; make certain that a base pressure of less than 1.33×10^{-2}Pa (1.0×10^{-4} Torr) can be achieved.

NOTE

It may be necessary to temporarily isolate the input gas flow lines with P.S.O. valve(s) to avoid the leakage that occurs with many MFCs.

3. Record the process chamber's base pressure.

4. Open the P.S.O. valves after recording the base pressure.

Controller Power up and Interlocks

1. Refer to the **Beginning Automatic Operation** section of the **Operation** chapter in the Mark ⊕ series Controller technical manual for additional information. Perform these steps by following these topics in this chapter:
   - Controller Power Up
   - Beginning Automatic Operation, which includes
     - MFC Configuration
     - Gas Line Purging
     - Auto Mode Configuration
     - Enter Adjustable Parameters.

⚠WARNING

To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing.

2. Once the controller has started, the status indicators (left of the STATUS EVENTS window) will flash yellow if the interlock state is not satisfied. This is illustrated in FIGURE 5.2.

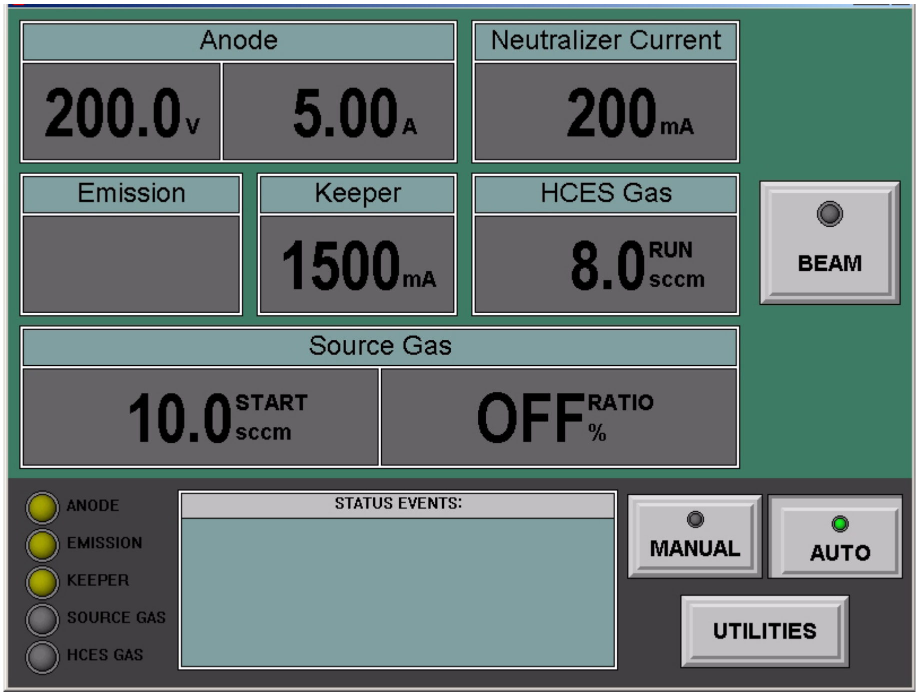


FIGURE 5.2 Status Indicators - AUTO Operation, Interlock Not Satisfied.

If the interlock state is satisfied, the status indicators will be dimmed, indicating that the unit is ready, as illustrated in FIGURE 5.3.

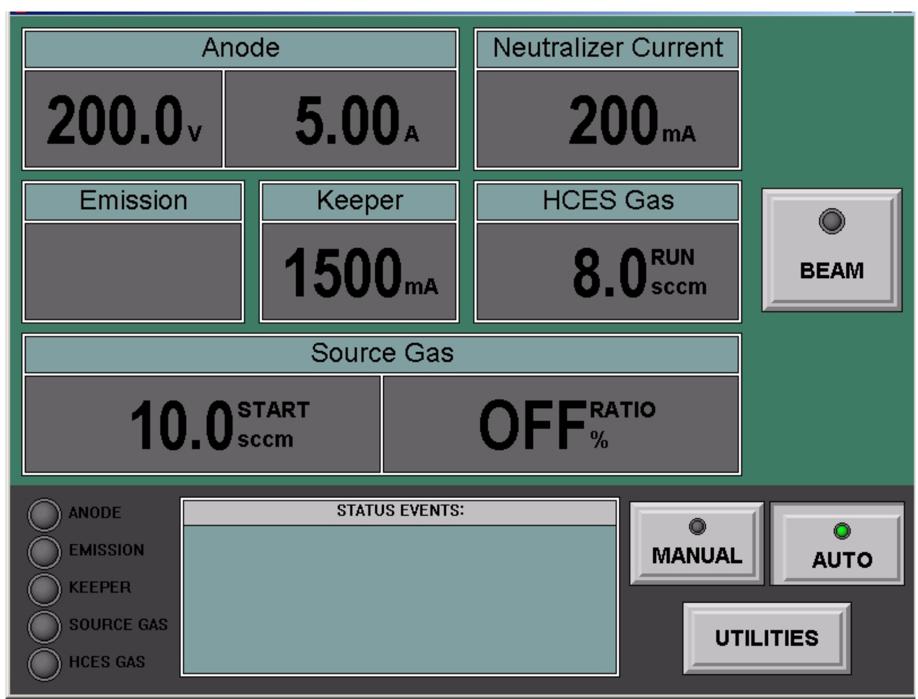


FIGURE 5.3 Status Indicators - AUTO Operation, Interlock Satisfied.

Refer to "Controller Interlocks" on page 17 for detailed information.

NOTE

Press any of the status indicators to open the MODULE STATUS INFORMATION window. This window provides module activity details, including interlock status.

CAUTION

To avoid possible source-controller damage, installation of process chamber vacuum interlocks is strongly recommended. Refer to "Drawings" on page 73.

3. At initial installation, press the **UTILITIES** button to open the Select Function dialog box, as illustrated in FIGURE 5.4.

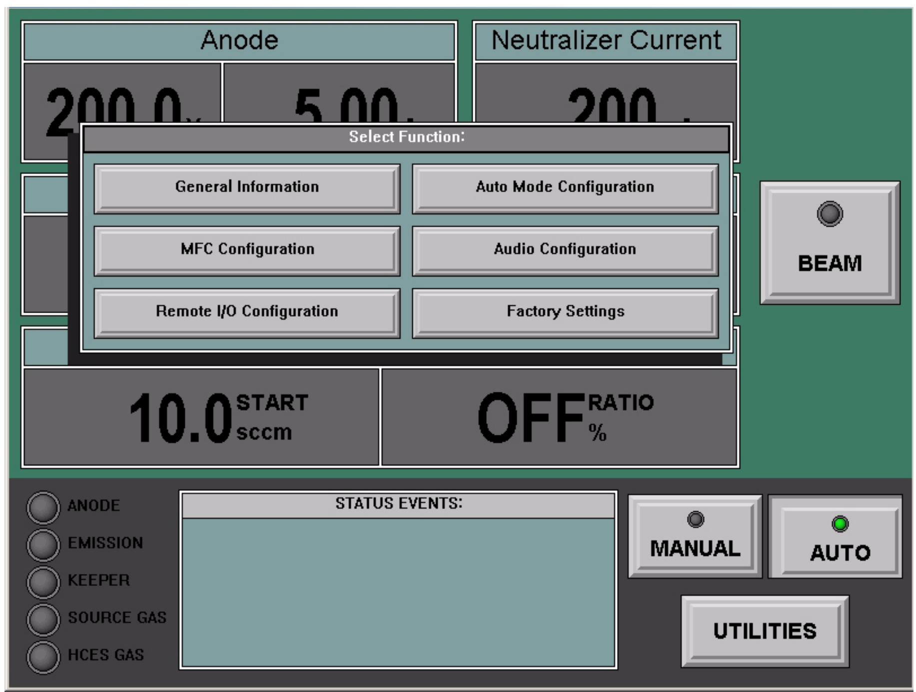


FIGURE 5.4 UTILITIES - Select Function Dialog Box.

Use this dialog box to configure the unit and prepare for routine operation.

4. After the MFCs are configured and the gas lines purged (refer to step "1." on page 20), press the **Auto Mode Configuration** button; the Auto Mode Configuration list opens. The following settings are recommended to test the source-controller installation:
   - ANODE START VOLTAGE – 200 to 450V
   - ANODE CURRENT CONTROL MODE – Anode Current Setpoint

- EMISSION CURRENT CONTROL MODE – Neutralization Setpoint.

Once this information is entered, the Auto Mode Configuration list will appear as shown in FIGURE 5.5.

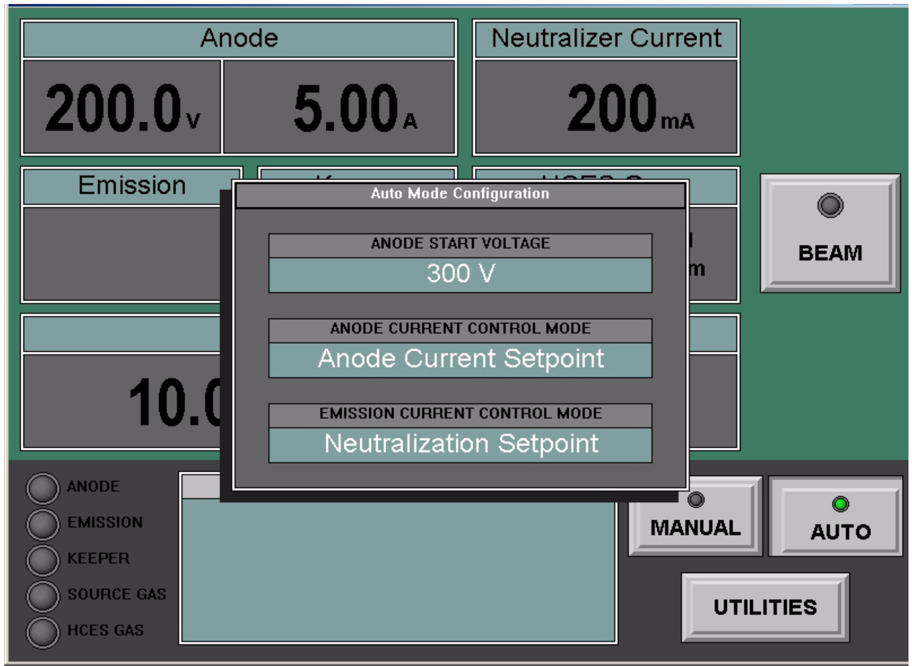


FIGURE 5.5 UTILITIES - Auto Mode Configuration List.

NOTE

Refer to the Auto Mode Configuration section of the Operation chapter in the Mark ⊕ series Controller technical manual for additional information, including alternate control modes.

Adjustable Parameters – Initial Settings

After successful installation, pumpdown and power supply/MFC configuration, the Mark ⊕ series Controller is nearly ready to automatically manage routine source operation. However, the unit still requires several initial settings for the adjustable parameters used in either manual or automatic modes of operation.

The information presented in Table 5.1 on page 24 offers suggested starting values for adjustable parameters. Follow the steps in the **Enter Adjustable Parameters** section in the **Operation** chapter of the Mark ⊕ series Controller technical manual to enter this data. A typical entry sequence appears in "FIGURE 5.6" on page 24.

FIGURE 5.6 Enter Adjustable Parameters.

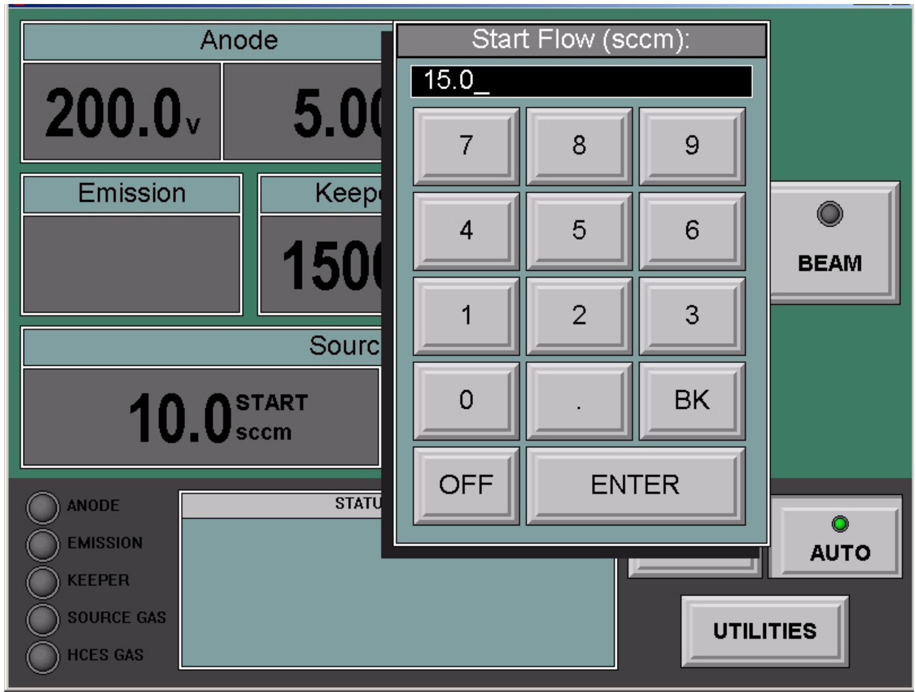


Table 5.1: Initial Mark⊕ Source-Controller Settings

Adjustable Parameter	Value	Remarks
Anode Voltage	150 to 200V	user adjustable
Keeper Current	1500mA	recommended for nearly all applications
Source Gas Start Flow	10 to 20sccm	argon, oxygen, nitro-gen
HCES Run Gas	5 to 10sccm	argon only
HCES Start Gas	50 to 70sccm	argon only
Anode Current	1 to 10A	user adjustable
Neutralization Current	+200 to +1000mA	recommended setting: 5 to 20% of the Anode Current

NOTE

The field adjustable MFC flow limit is usually the same as the MFC flow capacity. It may be desirable to limit the permissible peak flow, depending on vacuum system pumping capacity limitations.

Basic Sequence of Operation

Before initiating automatic source-controller operation, it is helpful to review the sequence of events used to start the source and sustain its steady state operation. The following descriptions help to explain the stages of source-controller activity from ignition to routine operation:

1. **Establish HCES gas flow; start the HCES** – The HCES requires a sizable argon gas flow through its cathode to initially start it, as indicated in Table 5.1 on page 24. After this flow is established, a high voltage (about 1500V peak) is applied to the keeper body that surrounds the cathode, to ignite the plasma that is localized to the cathode tip. At this stage, the keeper supply current typically reads about 150 to 250mA.

2. **Sustain HCES ignition** – The local plasma between the keeper and cathode serves to heat the cathode to thermionic emission temperatures (>1500°C/2730°F) whereby electrons are freely emitted from the cathode tip. As a result, the plasma resistance between keeper and cathode drops substantially and a significantly lower voltage (<100V) is required to sustain a constant current of about 1500mA (which is field adjustable). At this point the HCES is ignited; it is then possible to reduce the HCES's argon gas flow significantly (less than 10sccm) for sustained operation.

3. **Establish Cathode Emission/Neutralization Current** – After HCES ignition, the controller begins to drive a current from the cathode tip to the chamber common to obtain the desired emission/neutralization current set point, depending on the selected emission current control mode. An ideal emission supply voltage should be on the order of 15 to 35V.

NOTE

If the emission current supply voltage reaches 50 to 75V, consider either raising the HCES running gas flow set point or changing the cathode tip, depending on its age or condition.

4. **Establish Source gas flow; start the Source** – The ignited HCES now provides a ready source of primary electrons to sustain the DC discharge within the ion source. To produce this discharge, working gases are introduced into the source at a target start value. The anode power supply is then engaged (voltage regulated) to produce the DC discharge and the gridless ion beam.

5. **Anode Current control through Source gas flow regulation** – Once the anode potential is established to produce the discharge, the actual anode current flowing between the anode and cathode depends upon the input gas flow and its composition. Since the anode power sup-

ply is voltage regulated, the input flow to the source needs to be adjusted to obtain the desired discharge current set-point. This adjustment is achieved by controller servo loops enabled in AUTO mode. This maintains the operator requested anode voltage and current, resulting in a consistent level of mean ion beam current energy and beam current flux during normal operation.

Examples of steady state values of anode voltage and current as a function of gas flow are given in the current-voltage-flow (IVF) operating curves presented in "Source Performance" on page 65 for argon and oxygen for the original Mark II⊕ ion source design. The operator or process developer is encouraged to use these reference IVF curves to select initial anode and source input flow settings within the envelope of viable operation. Note that reference operating conditions differ between the original Mark II⊕ ion source design and its low voltage option.

NOTE

The source's steady-state operation is also sensitive to background vacuum pressure and local boundaries that may influence the concentration of neutral gas near the source. Because of this, actual steady-state IVF operating conditions will process/system dependent, and may differ somewhat from the values described in "Source Performance" on page 65.

6. **Neutralization** – The ion source is self-neutralizing; the ions flowing downstream from the source are not separated from the source electrons, as they are in a gridded ion source. However, additional ion beam neutralization is supported by injecting an emission current (additional cathode electrons) into the process. This emission current is field adjustable. Under routine operating conditions, the minimum recommended emission current for ion beam neutralization is +200mA. It is rarely necessary to set the emission current greater than 10% of the anode current setting. Once the source is started, the Mark ⊕ series Controller automatically adjusts the HCES's output settings to achieve the desired emission current with respect to the anode current.

7. **Ignition Transients** – Upon start up, it takes time (several seconds) for the ion source input gas flow and emission current to stabilize and reach near steady-state values. This transient start-up time can be reduced by finding the steady-state values for gas flow and emission current responses and then apply similar values for Start Gas Flow and Filament Start Current settings in the user Automode Configuration and user start settings.

8. **Initial warm-up and process recipe steps/sequences** – Upon start up, it takes time for the ion source's mass to heat up to steady-state conditions. The thermal response time is approximately 10 minutes

(as indicated by trends to the output coolant temperature). During warm-up, some source gas flow and/or anode current drift will occur until the source reaches thermal steady state conditions. Once the source has warmed up, the response time for process recipe changes is typically on the order of one minute or less.

Automatic Operation

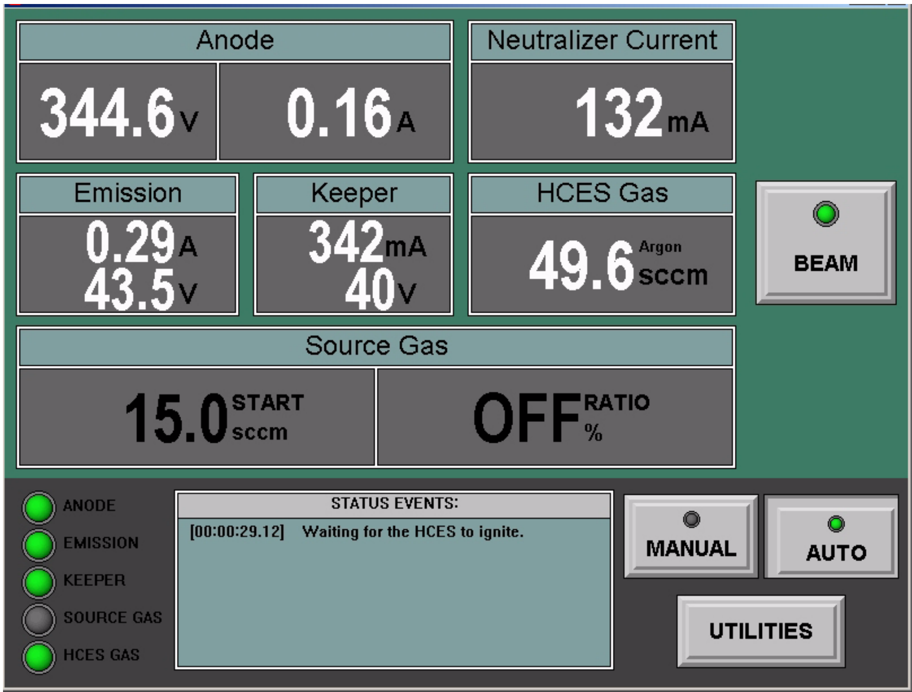
NOTE

The operating values shown in the following figures are typical of the original Mark II ⊕ ion source design. These values may be process and installation dependent, and will differ for the source's low voltage option.

Once all of the preceding have been performed (including entry of adjustable parameters from Table 5.1 on page 24), follow these steps to initiate automatic operation:

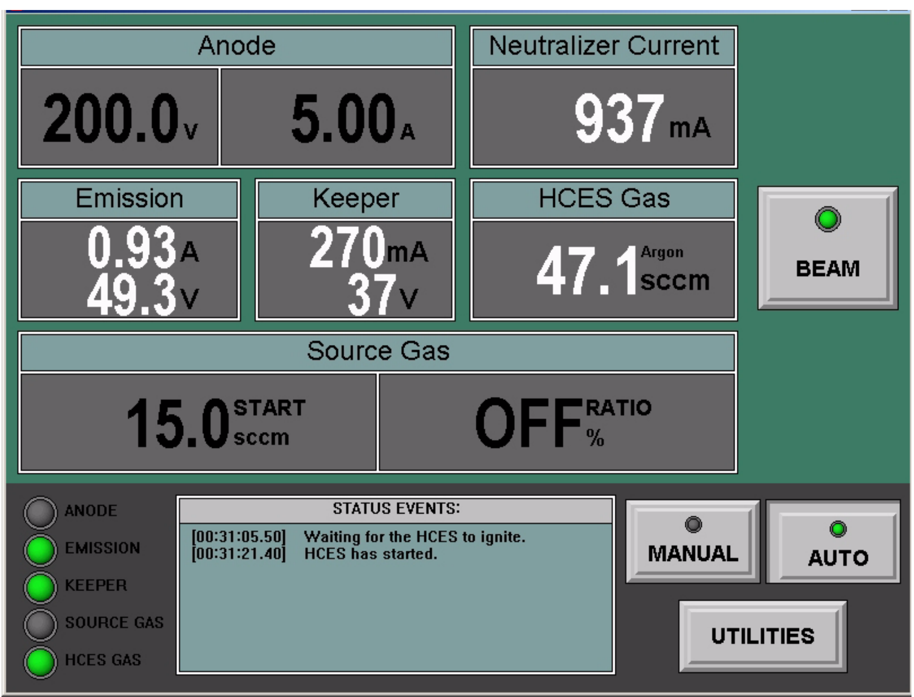
1. Press the controller's **AUTO** button; the button's indicator changes to green.
2. Initiate the source start sequence by pressing the **BEAM** button; the button's indicator changes to green.
   a. The controller will initiate gas flow to the HCES and then attempt to ignite the HCES up to three times, until the keeper and emission voltages are just under their factory set thresholds. A "snap shot" of this dynamic ignition event is shown in FIGURE 5.7 on page 28.

FIGURE 5.7 HCES Ignition.



Once ignited, the HCES gas flows and keeper voltage will adjust to their running values, as illustrated in FIGURE 5.8.

FIGURE 5.8 HCES Sustained Operation.



b. After the HCES starts, gas will flow to the source and the anode voltage will be applied to start the ion source, as shown in FIGURE 5.9.

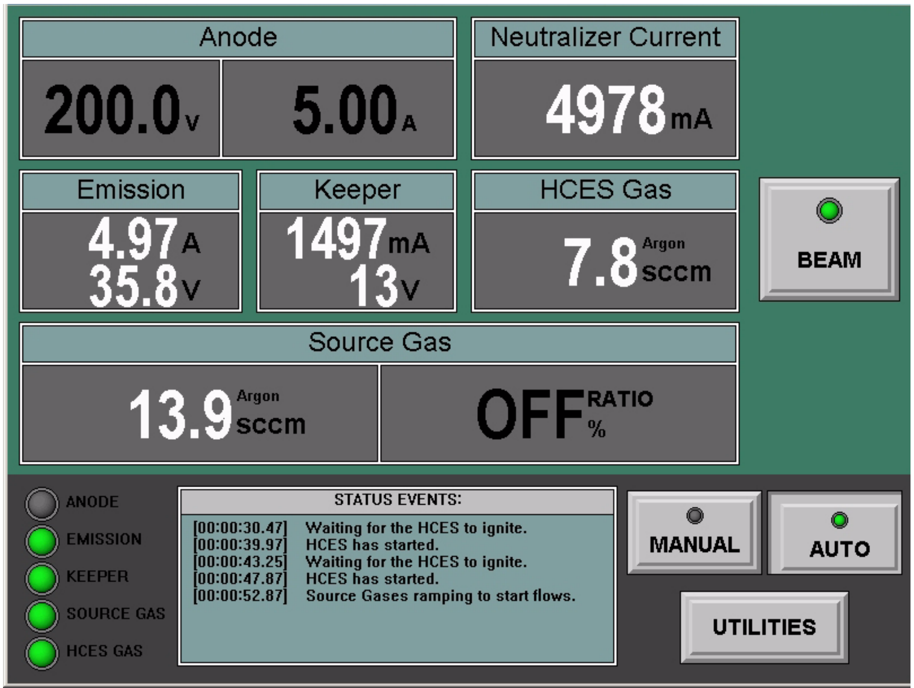


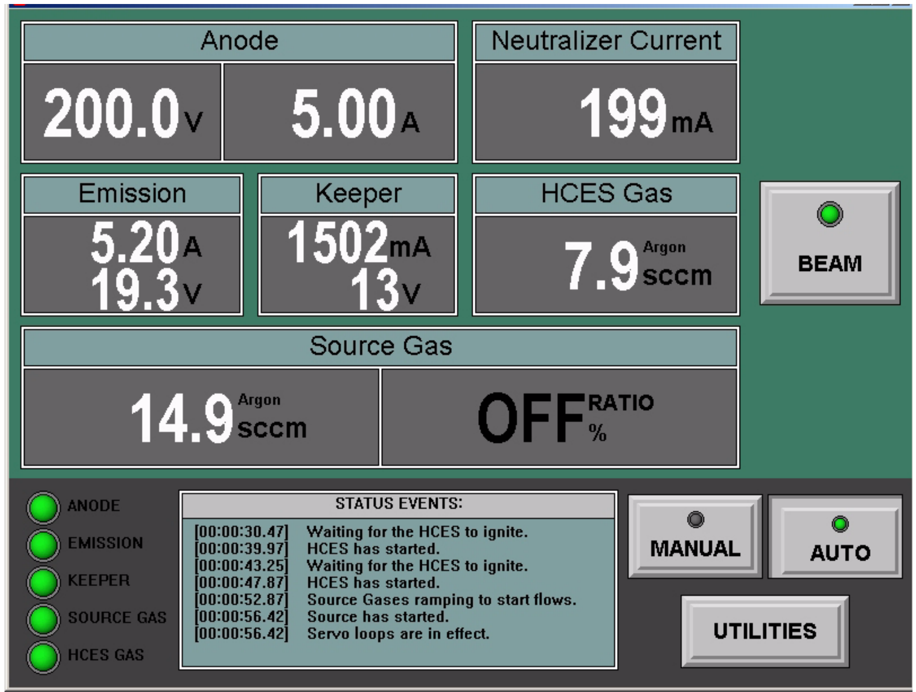
FIGURE 5.9 Source Gas Flow Starts.

c. When an anode current is detected by the controller, the unit will attempt to regulate the source's input gas flow in order to obtain the set-point anode current.

d. At the same time, the cathode emission supply will be adjusted to establish a net neutralization current of electrons into the ion beam. An illustration of sustained, controlled source operation appears in FIGURE 5.10 on page 30.

e. Input gas flow and emission currents will continue to be regulated throughout the process as the thermal condition of the source and the state of the process environment moves toward steady-state conditions.

FIGURE 5.10 Sustained, Controlled Operation.



3. The operator may make sequential changes to settings without turning-off the source.

   When switching set points or changing gases, broad excursions in process conditions may cause source-controller instabilities that can lead to a loss of the discharge. To avoid this condition, process developers are encouraged to

   - verify the robustness of transitions between process steps
   - add transition steps to smooth out operational discontinuities, or
   - stop and re-start the source with a new set of initial conditions between selected process steps.

4. Turn off the source/HCES by pressing the **BEAM** button once more; the button's indicator goes dark.

NOTE

The Mark ⊕ series Controller has several features to monitor and log errors or faults that may occur. Refer to the controller technical manual for definitions and descriptions of these fault detection features.

Venting and Cooling

Once the source is turned off, the source body and anode typically take at least 20 minutes to cool down (under vacuum) with the coolant running. However, radiation cooled bodies like the HCES, fixturing and workpieces will take considerably longer to cool (whether in vacuum or at atmospheric pressure) as they have very limited thermal transfer means for cooling. Operators should exercise extreme care and allow sufficient time to vent the process chamber and allow it to cool, to avoid exposure to hot components or surfaces. This is particularly important when preparing for preventive maintenance operations on the ion source and HCES. While the unit is water cooled, some source part temperatures can exceed 300°C (570°F) after running more than 30 minutes. Surface temperature cooling rate will depend upon local process chamber cooling and venting practices. It is recommended that either a remote or non-contact thermal sensor is used to survey ion source temperature after venting, to determine the best cool down waiting periods before starting source servicing. Refer to "Source Performance" on page 65. for cool down times and related recommendations.

⚠ **CAUTION**

Ion source surfaces may exceed 300°C (570°F) after use and venting. Avoid burns during servicing by using appropriate personal protective equipment and allowing for a sufficient cool down interval.

Chapter 6: Disassembly and Reassembly

An adjustable torque wrench is recommended for reassembly. Refer to "Drawings" on page 73 for recommended torque values.

CAUTION

To avoid galling and seizing of threaded parts, do not over tighten or use high torque values.

The assembled source and neutralizer are shown in FIGURE 6.1.

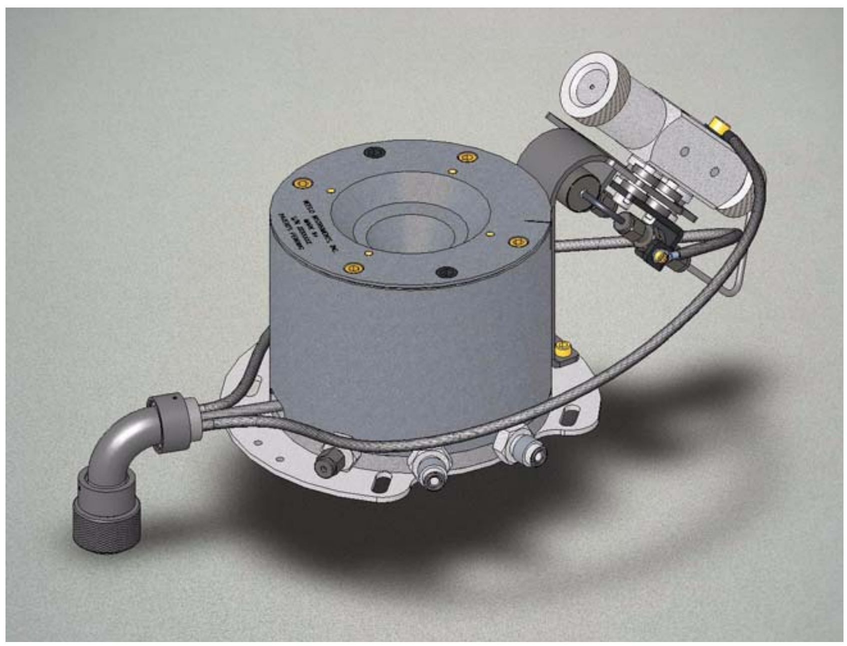


FIGURE 6.1 Assembled Mark II⊕ Gridless Ion Source with HCES.

Disassembly

⚠ **CAUTION**

Ion source surfaces may exceed 300°C (570°F) after use and venting. Avoid burns during servicing by using appropriate personal protective equipment and allowing for a sufficient cool down interval.Follow these steps to remove the anode assembly from the process chamber and disassemble it.

NOTE

The source is shown outside the process chamber for clarity. It is recommended that source disassembly be performed without removing the base assembly from the chamber.

1. Loosen the four ¼ –20 captive screws holding the anode assembly to the base assembly, using a 3⁄16 in. hex ball driver.

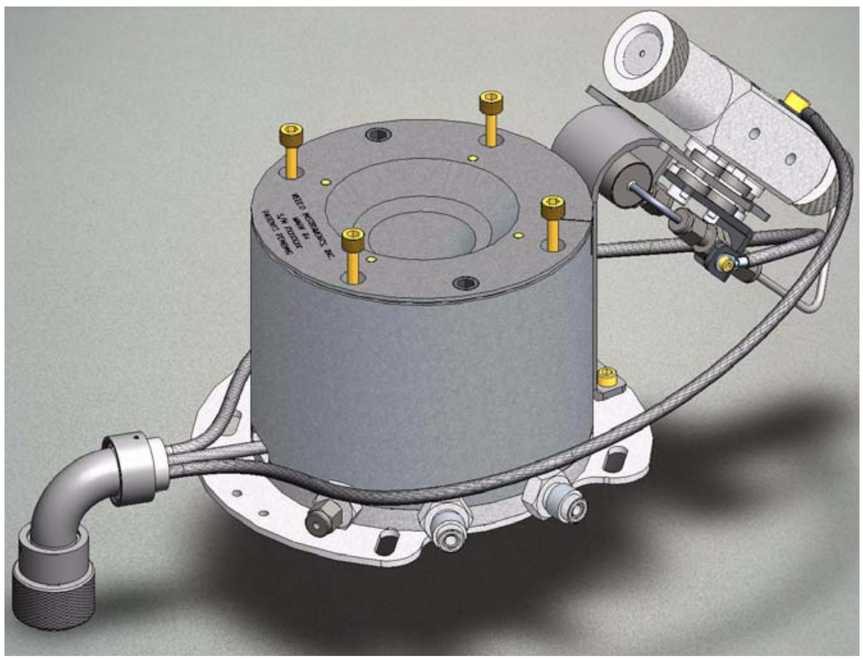


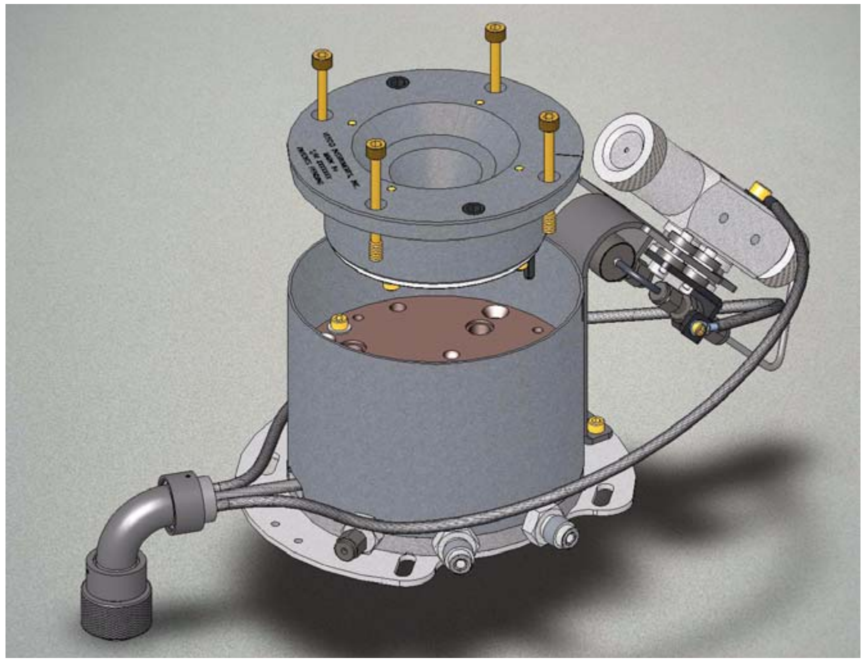
FIGURE 6.2 Loosen the Anode Assembly Hardware.

CAUTION

To avoid possible shorts during operation in vacuum, do not remove the two ½ –13 in. set screws (unplated) on the anode assembly top.

2. Lift the anode assembly from the base assembly by the captive hardware, and carefully place it on a clean work surface nearby.

FIGURE 6.3 Lift the Anode Assembly from the Base Fixture.

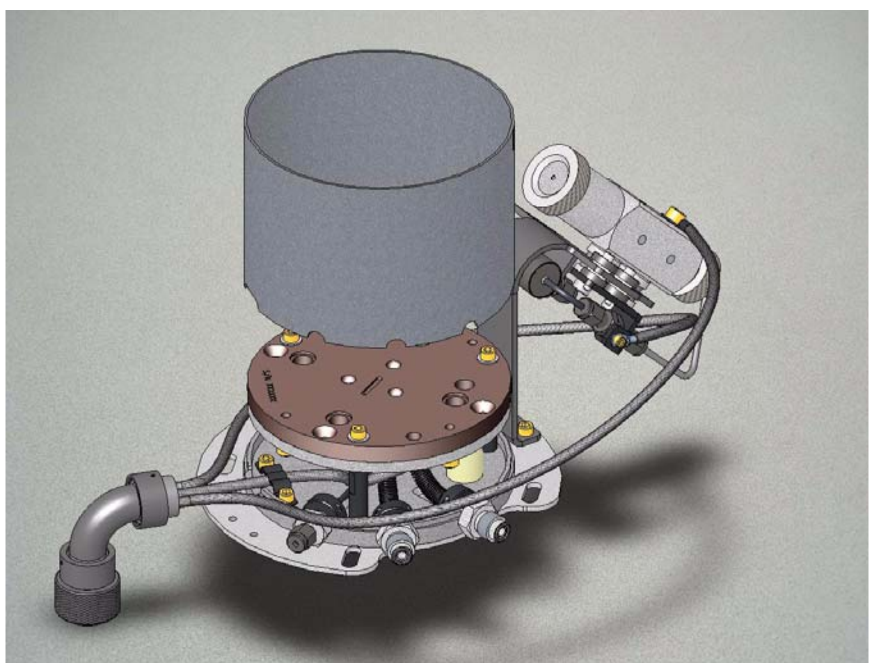


CAUTION

To avoid base assembly contamination and shorts, perform all anode assembly maintenance outside the process chamber, away from the base assembly.

3. Lift the body from the base assembly.

FIGURE 6.4 Remove the Body from the Base Assembly.



The base assembly contains the source's magnet and connections for power, gas and coolant.

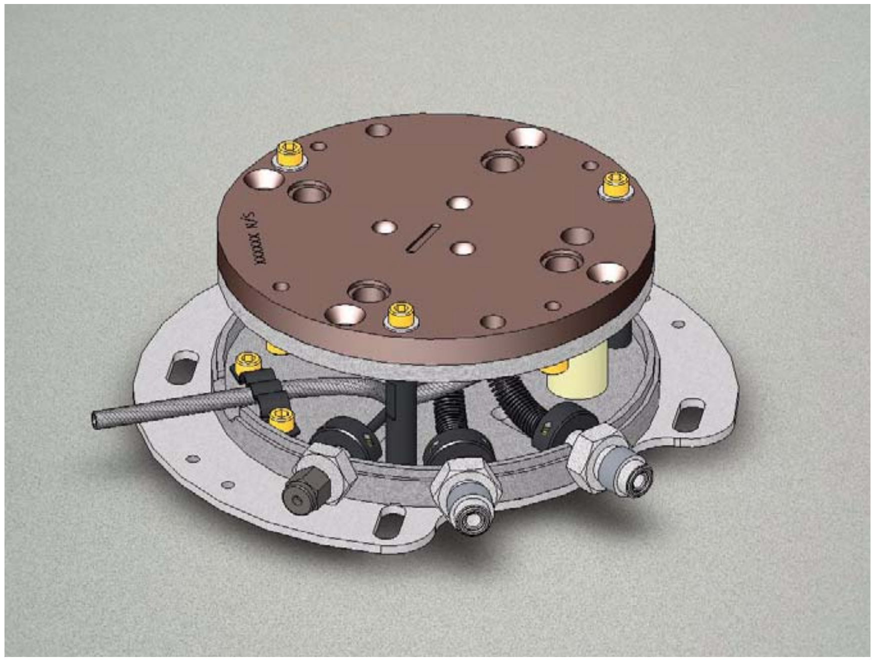


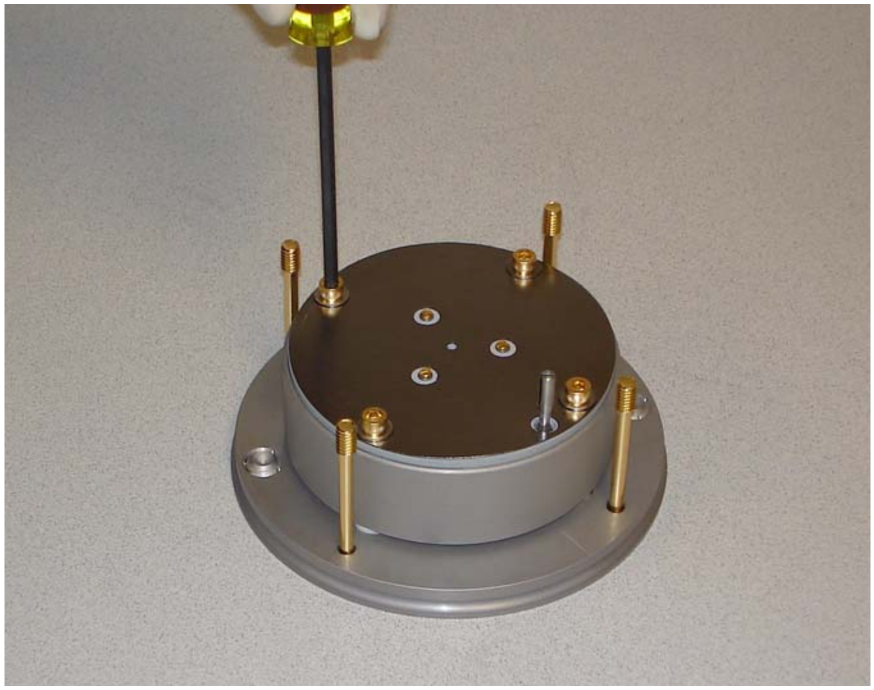
FIGURE 6.5 Ion Source Base Fixture.

NOTE

The power leads and the HCES are removed for clarity. The base assembly stays in the process chamber during routine source maintenance.

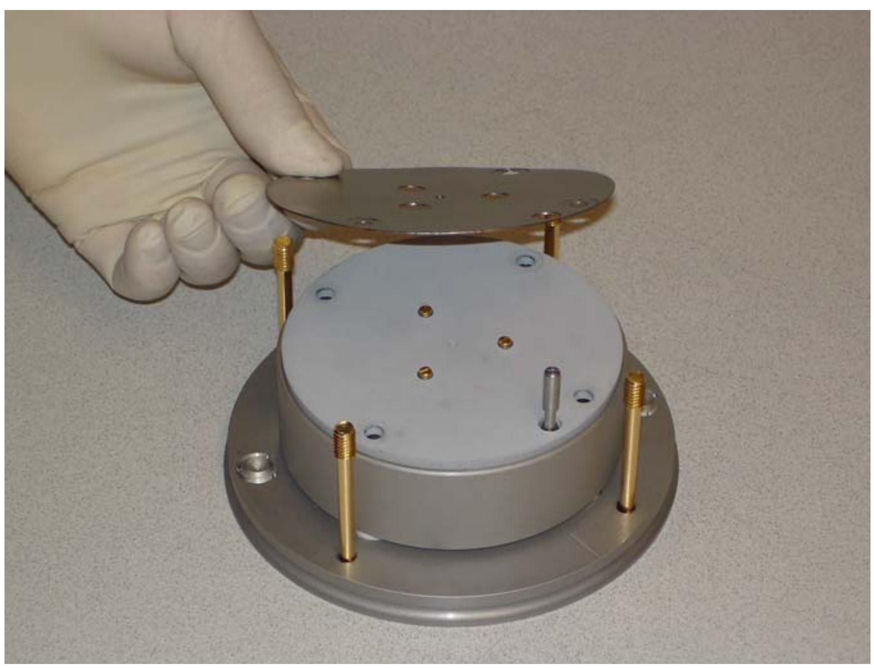
4. Loosen and remove the four 10–32 screws that hold the thermal transfer plate to the anode assembly pole piece, using a 5⁄32 in. hex ball driver.

FIGURE 6.6 Loosen and Remove the Hardware to Reach the Gas Distributor Plate.



5. Remove the cooling plate side thermal transfer sheet from the thermal transfer plate.

FIGURE 6.7 Remove the Cooling Plate Side Thermal Transfer Sheet.



6. Remove the thermal transfer plate and sheet from the anode.

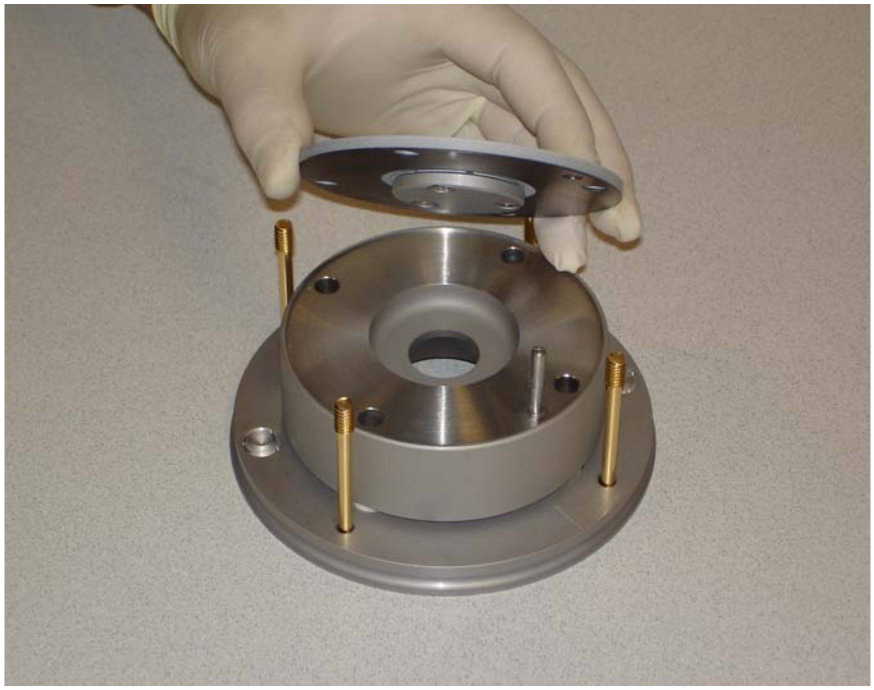


FIGURE 6.8 Remove the Thermal Transfer Plate and Sheet.

CAUTION

The thermal transfer sheets tear easily. The thermal transfer plate breaks easily if dropped or shocked. Handle them carefully to avoid part damage.

7. Loosen and remove the anode power connector; use an adjustable wrench on the connector's flats to initially loosen it, if necessary.

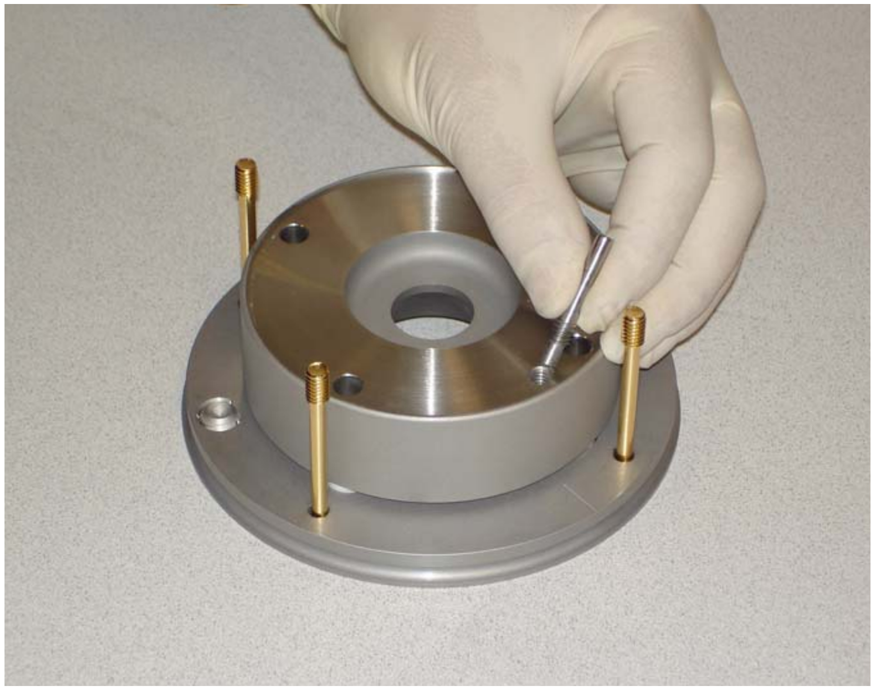


FIGURE 6.9 Remove the Anode Power Connector.

CAUTION

To avoid connector breakage, apply tools only to the anode connector's tooling flat as provided. Avoid striking or forcing it. Do not insert tools into the slotted end of the part. Keep the threads clean.

8. Separate the anode from the pole piece for cleaning or replacement.

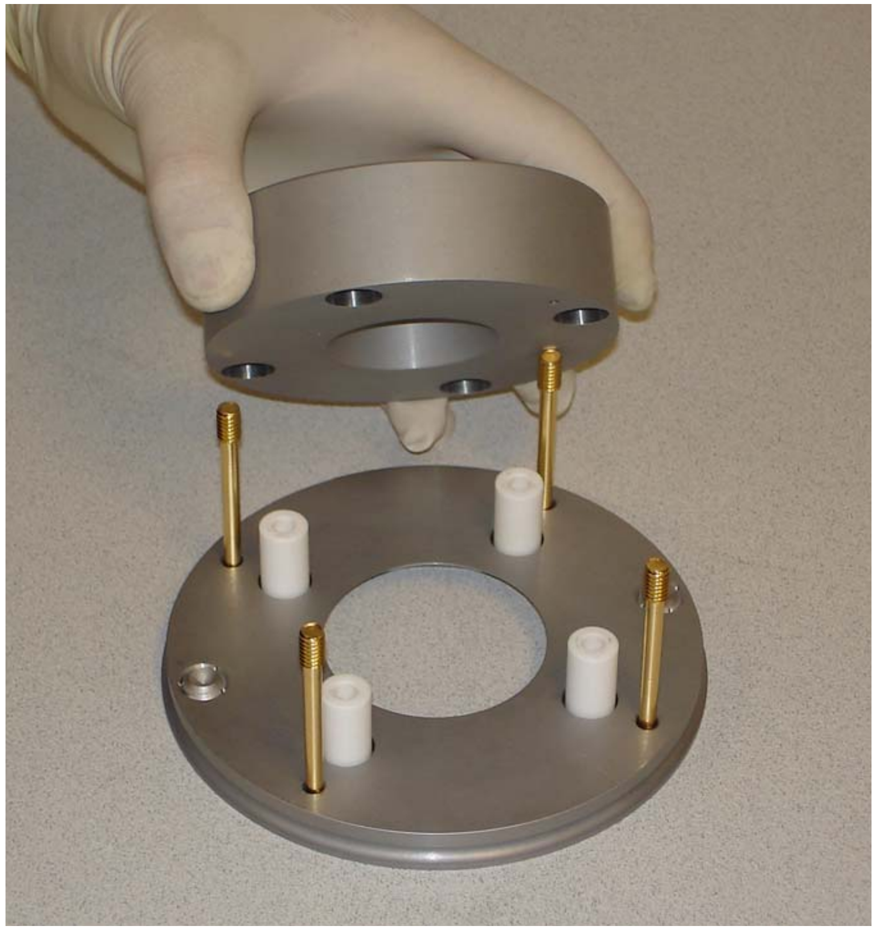
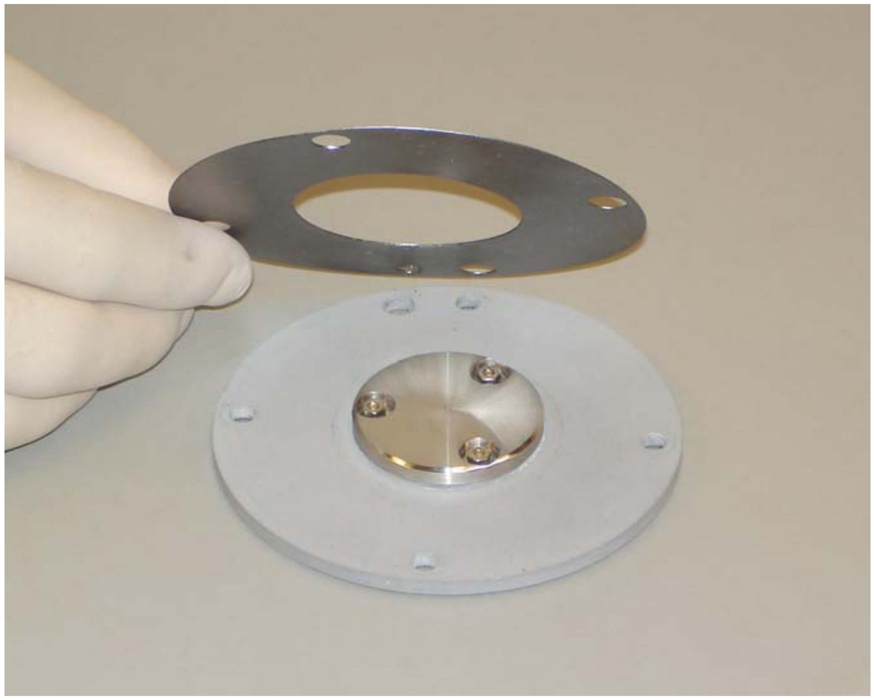


FIGURE 6.10 Separate the Anode from the Pole Piece.

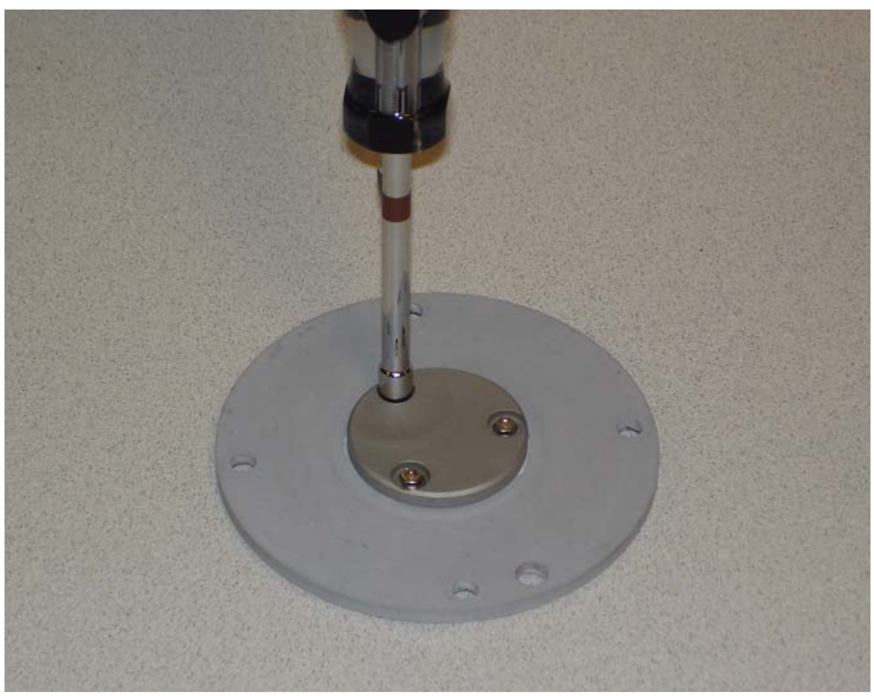
9. Remove the anode side thermal transfer sheet from the thermal transfer plate.

FIGURE 6.11 Remove the Anode Side Thermal Transfer Sheet.



10. Loosen and remove the hardware that holds the gas distributor plate to the thermal transfer plate, using a 3⁄16 in. hex nut driver.

FIGURE 6.12 Loosen and Remove the Gas Distributor Plate Hardware.



11. Remove the gas distributor plate; inspect it for erosion. Replace if defects are found or whenever the working gas changes. Refer to "Anode Assembly Maintenance" on page 52.

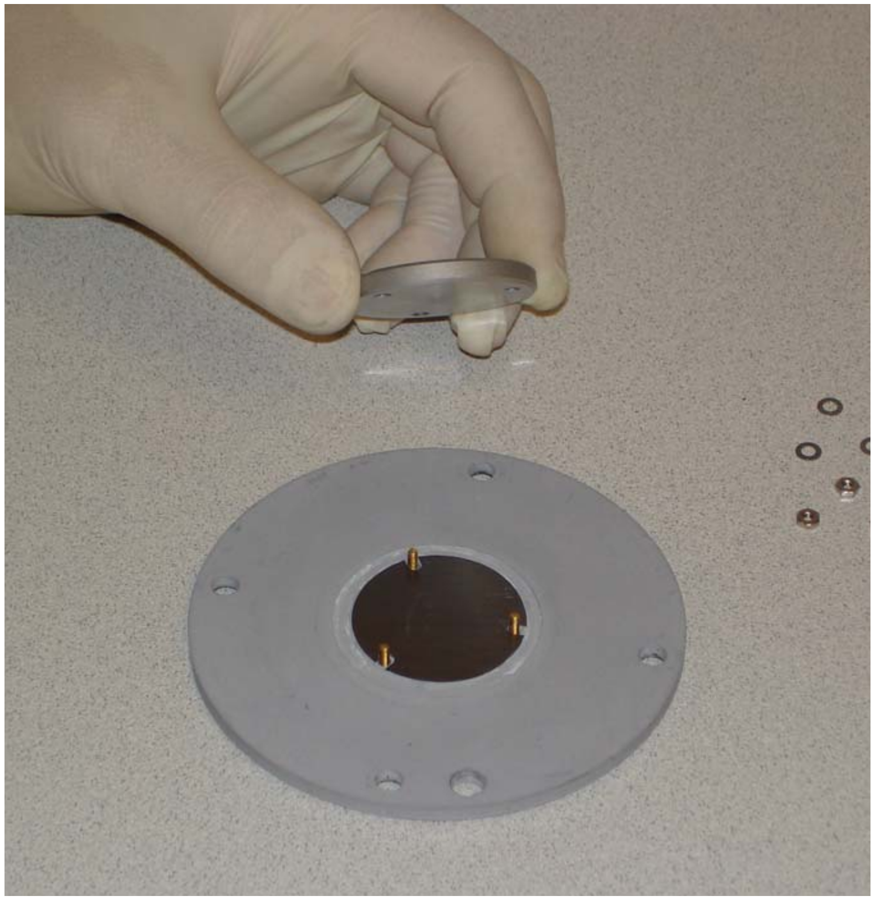


FIGURE 6.13 Remove the Gas Distributor Plate.

Reassembly

Reassemble the source by reversing the steps followed to disassemble it. Refer to "Drawings" on page 73 for hardware torque specifications. Pay special attention to the following:

1. When reversing step "10." on page 40, remove any fibers or particles that may be held on the thermal transfer plate by static attraction. If needed, use compressed dry nitrogen to clean before assembly. Center the gas distributor plate in the thermal transfer plate's recess before tightening the 2–56 hardware to 0.17N–m (1.5 in.–lbs.).

FIGURE 6.14 Center the Gas Distributor Plate on the Thermal Transfer Plate.

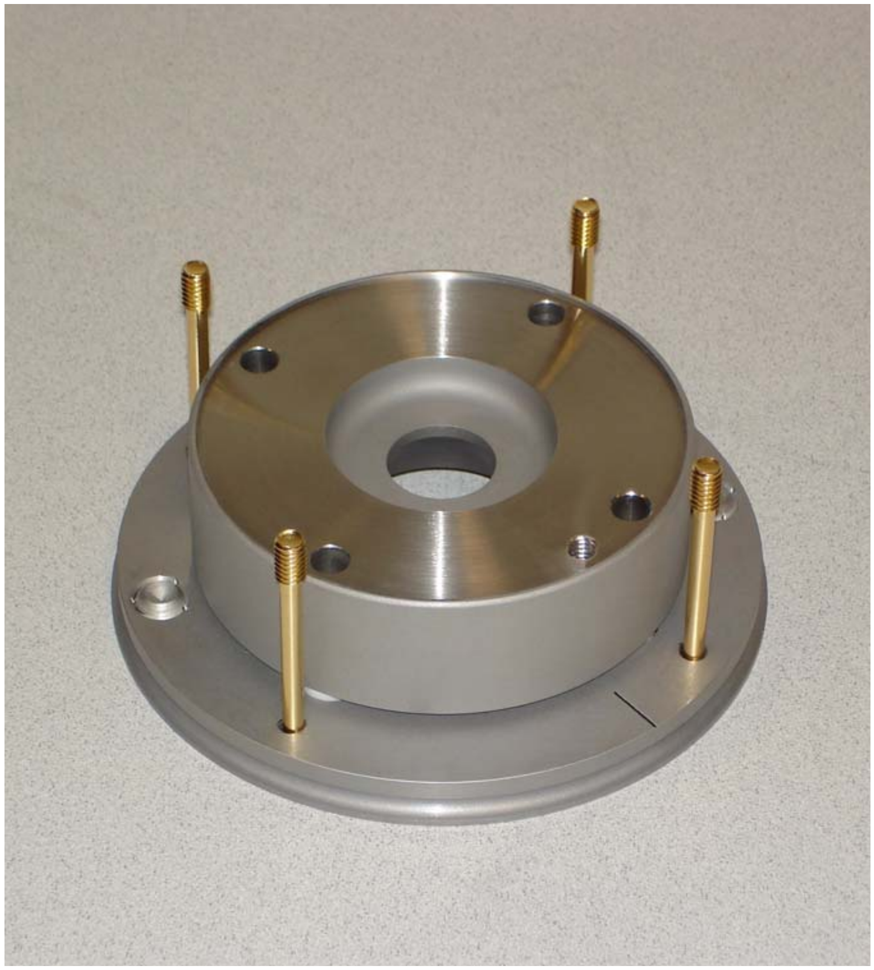
2. Progressively tighten the hardware in a circular pattern.

NOTE

To ensure proper cooling and satisfactory operating performance, progressively tighten the hardware in a circular pattern.

3. When reversing step **"8." on page 39**, make certain to install the anode so that the power connector's threaded hole lines up with the mark on the pole piece.

FIGURE 6.15 Align the Power Connector with the Pole PieceMark.



4. When reversing step **"7." on page 38**, check that the power connector is fully seated. Thread the connector into the anode until it bottoms out; torque to 0.34 to 0.68N–m (3 to 6 in.–lbs.) The pin's last thread should be just below the anode's surface.

CAUTION

To avoid connector damage, apply tools only to the anode connector's tooling flat as provided. Do not insert tools into the slotted end of the part. Clean the threads before reassembling, if necessary.

5. When reversing step **"4." on page 36**, progressively tighten the 10–32 screws in a criss cross pattern, using a 5⁄32 in. hex ball driver; tighten to 0.34N–m (3 in.–lbs.).

CAUTION

To avoid damaging the thermal transfer plate and/or sheets, use the specified torque values.

6. When reversing step **”2.” on page 34**, check that the body is fully seated on the base assembly and that the body’s mark aligns with the one on the anode assembly.

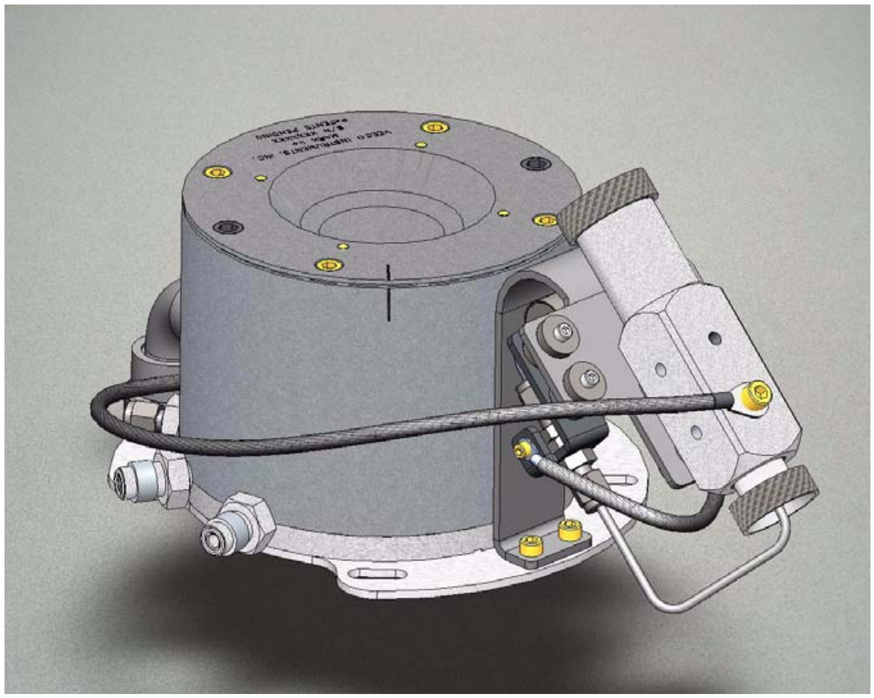


FIGURE 6.16 Align Anode Assembly and Body Marks.

CAUTION

To avoid incorrect anode assembly seating and possible lead damage, align the assembly as shown before tightening the hardware.

7. Use a $\frac{3}{16}$ in hex ball driver to progressively tighten the ¼–20 captive hardware, using a criss cross pattern. A torque value of 1.36N–m (12 in.–lbs.) will properly seat the anode to the base assembly.

NOTE

To ensure proper cooling and satisfactory operating performance, progressively tighten the hardware in a criss cross pattern.

Chapter 7: Maintenance

General

The Mark ⊕ series ion source requires periodic inspection and preventive maintenance to assure reliable and trouble-free performance. As with any vacuum or plasma-based process, the need for maintenance may be triggered by various events which depend on the particular application and process. Here are some examples:

- build-up of thick films and coatings (conductive or insulating) on the anode or other source components
- process related formation of loose flakes and debris on the source assembly
- failed or unreliable cathode operation (end-of-life of HCES tip)
- thinning and/or perforation of the ion source's gas distributor
- frequent anomalous electrical or source control events, as indicated on the Mark ⊕ series Controller display: arcing, strong spikes, or drifts in current and flow response or
- drifting or high variance in process operation or reduced product yield.

If the following maintenance techniques are routinely performed, unscheduled disruption of production processes may be minimized. They are intended as guidelines to help the operator develop systematic procedures and processes that are specific to the individual installation and application.

Obtain, read and understand the Material Safety Data Sheet (MSDS) for any chemicals or materials referenced in this chapter. Follow all local procedures in the safe handling and use of these materials, including the use of any required personal protective equipment.

⚠WARNING

To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before performing any maintenance.

Veeco strongly recommends servicing the source's anode assembly outside the process chamber. This minimizes chamber contamination and possible base assembly damage. A spare anode assembly (available separately) may be kept on hand to change out with the anode assembly to be serviced, greatly reducing process down time.

⚠ CAUTION

Ion source surfaces may exceed 300°C (570°F) after use and venting. Avoid burns during servicing by using appropriate personal protective equipment and allowing for a sufficient cool down interval.

Recommended Equipment/Materials

Regular maintenance will require anode assembly removal from the source body and from the process chamber, followed by disassembly, cleaning and reassembly. Here is a list of recommended materials to facilitate maintenance:

General –

- clean, lint free, powder free examination gloves for handling clean-room materials
- lint free task wipes
- isopropyl alcohol
- hand tools (free of oils, particles, fibers and other contaminants)
  - hex key wrenches or ball drivers
  - open end wrenches
  - flat blade screwdriver
  - nut drivers, all in US fractional sizes

Maintenance within the process chamber –

- filtered clean room vacuum

Bench-top maintenance of source components –

- clean, lint free, nonporous work surface
- 600 grit silicon carbide sandpaper.
- compressed, dry nitrogen (for hand blow-off of parts).

Some metallic surfaces as well as select insulators may require initial abrasive cleaning and follow up wet cleaning. Refer to "Bead Blast and Ultrasonic Cleaning" on page 60 for detailed information.

Recommended Maintenance

"FIGURE 7.1" on page 47 through "FIGURE 7.6" on page 55 illustrate the sequence of recommended maintenance steps. These steps take advantage of the source's modular design features. During a routine maintenance cycle, it is suggested that the used components (the anode assembly or cathode tip, for example) be removed and directly replaced with either a reconditioned or new component (available separately). This approach allows the system to be promptly returned to service, while component inspection and maintenance is performed outside the process chamber, independently from source operation.

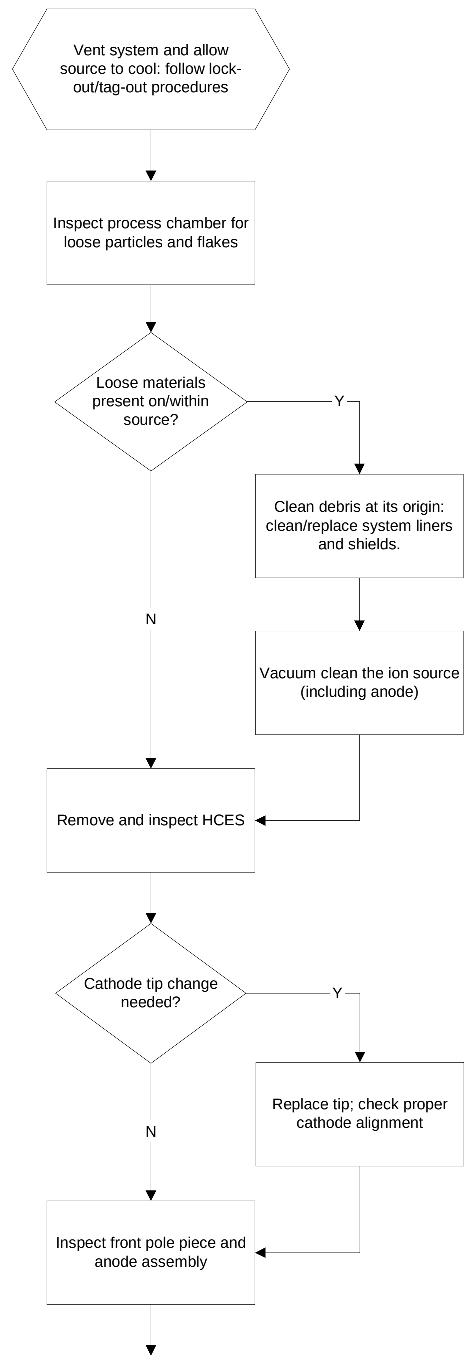
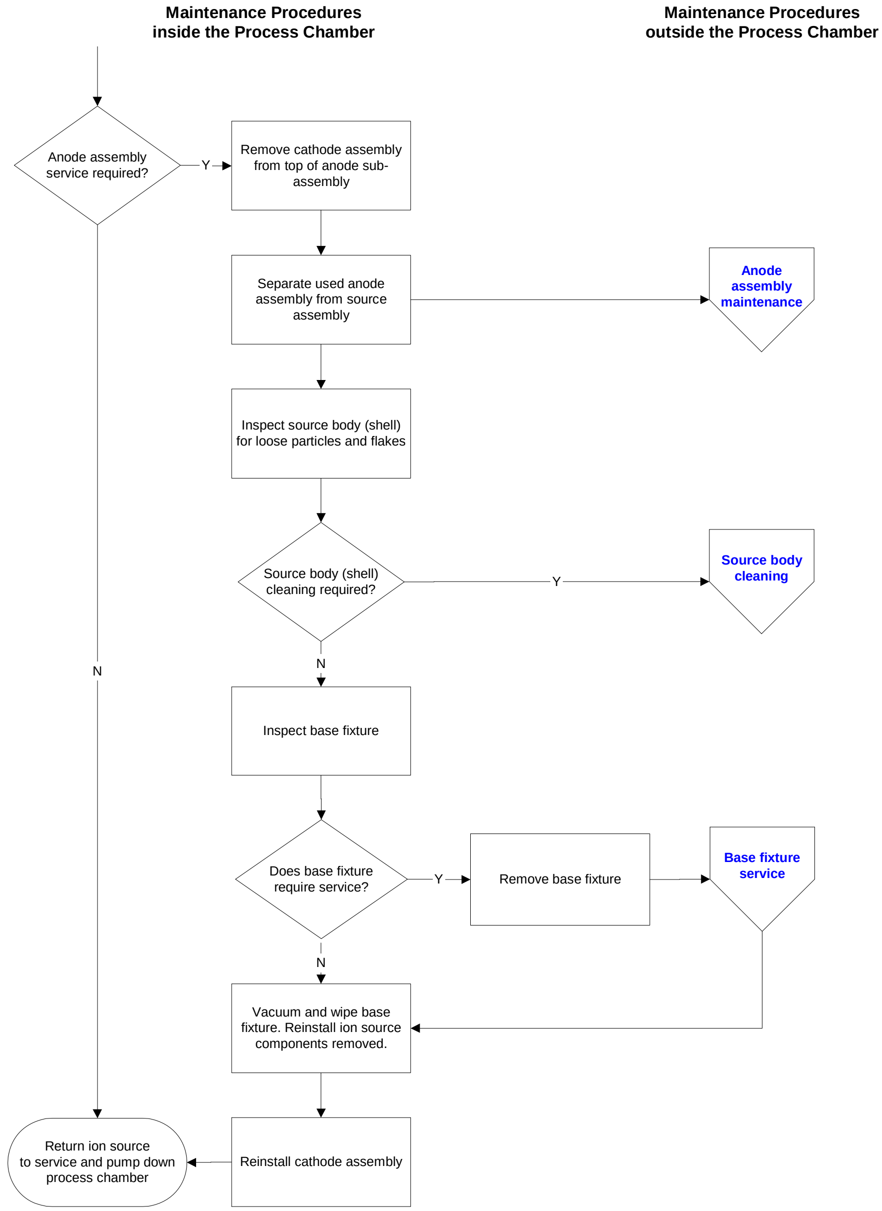


FIGURE 7.1 Source Maintenance Inside the Process Chamber.

Source Maintenance Inside and Outside the Process Chamber

Refer to FIGURE 7.2 and wear clean examination gloves when performing maintenance.

FIGURE 7.2 Source Maintenance Inside and Outside the Process Chamber.



NOTE

For best results, Veeco recommends allowing argon gas flow to the HCES during venting and cool-down, to keep the tip surface well purged of reactive gases and oxidizing moisture.

1. Vent the process chamber, turn off power to the controller and allow the ion source assembly to cool before handling its components.

WARNING

To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing.

2. Inspect process shields, tooling, fixtures or liners for excess accumulation of coatings and films. Remove and clean as necessary.

3. Inspect the ion source face for particles and flakes that may have delaminated from process surfaces or fixturing. Accumulation of such material may cause minor shorting of the anode within the source.

4. Inspect the inside of the ion source anode assembly. If needed, refer to step "1." on page 33 . Then, vacuum clean the ion source face and the anode assembly throat to prevent the accumulation of contaminants within the source.

CAUTION

Ion source surfaces may exceed 300°C (570°F) after use and venting. Avoid burns during servicing by using appropriate personal protective equipment and allowing for a sufficient cool down interval. Refer to "Source Performance" on page 65.

5. Remove the HCES from the source assembly.

6. Inspect the HCES assembly. Replace and/or align the cathode tip and keeper face-plate if necessary. Refer to the HCES 5000 technical manual for detailed information.

NOTE

A typical HCES service interval is about 50 hours, but this interval is process dependent.

7. Inspect the anode assembly. If service is required, remove the anode assembly from the source's base assembly and the process chamber; set it aside on a clean work surface. Refer to step "1." on page 33 and step "2." on page 34.

8. Remove the source's outer body from the base assembly; refer to step "3." on page 34. Inspect it for deposited films or coatings. If it needs a thorough cleaning, set it aside on a clean work surface. Otherwise, wipe down the body with an alcohol moistened, lint-free task wipe before replacing it.

9. Inspect the top surface of the exposed source base assembly for any accumulated debris, particularly at the central gas input feed point. Refer to "FIGURE 6.5" on page 35. Vacuum clean it and wipe down with an alcohol moistened, lint-free task wipe to remove any accumulated debris. Examine the base assembly for any signs of arcing or coating build up from extended use.

Base assembly discoloration or other appearance/finish changes (including surface oxidation and minor deposition) are likely to occur over time. This is due to thermal cycling of the interface between anode assembly and the fluid cooled copper base assembly during routine operation. Schedule any inspection and long term preventive maintenance for the base assembly (including its input fittings and electrical leads) to coincide with major process chamber maintenance or re-tooling.

NOTE

Remove the base assembly from the process chamber if additional inspection or service is necessary.

10. After base assembly and body surface cleaning, align and replace the outer body by reversing step **”3.” on page 34**. Align and install a clean anode assembly by following step**”6.” on page 44**.

NOTE

If a clean replacement anode assembly is not available for immediate installation, replace the body on the base assembly; cover the assembly with aluminum foil to prevent particle contamination of the base assembly.

11. Reinstall the HCES onto the anode assembly. Check that the cathode input gas line and its isolated body are not in electrical contact with any other fixturing, tooling or shield**.**

CAUTION

To avoid electrical shorts and possible HCES - controller damage, maintain at least 5cm (2 in.) clearance between the isolated gas line/ cathode and any conductive surface within the process chamber.

12. Close the process chamber and return the system to service.

Ion Source Maintenance Outside the Process System

What follows are recommended maintenance tasks to be performed on components after their removal from the process chamber. The anode assembly will require the most frequent attention using these methods. The source’s body and base assembly will be maintained less often in this manner. Contact "Service Support" on page 62 for information on the availability of spare parts, assemblies and rebuild kits.

FIGURE 7.3 Anode Assembly Maintenance.

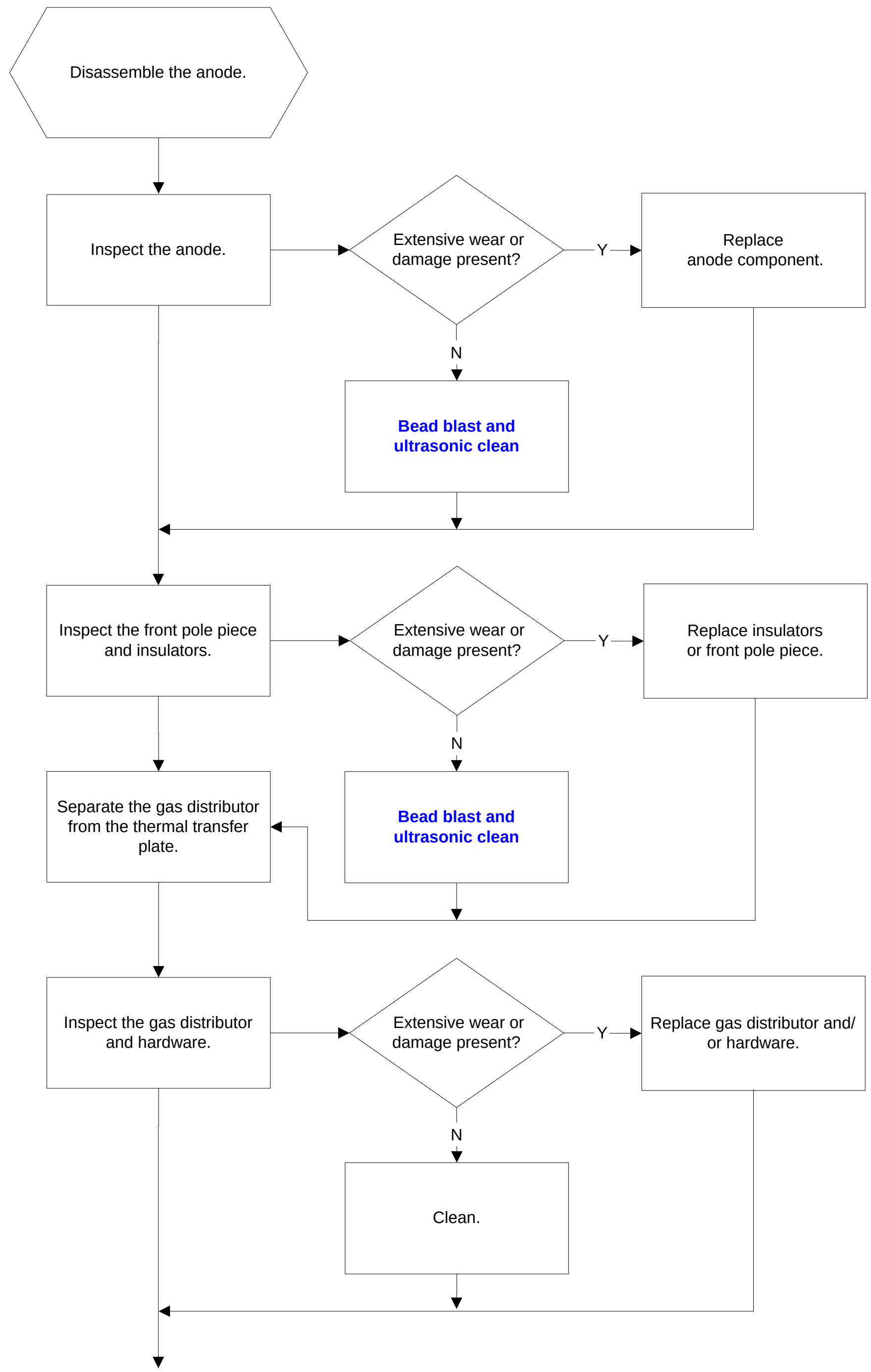
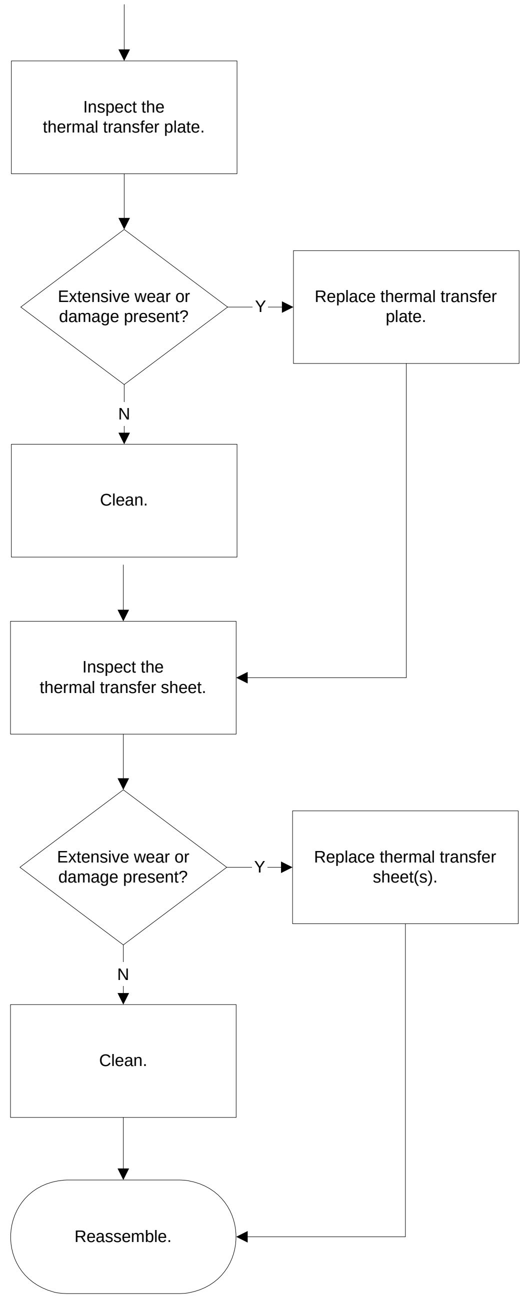


FIGURE 7.4 Anode Assembly Maintenance (continued).



Anode Assembly Maintenance

Refer to "FIGURE 7.3" on page 51 and FIGURE 7.4 when performing these steps.

1. Place the anode assembly to be serviced on a work surface that has been cleaned of oil, particles, fibers and other contaminants.

2. Follow steps **"4." on page 36** through **"8." on page 39** to disassemble the anode assembly. Leave the gas distributor attached to the thermal transfer plate at this time.

3. Inspect the anode assembly for excessive build up of coatings and films, arc damage or excessive wear from extended use and/or bead blast reconditioning.

   a. If the anode is excessively worn, replace it with a new one.

   b. If the anode simply requires cleaning, confirm that the anode power connector was removed by following step **"7." on page 38**.

   c. Prepare the anode for cleaning "Bead Blast and Ultrasonic Cleaning" on page 60.

NOTE

The masking plate protects the anode's surface finish when cleaning.

4. Inspect the pole piece for excessive build up of coatings, films and wear from extended use and/or bead blast reconditioning.

5. In particular, look for chipping and cracking of the three cylindrical pole piece insulators.

   a. If the pole piece insulators are chipped or damaged, replace them with new ones.

   b. Inspect the pole piece. If, the pole piece is excessively worn, replace it with a new part.

   c. If the pole piece insulators and/or pole piece simply require cleaning, loosen and remove the four gold plated ¼ –20 captive screws from the pole piece, using a 3⁄16 in. hex ball driver

   d. Prepare the pole piece and insulators for cleaning; refer to "Bead Blast and Ultrasonic Cleaning" on page 60.

6. Inspect the gas distributor while it is still mounted to the thermal transfer plate. Check the gas distributor and its mounting hardware for wear and for coatings build-up, especially along its circumference.

   a. If excessive coatings build-up, wear or component damage is present, follow steps**"10." on page 40** and**"11." on page 41** to remove the gas distributor from the thermal transfer plate.

   b. After removal, measure the gas distributor's thickness at its center, using either a depth or ball-end micrometer. If the distributor's center-axis thickness is less than 1.5mm (0.059 in.) or about 70% of its total thickness, replace it with a new one, using new mounting hardware.

CAUTION

To avoid damage to the thermal transfer plate and the base assembly, replace the gas distributor before it reaches the recommended minimum thickness, and well before wear and sputter erosion perforate it.

c. If the gas distributor is still usable, clean with an alcohol moistened, lint-free task wipe; allow it to air dry or blow-dry with compressed nitrogen before reassembly.

7. Inspect the thermal transfer plate for cracks, chips and wear. Wet the plate's surface with isopropyl alcohol to reveal hairline cracks that may have developed within the plate. If cracks, chips and/or excess wear are found, replace the plate with a new one.

8. Remove surface coatings and deposits build-up from the transfer plate's center (under the gas distributor), particularly if these deposits are loose and conductive:

   a. Place the thermal transfer plate on a smooth flat surface.

   b. Gently hand-clean any circular track of deposits from the plate, using 600 grit silicon carbide sandpaper. Confirm that the center hole and assembly holes are also clean of any loose debris or deposits.

NOTE

Avoid sanding the front plate areas where the transfer plate is joined to thermal transfer sheets.

   c. After thorough deposits removal, clean the plate of all residual particles using an alcohol moistened lint free task wipe; blow dry with compressed, dry nitrogen.

CAUTION

Use only isopropyl alcohol and a task wipe for this step; avoid all of the following when cleaning the thermal transfer plate: ultrasonic tanks, water or solvent soaking.

9. Inspect the thermal transfer sheets used in the anode assembly.

   a. If there is any evidence of cuts, gouges or perforations, discard the sheet and replace it with a new one.

   b. Clean serviceable sheets with an isopropyl alcohol moistened lint-free task wipe; lightly blow-dry with compressed, dry nitrogen.

CAUTION

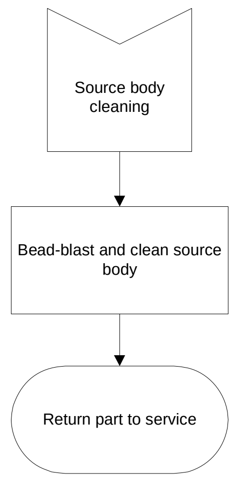
Use only isopropyl alcohol and a task wipe for this step; avoid wet cleaning the thermal transfer sheets.

10. Follow the first 5. steps under "Reassembly" on page 42 put the anode assembly together.

Source Body and Base Assembly Maintenance

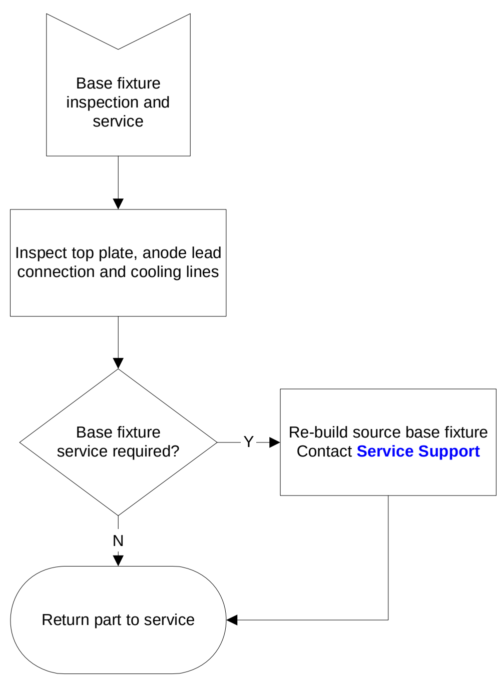
Refer to FIGURE 7.5 and FIGURE 7.6 when performing the following inspection and maintenance steps.

FIGURE 7.5 Source Body Maintenance.



Inspect the source body for excessive build up of coatings and films, arc damage or wear from extended use and bead blast reconditioning. Pay special attention to the body's top edge that seats against the anode assembly. If coatings and films are present, prepare the body for cleaning; refer to "Bead Blast and Ultrasonic Cleaning" on page 60.

FIGURE 7.6 Base Assembly Maintenance.



1. If maintenance is required on the ion source base assembly (or is scheduled for the entire system), remove it (with its electrical leads) and the HCES from the process chamber.

NOTE

Base assembly inspection and preventive maintenance are recommended whenever the system is scheduled for major maintenance or re-build. Refer to "Installation" on page 7 and to "Drawings" on page 73 when servicing the base assembly.

2. Inspect these base assembly areas for wear and/or damage: gas fittings, anode power connector socket and lead, coolant lines, and the surface of the fluid cooled copper plate.

3. If any of these components are worn or damaged, repair the base assembly or replace the ion source. Contact "Service Support" on page 62 for repair instructions and parts availability.

Recommended Service and Preventive Maintenance Intervals

Table 7.1 on page 57 provides Veeco's recommended guidelines on preventive maintenance intervals for ion source component servicing. This information should be considered a guideline only; actual field service intervals will depend upon local process conditions related to the application, specific tool settings and use.

CAUTION

To avoid source and anode assembly damage, Veeco strongly recommends replacing the gas distributor on or before the interval shown.

⚠ **WARNING** **To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing.**

Table 7.1: Recommended Preventive Maintenance

Component/Sub Component	Recommended Preventive Maintenance Period	Early Warning Operating Condition or Inspection Measurement
Cathode (HCES)	Visually inspect components after each run.	n.a.
Tantalum cathode tip	Replace tip about every 75 to 150 hours of operation; elevated anode current settings during operation will reduce service life.	The cathode becomes difficult to ignite. The emission voltage required to reach the emission or neutralization current set points routinely exceeds 45V while operating the HCES above 10sccm of Ar. These symptoms suggest the cathode tip is near end of life.
Tantalum cathode keeper plate	Inspect keeper plate condition; clean away deposits. Measure the inside diameter; replace it when ID exceeds 2.8mm (0.110 in.). Replace the keeper plate about every 50 to 100 hours of operation, depending on the anode current.	The keeper inner diameter becomes > 2.8mm (0.110 in.) and the cathode becomes more difficult to start and be sustained with less than 10sccm of Ar.
Cathode gas and electrical connections	Tighten loose connections. Inspect all ceramic insulators that support the HCES. Replace if cracked, chipped or broken. Inspect HCES gas line weld fittings and insulator. Replace if stressed or damaged.	n.a.
Anode assembly	Visually inspect the anode assembly after each run. Vacuum the anode assembly to remove loose debris or particles from the process chamber between runs. Remove the assembly every 100 to 150 hours of operation and replace with new or reconditioned anode assembly.	1. Increasing gas flow or decreasing anode current, due to oxide coating build-up. 2. Inability to reliably start the source when it is cold. 3. Build-up and delamination of re-deposited gas distributor materials on the anode body throat.
Anode (stainless steel)	Clean off deposits by bead blasting every 100 to 150 hours of operation.	Build-up of oxide coatings or gas distributor deposits.

⚠WARNING

To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing. Disconnect the controller's main power before troubleshooting any electrical connection.

Table 7.1: Recommended Preventive Maintenance (Continued)

<table>
<tr><th>Component/Sub Component</th><th>Recommended Preventive Maintenance Period</th><th>Early Warning Operating Condition or Inspection Measurement</th></tr>
<tr><td>Gas distributor and 2–56 hardware</td><td>Remove and inspect during anode assembly preventive maintenance. Replace hardware when installing a new gas distributor. The wear rate of a gas distributor is dependent on the working gas and plate material, and is proportional to the net operating power. The following provides recommended replacement intervals for routine operation using the process gases shown.
<table>
<tr><th rowspan="2">Material</th><th colspan="2">Process Gas</th></tr>
<tr><th>Ar</th><th>O_2</th></tr>
<tr><td>graphite</td><td>< 75 hrs. @ 1kW
Graphite is not recommended above 1.5 kw in argon.</td><td>Graphite is not recommended for use with oxygen.</td></tr>
<tr><td>stainless steel, molybdenum, tantalum</td><td>< 10 hrs. @ 3kW
< 20 hrs. @ 2kW
< 35 hrs. @ 1kW</td><td>< 200 hrs. @ 3kW
< 450 hrs. @ 2kW
< 600 hrs. @ 1kW</td></tr>
</table></td><td>The center thickness of the plate is less than 1.5mm (0.059 in.) when measured with a ball end micrometer, following anode disassembly.</td></tr>
<tr><td>Anode assembly: thermal transfer sheets</td><td>Remove and inspect these sheets during anode assembly preventive maintenance. Replace individual sheets if they are torn, folded, sheared or fractured.</td><td>n.a.</td></tr>
<tr><td>Anode assembly: thermal transfer plate</td><td>Remove and inspect these sheets during anode assembly preventive maintenance. Replace immediately if the plate is severely chipped, cracked, or broken. Do not use broken, chipped or cracked thermal transfer plates.</td><td>Wipe the surface of the thermal transfer plate using a lint-free task wipe moistened with isopropyl alcohol; visually inspect for hair line cracks, damage, or abrasive cleaning wear. Replace as needed. Hand clean only. Do not bead blast or ultrasonically clean.</td></tr>
<tr><td>Anode assembly: ceramic insulators</td><td>Clean off deposits by bead blasting every 100 to 150 hours of operation. Replace damaged or cracked ceramic insulators.</td><td>n.a.</td></tr>
</table>

⚠WARNING **To avoid electrical shock, keep clear of "live" circuits. Follow all local lock-out/tag-out procedures before continuing. Disconnect the controller's main power before troubleshooting any electrical connection.**

Table 7.1: Recommended Preventive Maintenance (Continued)

Component/Sub Component	Recommended Preventive Maintenance Period	Early Warning Operating Condition or Inspection Measurement
Anode assembly: ¼ –20 captive screws	Visually inspect and replace as needed when the gold plating on the threads is worn away, or when the hex head cap fills with deposited material, making assembly difficult.	n.a.
Pole piece	Clean off deposits by bead blasting every 100 to 150 hours of operation.	n.a.
Source body (shell)	Clean off deposits by bead blasting every 200 to 300 hours of operation, or whenever routine process chamber preventive maintenance is performed on the liners and shields.	Delamination of loose coating debris on the body cylinder.
Base assembly (serialized)	Inspect the source's partition plate surface for gross scratches or wear when replacing the anode assembly. Visually inspect the base assembly for any signs of damage or loosened parts whenever routine process chamber preventive maintenance is performed. Refer to the "Drawings" on page 73 for detailed assembly information, part numbers and recommended torque values.	The base assembly (including the magnet assembly) typically requires no maintenance.
Lead assembly	Visually inspect the lead assembly for any signs of damage, breaks or wear whenever routine process chamber preventive maintenance is performed. Tighten the strain reliefs and fittings that may have loosened. Check lead continuity and isolation during reinstallation. Refer to "Electrical Continuity" on page 16 for details.	Lead continuity and isolation checks during routine process chamber preventive maintenance may reveal damaged, open or shorted lead connections.
NOTE	**Field disassembly or rework of the source lead assembly is not recommended. Contact "Service Support" on page 62 for assistance.**	
Water cooling lines	Visually inspect the water cooling lines for any signs of damage, breaks or punctures. Use new VCR brand gaskets when servicing in vacuum connections.	High process chamber base pressures when water leaks are present.

Bead Blast and Ultrasonic Cleaning

Follow these steps to clean metallic source components and the anode assembly's insulators. The frequency of such cleaning processes will be process dependent. Use only the media type and grit recommended.

CAUTION

Certain ion source parts are subject to irreparable damage when they are bead blasted.

Bead blast cleaning of the following components is NOT recommended: gas distributor, thermal transfer plate, thermal transfer sheets, and all gold plated hardware.

CAUTION

To avoid introducing other contaminants during cleaning, use only clean aluminum-oxide media.

Equipment/Materials

Here is a list of the materials and equipment necessary for bead blasting and cleaning of metallic and alumina components:

- Trinco Dry Blast Model #36/BP with Nozzle 340-S
- aluminum oxide media, 89 micron diameter average, ±50 micron (150 grit)
- ultrasonic cleaner
- dishwashing detergent-water solution
- ammonia-water solution
- isopropyl alcohol
- lint-free task wipes
- heat lamp or drying oven
- compressed, dry nitrogen (for hand blow off of components).

Procedure

1. Install the masking plate (provided) onto the anode assembly before cleaning it. Other part masking is not required before bead blasting.

2. Bead blast at 205 to 275kPa (30 to 40 psi) with aluminum-oxide media and the recommended nozzle size. Vary the nozzle angle and position to cover all surfaces.

NOTE

It may be necessary to adjust the pressure, depending on nozzle size.

3. Inspect the parts to confirm that all coatings and films have been removed from all treated surfaces, including all assembly holes and counter bores. Make certain that the central rings and/or apertures of the anode and front pole pieces are thoroughly cleaned. The plasma contacts these areas, making them especially prone to coating accumulation.

4. Wet clean:
   a. Wash all surfaces with mild dishwashing detergent and rinse thoroughly with clean, hot water.
   b. Place in an ultrasonic cleaner with clean water and ammonia-water solution for 20 minutes.
   c. Remove from ultrasonic cleaner and rinse thoroughly with clean, hot water.

5. Place in an isopropyl alcohol bath or clean with an alcohol moistened lint free task wipe.

6. Remove and quickly dry with compressed nitrogen.

7. Dry under a heat lamp or inside a drying oven for 10 minutes.

8. Stage cleaned parts and components; reassemble them shortly after cleaning.

Chapter 8: Service Support

For service, contact:

Veeco Instruments Inc.
2330 East Prospect
Fort Collins, CO 80525
Phone: 1.888.221.1892
Fax: 970.493.1439
ftcsupport@veeco.com

When contacting Veeco Instruments Inc. for parts or service:

Provide the ion source model number and serial number; the ion source power supply model and serial number; a list of all operating parameters and/or error messages displayed by the power supply; gas flow rate; and vacuum chamber pressure.

Appendix A: Specifications

General

Source model:	Mark II[⊕] fluid cooled with HCES
Cathode type:	hollow cathode
Cooling[a]	water, 1.5ℓ/min. (0.4gpm) minimum flow
Dimensions (length x diameter):	111mm x 140mm (4.4 in. x 5.50 in.)
Weight (source only):	5.9kg (13 lbs.)
Maximum discharge power (discharge voltage x discharge current):	3000W
Power Rejection/Load	60% of input source power (typical) 2000W (maximum)
Discharge (anode) voltage, V_A [b]	original design – argon: ~50 to 300V oxygen: ~110 to 300V low voltage option – argon: ~40 to 300V oxygen: ~75 to 300V
Mean ion beam current energy:	30 to 180eV (~60% of anode voltage set point)
Discharge (anode) current, I_A:	Mark II[⊕] HO Controller: ~1.0 to 10A @V_A=300V Mark III[⊕] Controller: ~1.0 to 15A @V_A=200V
Maximum ion beam current:	~3 to 3.5A(~25% of I_A @ 30cm from the source)[c]
Maximum operating pressure:	1.33×10^{-1} Pa (1.0×10^{-3} Torr)
Permissible gas types [a., d]	Oxygen, nitrogen, argon (and other inert gases)
Gas flow range:	5 to 100sccm[e]

NOTES

a. Refer to “Facilities Requirements” on page 64 for grade/quality information.
b. The lower voltage range depends on current settings and available gas flow capacity. Refer to “Source Performance” on page 65.
c. The total ion beam current diminishes with distance from the source.
d. Direct injection only. Other reactive gases may be introduced downstream of the source for deposition applications.
e. The vacuum system’s pumping speed may affect actual gas flow requirements.

Facilities Requirements

These are the minimum facilities required for successful source start-up and continued operation within the values shown.

NOTE

Process specific conditions may require more stringent material specifications.

Process gas –

- pressure: refer to the supplier MFC technical manual for maximum inlet pressure.
- flow:
  - source – 50 to 100sccm
  - HCES – 100sccm
- filter to: at least 2 microns at point of use
- quality: 99.999% minimum purity

NOTE

The vacuum system's pumping speed affects actual gas flow requirements.

Coolant –

- inlet temperature:
  - 10°C (50°F) minimum
  - 40°C (104°F) maximum
- flow: 1.5ℓ/min. (0.4gpm)
- pressure:
  - 690kPa (100 psig) maximum
  - differential – Refer to FIGURE A.1

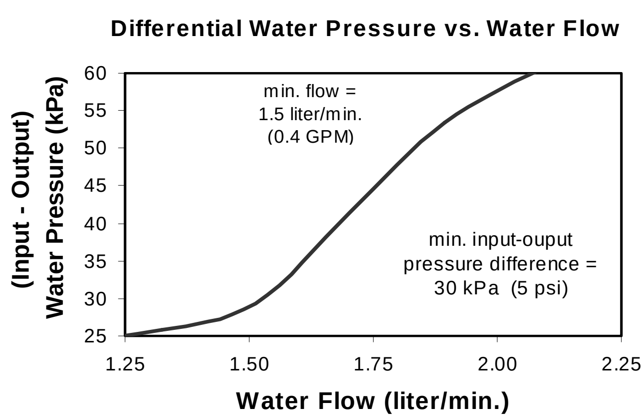


FIGURE A.1 Differential Water Pressure vs. Water Flow.

Appendix B: Source Performance

The following representative data is for the Mark II⊕ fluid cooled ion source, with HCES, for working gases of argon and oxygen:

- operational anode voltage, anode current and input gas flows
- typical angular ion beam current density profiles at a fixed radial distance from the source at various anode voltages
- total integrated output ion beam currents at various input anode voltages and currents.

Because ion source performance depends upon the vacuum system's working background pressure and pumping capacity, the actual field performance may deviate from these particular performance curves. These curves are offered to assist with initial process settings, to help anticipate performance trends, and aid with either static or dynamic process settings development.

Performance data was taken when operating the ion source as follows:

- powered by a Veeco Mark II⊕ HO Controller in AUTO Mode
- fixed HCES argon gas flow between 5 and 10sccm
- fixed neutralization current of 200mA.
- typical process chamber pressure range of 0.133 to 1.33 x 10^{-1} Pa (0.1 to 1.0 x10^{-3} Torr).

Low Voltage Option

The low voltage option is a special configuration of the Mark II⊕ ion source that is occasionally recommended for the following situations:

- source operation at lower net ion energies (anode voltages) and lower beam current power when processing at or near a material's sputtering threshold
- processing materials that may be sensitive to the high beam current density of the original Mark II⊕ ion source.

"FIGURE B.1" on page 66 through "FIGURE B.6" on page 68 provide detailed specifications for the original Mark II⊕ ion source design. "FIGURE B.7" on page 69 through"FIGURE B.12" on page 72 provide similar information for the low-voltage option.

Operating Curves - (Anode Voltage, Current and Input Flow)

FIGURE B.1 and FIGURE B.2 provide operating curves for the original Mark II⊕ source design for argon and oxygen. These curves may be used to anticipate the typical input gas flows when attempting to power the ion source at specific input anode voltage, V_A, and anode current I_A settings.

Typical variance associated with the input flow responses are ±1sccm which increases by about +2sccm as the ion source reaches thermal steady state conditions.

FIGURE B.1 Input Gas Flow for Argon vs. Anode Potential (V_A) and Anode Current (I_A).

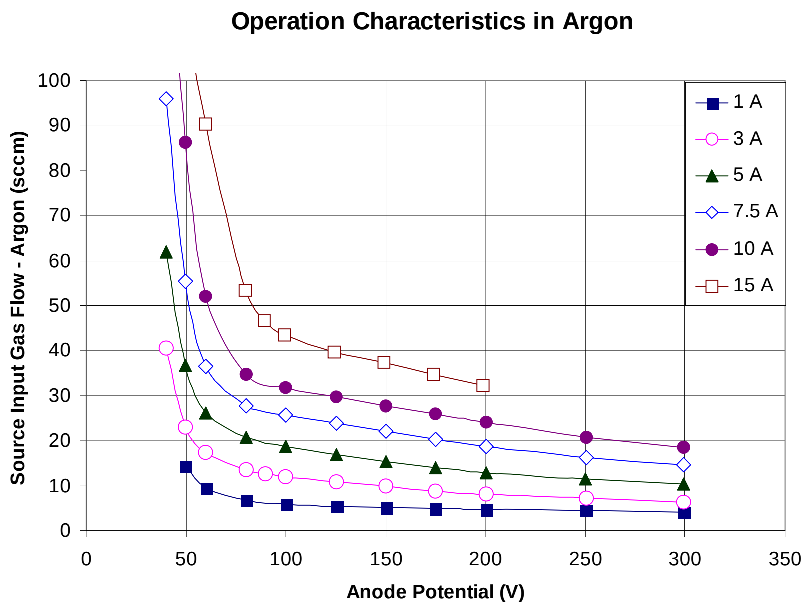
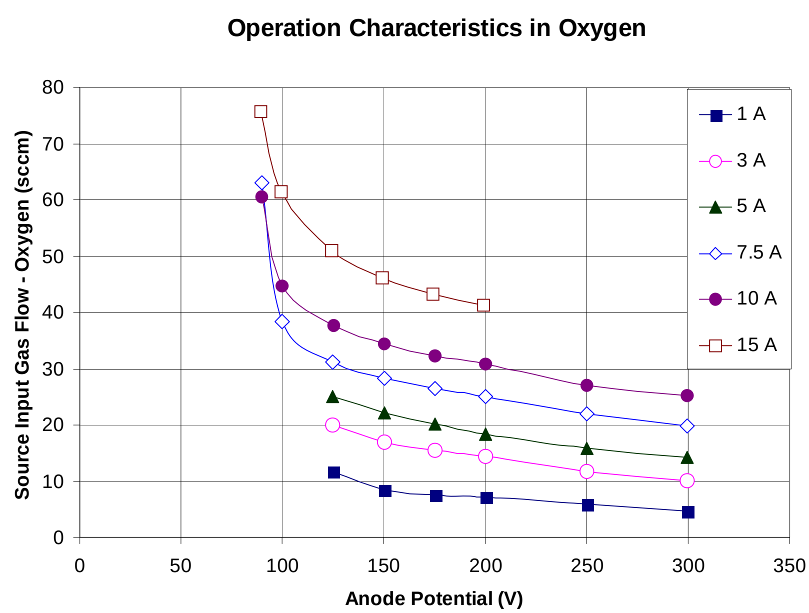


FIGURE B.2 Input Gas Flow for Oxygen vs. Anode Potential (V_A) and Anode Current (I_A).



Angular Ion Beam Current Density Profiles

FIGURE B.3 and **FIGURE B.4** show exemplary ion beam current density profiles for the original source design as taken by a Faraday cup that was angularly swept at a fixed distance of R=30cm from the ion source face. Source profiles for argon and oxygen are shown for an anode current of 7.5A and at various anode potentials. Ion beam current density readings at angles of ± 90° are nominally zero.

FIGURE B.3 Angular Beam Current Density at R=30cm and Anode Current=7.5A (Argon).

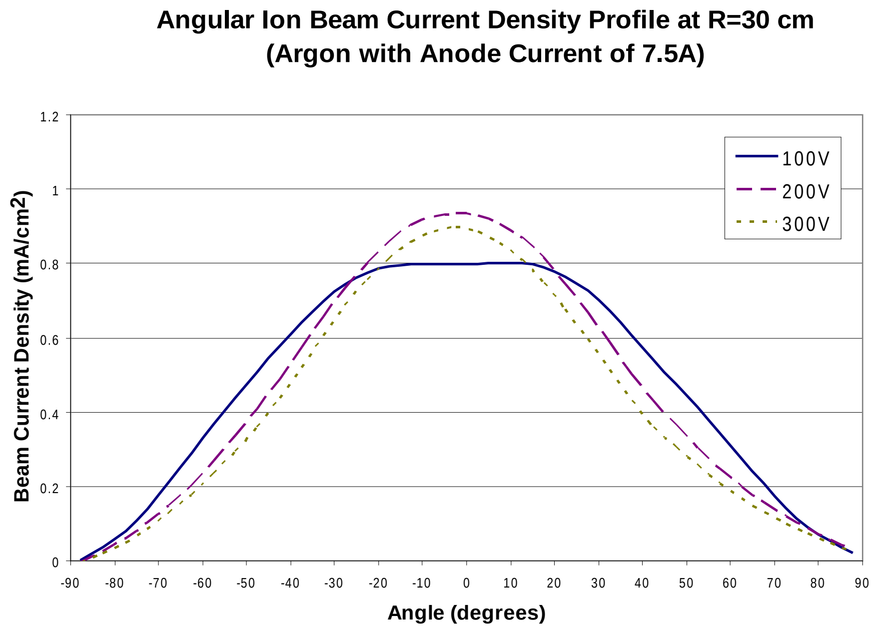
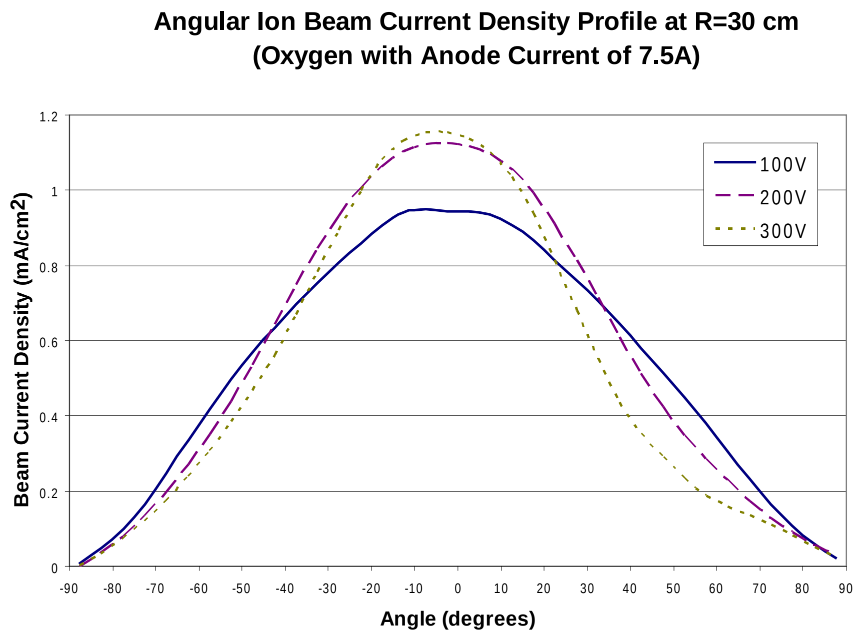


FIGURE B.4 Angular Beam Current Density at R=30cm and Anode Current=7.5A (Oxygen).



Total Output Ion Beam Current

It is possible to obtain a estimate of the total ion beam current (I_B) by integrating the beam current density over the half sphere in front of the ion source, using the angular ion beam current density profiles similar to FIGURE B.3 and "FIGURE B.4" on page 67. FIGURE B.5 and FIGURE B.6 show total output ion beam currents for normal range of operation of interest for most applications in argon and oxygen. Typically, the total current of accelerated ions is about 20 to 30% of the anode-to-cathode current used to sustain the ion source discharge.

FIGURE B.5 Total Ion Beam Current vs. Anode Voltage at R=30cm (Argon).

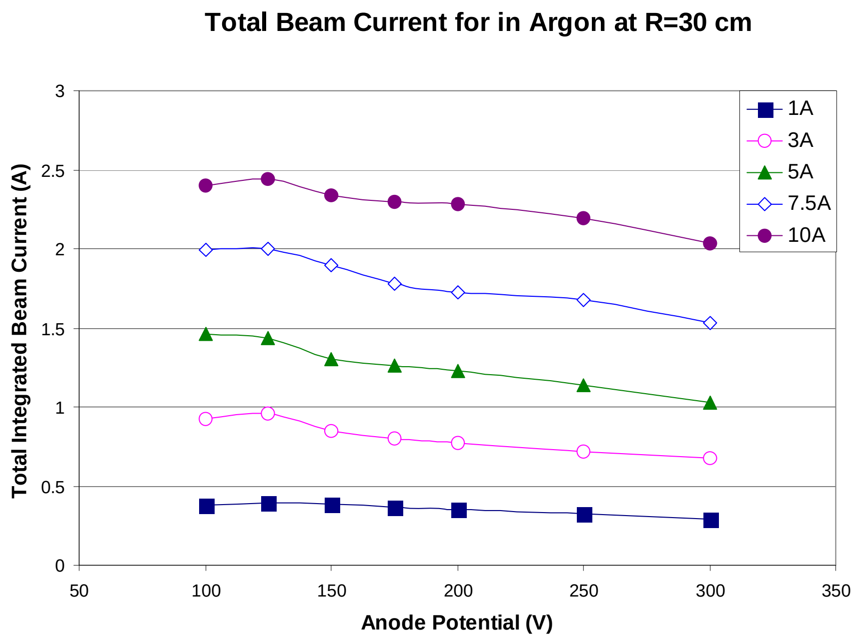
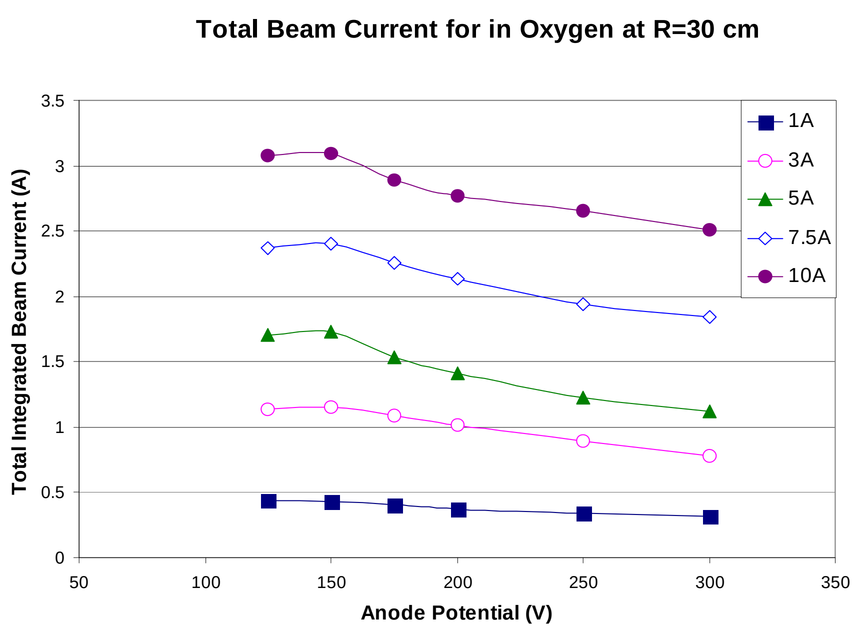


FIGURE B.6 Total Ion Beam Current vs. Anode Voltage at R=30cm (Oxygen).



Operating Curves, Low Voltage Option – (Anode Voltage, Current and Input Flow)

The Mark II® source's low voltage option is configured for reliable operation at reduced working anode potentials. This option may be better suited to delicate processes whose substrate surfaces are highly sensitive to ion energies at or just above their sputtering threshold. In addition to lower voltage operation, this option also works at gas flows notably less than the original design. Given its reduced input gas flow, the output beam current for the low voltage source option is less than the original design at the same input power settings.

FIGURE B.7 and "FIGURE B.8" on page 70 provide operating curves for the Mark II® source's low voltage option for argon and oxygen. These curves may be used to anticipate the typical input gas flows when attempting to power the ion source at specific input anode voltage, V_A, and anode current I_A settings.

Typical variance associated with the input flow responses are ±1sccm which increases by about +2sccm as the ion source reaches thermal steady state conditions.

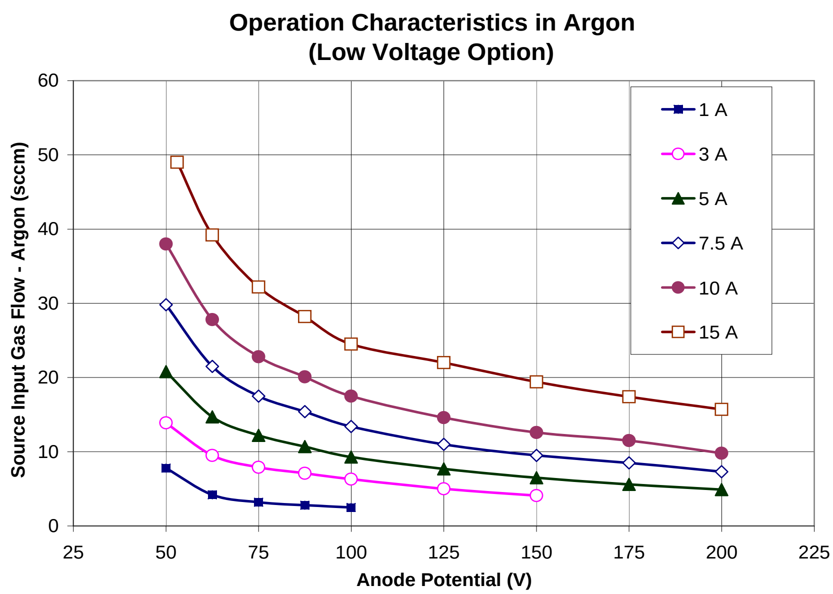
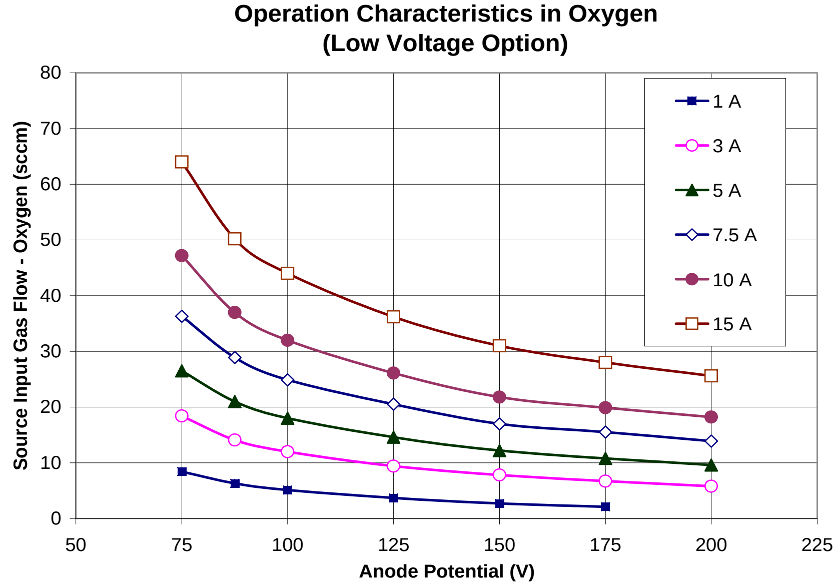


FIGURE B.7 Input Gas Flow vs. Anode Potential (V_A) and Anode Current (I_A) - Low Voltage Option (Argon).

FIGURE B.8 Input Gas Flow vs. Anode Potential (V_A) and Anode Current (I_A) - Low Voltage Option (Oxygen).



Angular Ion Beam Current Density Profiles, Low Voltage Option

FIGURE B.9 and "FIGURE B.10" on page 71 show exemplary ion beam current density profiles for the Mark II® source's low voltage option, as taken by a Faraday cup that was angularly swept at a fixed distance of R=30cm from the ion source face. Source profiles for argon and oxygen are shown for an anode current of 7.5A and at various anode potentials. Ion beam current density readings at angles of ± 90° are nominally zero.

FIGURE B.9 Angular Beam Current Density at R=30cm and Anode Current= 7.5A - Low Voltage Option (Argon).

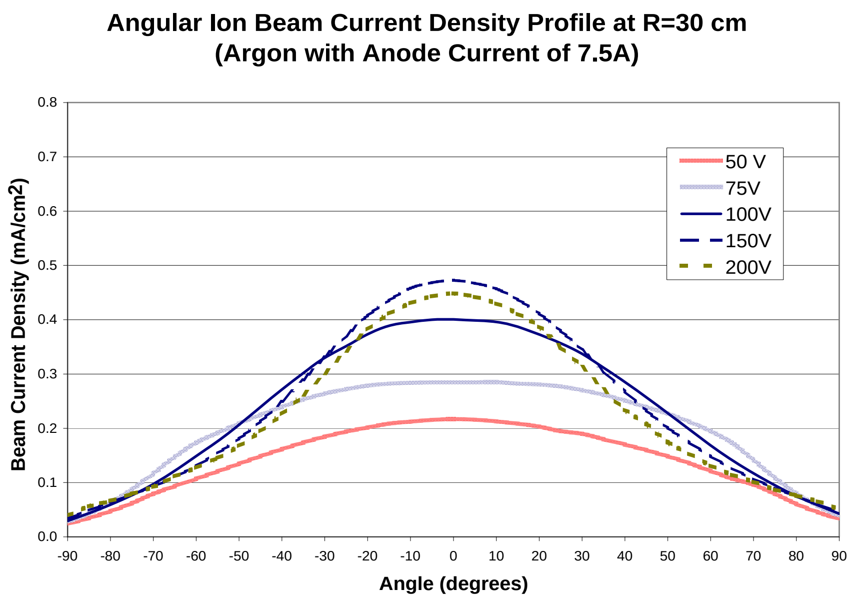
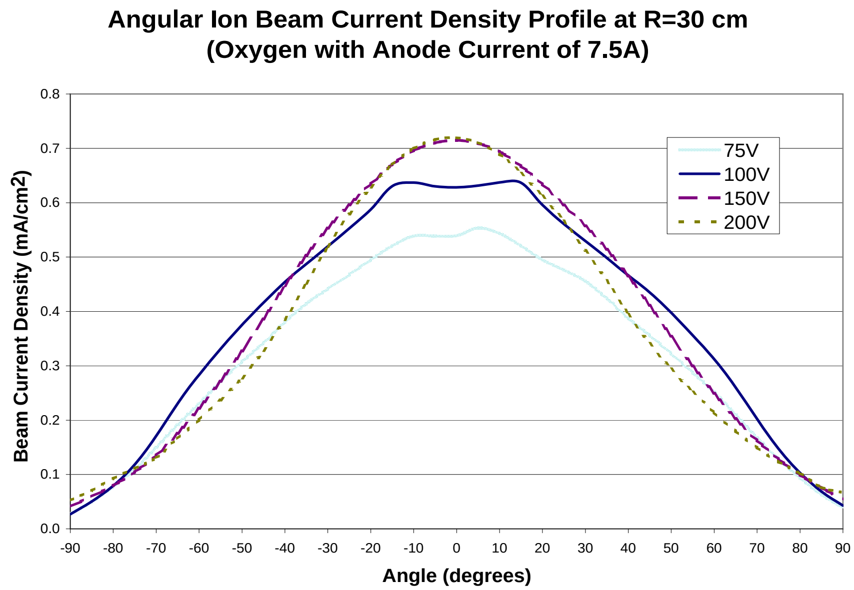


FIGURE B.10 Angular Beam Current Density at R=30cm and Anode Current= 7.5A - Low Voltage Option (Oxygen).



Total Output Ion Beam Current, Low Voltage Option

FIGURE B.11 and "FIGURE B.12" on page 72 show total output ion beam currents for the for the Mark II$^{\oplus}$ source's low voltage option in a normal range of operation of interest for most applications in argon and oxygen. This source option's total current of accelerated ions is about 15 to 25% of the anode-to-cathode current used to sustain the ion source discharge. Note that the source's low voltage option runs at lower input gas levels; as a result, this source option produces a lower overall beam current for the same input power settings.

FIGURE B.11 Total Ion Beam Current vs. Anode Voltage at R=30cm.- Low Voltage Option (Argon).

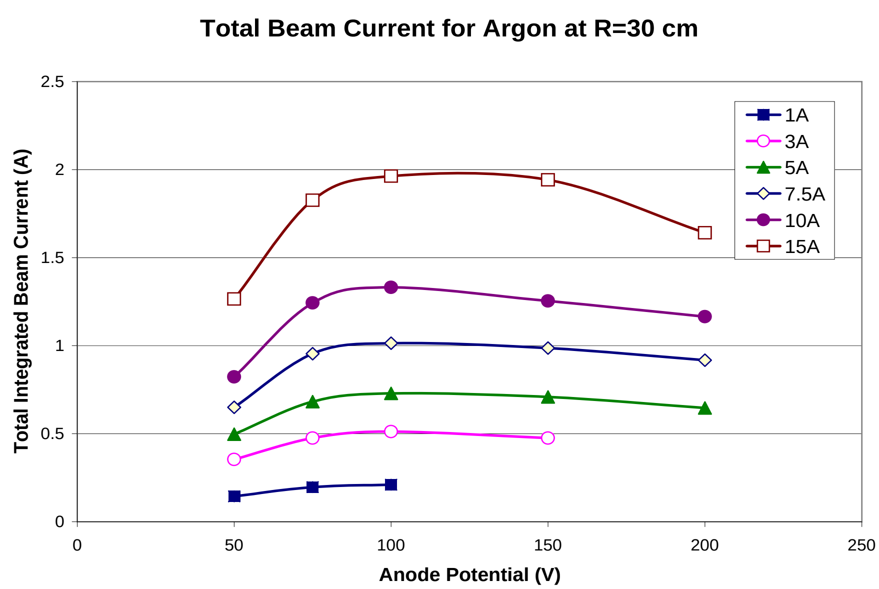
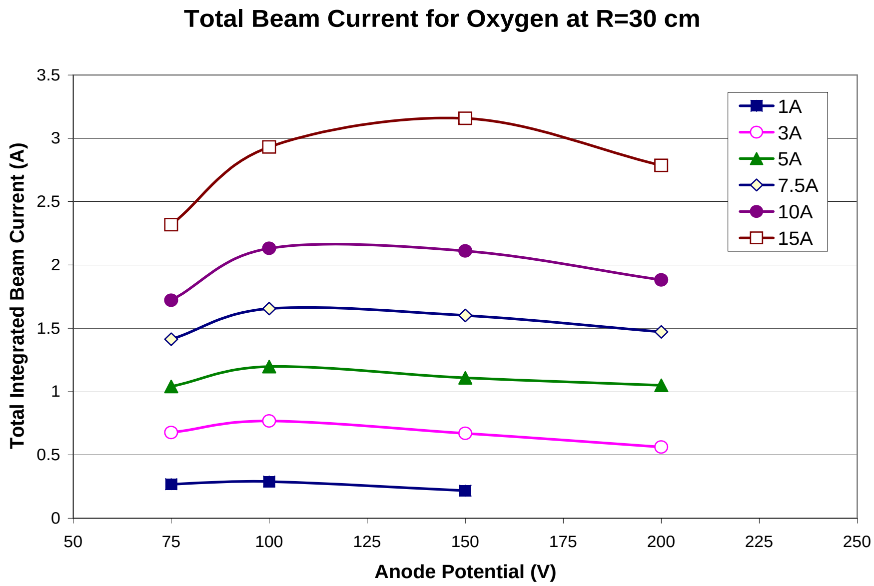


FIGURE B.12 Total Ion Beam Current vs. Anode Voltage at R=30cm.- Low Voltage Option (Oxygen).



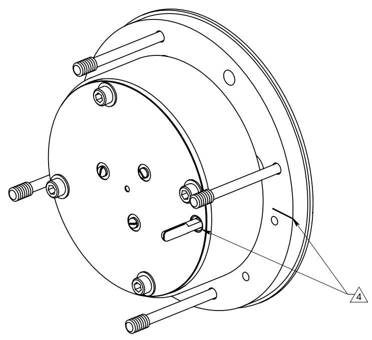
Appendix C: Drawings

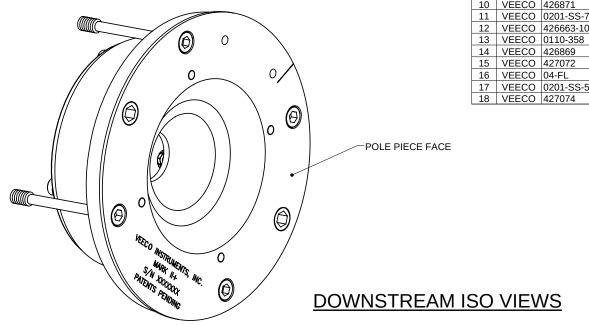
Table C.1: Drawings

Drawing Number	Description
426667-1	"Mark II⊕ Anode Assembly –HCES"
427073	"Mark II⊕ Source Assembly –HCES"
427073 DIAG	"Mark II⊕–HCES Fluid Cooled Wiring Diagram"

Mark II⊕ Anode Assembly –HCES

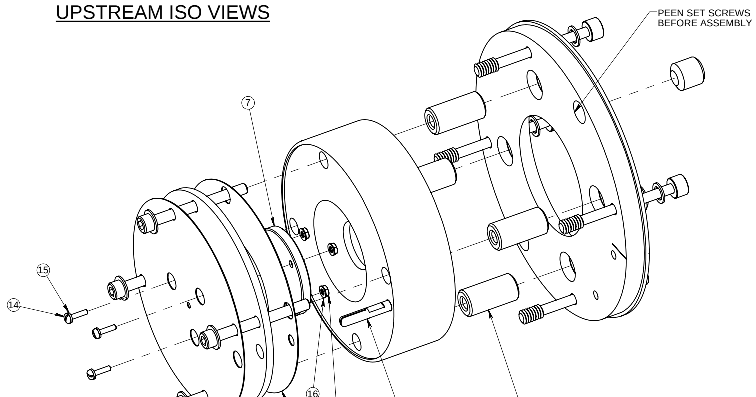
ITEM	VENDOR	VENDOR #	DESCRIPTION / MATERIALS	QTY
1	VEECO	426663-1	ANODE, MARK II+	1
2	VEECO	426663-3	POLE PIECE	1
3	VEECO	426663-6	THERMAL TRANSFER PLATE	1
4	VEECO	426663-24	ANODE THERMAL TRANSFER SHEET (ANODE SIDE)	1
5	VEECO	426663-25	ANODE THERMAL TRANSFER SHEET (COOLING PLT SIDE)	1
6	VEECO	426663-27	ANODE THERMAL TRANSFER SHEET (GAS PLT SIDE)	1
7	VEECO	426663-7	GAS DISTIBUTOR, STAINLESS	1
8	VEECO	426663-21	ANODE POWER CONNECTOR MALE (MOLYBDENUM)	1
9	VEECO	426663-9	POLE PIECE INSULATOR	4
10	VEECO	426871	SCREW,SS, 10-32 X 1.938 SHCS, AU	4
11	VEECO	0201-SS-718	WASH,FLT,.205 I.D. X .440 O.D. X .030 THK,SS	4
12	VEECO	426663-10	SCREW, 1/4-20 X 2.25 CAPTIVE PANEL SCREW,AU	4
13	VEECO	0110-358	WASHER, SS, .375 O.D. X .250 I.D. X .031 PREC.	4
14	VEECO	426869	SCREW,SS,2-56 X .375 SLOTTED PANHD,AU	3
15	VEECO	427072	WASH,FLT,.089 I.D. X ..187 O.D. X .031 THK,SS	3
16	VEECO	04-FL	WASH,FLT,.115 I.D. X .219 O.D. X .016 THK,SS	3
17	VEECO	0201-SS-502	NUT, SS, 2-56 HEX	3
18	VEECO	427074	SCREW,SS,1/2-13 X .500 SET CUP PT	2

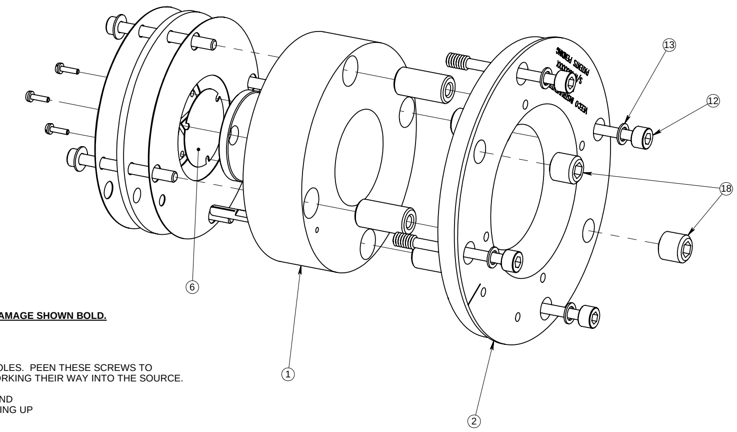




UPSTREAM ISO VIEWS

DOWNSTREAM ISO VIEWS





10 11 5 3 4

RECOMMENDED TORQUE SPECS. TO AVOID THREAD GALLING AND PART DAMAGE SHOWN BOLD.

NOTES:

1) INSERT TWO 1/2-13 SET SCREWS FLUSH WITH TOP OF POLE PIECE TO PLUG HOLES. PEEN THESE SCREWS TO THE BACK SIDE OF POLE PIECE, 3 PLACES EACH, TO PREVENT THEM FROM WORKING THEIR WAY INTO THE SOURCE.

2) THREAD THE 4 CAPTIVE PANEL SCREWS INTO AND THROUGH THE WASHERS AND POLE PIECE. BUILD THE REST OF THE ASSEMBLY WITH THESE SCREWS POINTING UP AND THE POLE PIECE FACE SETTING FLAT ON A WORK BENCH.

3) INSERT THE 4 POLE PIECE INSULATORS INTO THE CBORES OF THE POLE PIECE, BEING SURE THAT THEY ARE FULLY SEATED AND NOT CAUGHT ON THE SECONDARY CBORE LEDGE. MAKE SURE THAT THERE ARE NO DEBRIS CHIPS CAUGHT UNDER THESE INSULATORS OR THEY CAN CHIP AND BREAK.

4 CAREFULLY SET THE ANODE ONTO THE 4 INSULATORS USING SAME PRECAUTION AS IN PREVIOUS STEP. BE SURE THAT THE ANODE IS ORIENTATED SO THAT IT'S TAPPED HOLE IS LINED UP WITH THE MARK IN THE POLE PIECE.

5) THREAD ANODE CONNECTOR INTO ANODE UNTIL IT BOTTOMS OUT, THEN TORQUE APPROX. **3-6 INCH/POUNDS**.

6) CREATE A SUB ASSEMBLY BY ATTACHING THE SMALL THERMAL TRANSFER SHEET AND THE GAS DISTRIBUTOR TO THE THERMAL TRANSFER PLATE WITH THE 2-56 HARDWARE. BE SURE THAT THE GAS PLATE IS CENTERED WITH THE GAS GROOVE OF THE THERMAL TRANSFER PLATE (TTP). TORQUE TO **1.5 INCH/POUNDS.** FIBER AND PARTICLES WILL ATTRACT TO THE TTP DUE TO STATIC. BLOW THESE OFF WITH COMPRESSED NITROGEN.

7) ATTACH THIS SUB ASSEMBLY, THE ANODE, AND THE 2 REMAINING THERMAL TRANSFER SHEETS TO THE POLE PIECE WITH THE FOUR 10-32 SCREWS AND WASHERS. TORQUE TO **3 INCH/POUNDS.**

A	EC # FC11860 PRODUCTION RELEASE	SAT	7-26-06
	CHANGE	CHG / CHK	DATE

UNLESS OTHERWISE SPECIFIED:
UNITS: ±INCHES [±mm]

TOL in.	TOL [mm]	SURFACE FINISH
.X .1		32 √ FAO
.XX .02	.X .5	
.XXX .005	.XX .13	ANGLE
.XXXX .0005	.XXX .013	± 1 deg.

DIMENSIONED IN ACCORDANCE WITH ASME Y14.5M–1994 STANDARDS
REMOVE ALL BURRS AND SHARP EDGES
ALL THREADS CLASS 2

DRAWN	SAT	DATE 10-3-06
CHECK		DATE
ENGR	SAT	DATE 10-3-06
MFG ENGR	TR	DATE
PROJ MGR	TR	DATE

TITLE
MARK II+
ANODE ASSEMBLY
(FLUID COOLED HC SOURCE)

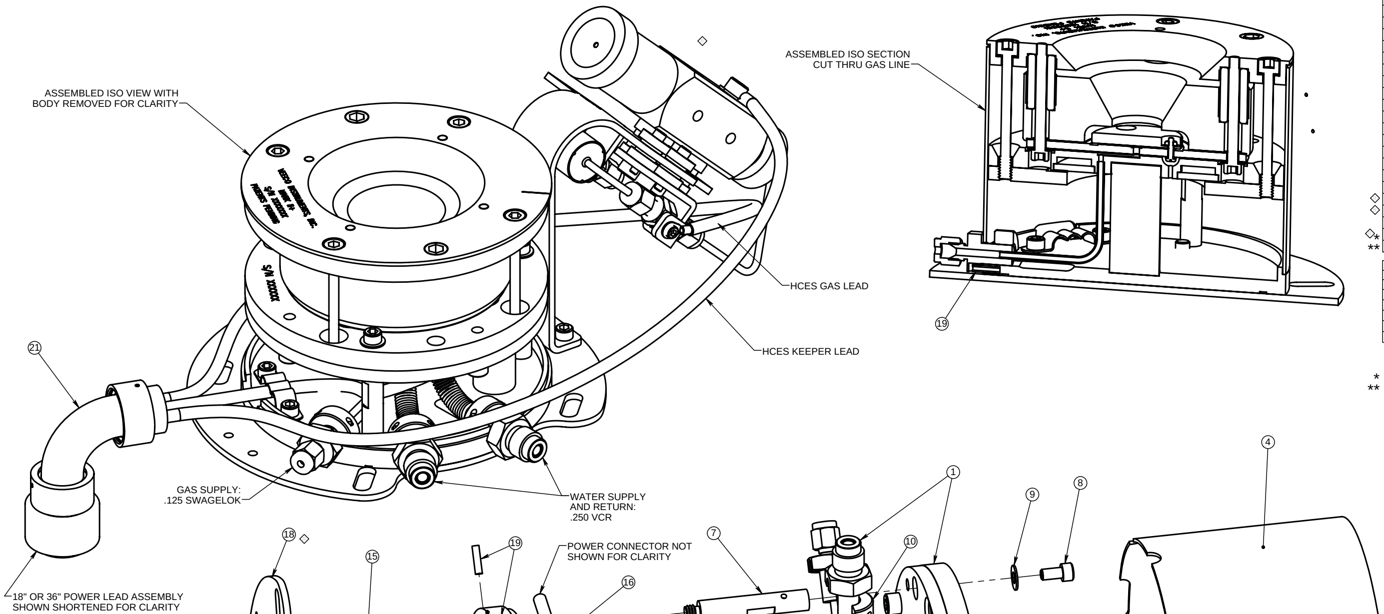
DO NOT SCALE DRAWING
SCALE 1:1 SHEET 1 OF 1

THIRD ANGLE PROJECTION

Veeco
VEECO INSTRUMENTS

D PART NUMBER 426667-1 REV A

Mark II⊕ Source Assembly –HCES

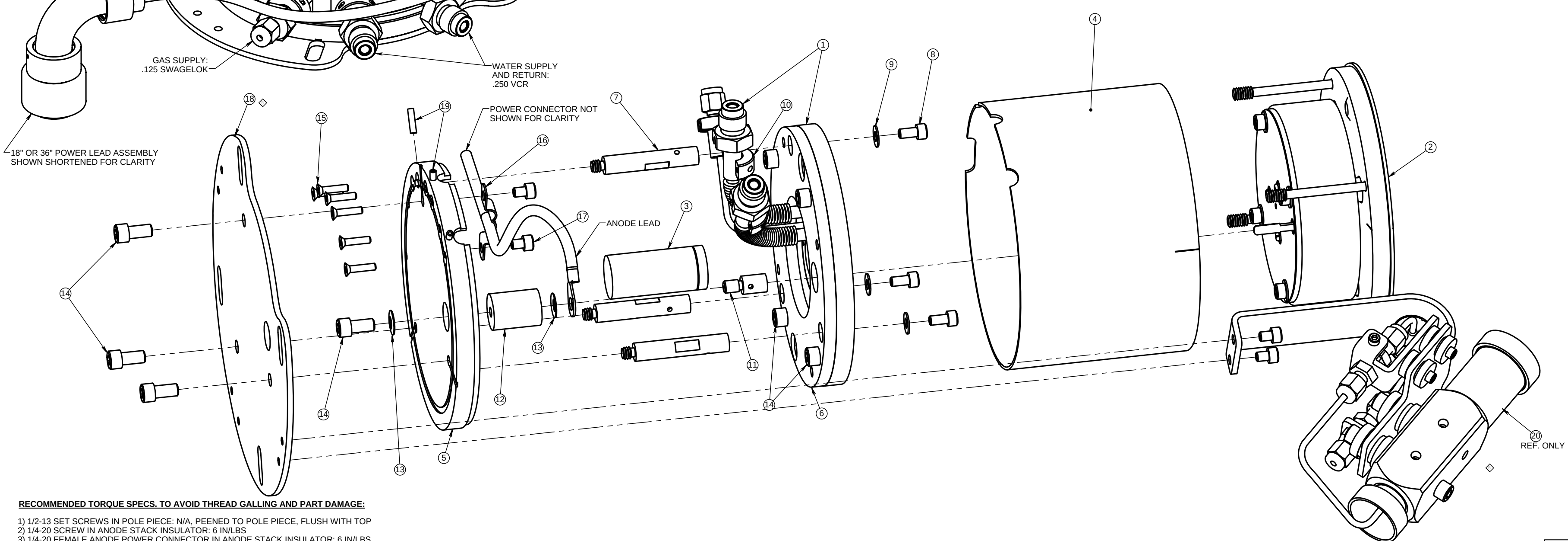


ITEM	VENDOR	VENDOR #	DESCRIPTION / MATERIALS	QTY
1	VEECO	426666	COOLING PLATE	1
2	VEECO	426667-1	MARK II+ ANODE ASSEMBLY (FLUID COOLED HC SOURCE)	1
3	VEECO	426663-5	MAGNET, .900 DIA. X 2.000	1
4	VEECO	426663-4	BODY	1
5	VEECO	426663-2	BASE	1
6	VEECO	426663-28	ANCHOR PLATE	1
7	VEECO	426663-13	STDF, 1/4-20 M, 10-32 F X 1.957	3
8	VEECO	B17490-7	SCREW,SS, 10-32 X .375 SHCS AU PLTD	3
9	VEECO	0201-SS-718	WASH,FLT,.205 I.D. X .440 O.D. X .030 THK,SS	3
10	VEECO	0110-167	2 PIECE SS CLAMP COLLAR, .375 I.D. X .875 O.D. X .343 THK.	3
11	VEECO	426663-20	ANODE POWER CONNECTOR (FEMALE)	1
12	VEECO	426663-19	ANODE STACK INSULATOR STANDOFF	1
13	VEECO	427368	WASH,SS,BELV,.500OD X .255ID X .040H X .018T	2
14	VEECO	425555	SCREW,SS, 1/4-20 X .500 SHCS, AU PLTD	8
15	VEECO	426867	SCREW, SS, 6-32 X .625 FLTHD, SOC.,AU	6
16	VEECO	426663-15	ELECTRICAL STRAIN RELIEF	1
◇ 17	VEECO	B17490-16	SCREW,SS, 10-32 X .250 SHCS AU PLATED	2
◇ 18	VEECO	427624	PLATE, MOUNT, MARK II+, HCES VERSION	1
19	VEECO	426669	PIN,SS,SPRING, .125 O.D. X .500 (MAGNETIC 420 SS)	3
◇* 20	VEECO	427805	HCES ASSEMBLY, MARK II+	1
** 21	VEECO	427358	LEAD ASSY, MARK II+ POWER, HCES, 18.0 LONG	1

ITEM	VENDOR	VENDOR #	DESCRIPTION / MATERIALS	QTY
22	VEECO	426663-22	MASK, BEAD BLAST, ANODE	1
23	VEECO	0201-SS-609	SCREW, SS, 10-32 X ,625 BTN	4
24	VEECO	0201-SS-502	NUT, SS, 2-56 HEX	3
25	VEECO	426869	SCREW, SS, 2-56 X .375 SLTD PAN HD, AU	3
26	VEECO	426663-24	SHT, THERMAL TRANSFER, ANODE	1
27	VEECO	426663-25	SHT, THERMAL TRANSFER, H2O PLATE	1
28	VEECO	426663-27	SHT, THERMAL TRANSFER, GAS DISTRIBUTOR	1

ITEMS 22-28 ARE SUPPLIED SPARES. NOT SHOWN OR USED IN INITIAL ASSEMBLY.

* SHOWN AS REFERENCE ONLY. INSTALLED AT NEXT ASSEMBLY.
** FOR 36" OPTION USE P/N 427359



RECOMMENDED TORQUE SPECS. TO AVOID THREAD GALLING AND PART DAMAGE:

1) 1/2-13 SET SCREWS IN POLE PIECE: N/A, PEENED TO POLE PIECE, FLUSH WITH TOP
2) 1/4-20 SCREW IN ANODE STACK INSULATOR: 6 IN/LBS
3) 1/4-20 FEMALE ANODE POWER CONNECTOR IN ANODE STACK INSULATOR: 6 IN/LBS
4) 1/4-20 SCREWS IN MOUNT PLATE TO BASE: 12 IN/LBS
5) 1/4-20 SCREWS IN ANCHOR PLATE TO COOLING PLATE: 12 IN/LBS
6) 1/4-20 CAPTIVE SCREWS IN ANODE ASSY TO ANCHOR PLATE: 12 IN/LBS
7) 1/4-20 STANDOFF IN BASE: 18 IN/LBS
8) 1/4-20 SCREW IN KEEPER LEAD TO HCES BODY: 12 IN/LBS
9) 10-32 SCREWS IN COOLING PLATE TO STANDOFFS: 12 IN/LBS
◇ 10) 10-32 SCREWS IN HCES BRACKET TO MOUNT PLATE: 12 IN/LBS
11) 10-32 SCREWS IN STRAIN RELIEF TO BASE: 12 IN/LBS
12) 6-32 SCREWS IN CLAMP COLLAR TO BASE: 8 IN/LBS
13) 4-40 SCREW IN GAS LEAD TO HCES GAS LINE: 6 IN/LBS

	CHANGE	CHG / CHK	DATE
B	EC11925; CHANGED HCES TO BOTTOM MOUNT VERSION; REMOVED ASSY NOTES	ADF	10-03-07
A	EC11860; PRODUCTION RELEASE	SAT	08-02-06

UNLESS OTHERWISE SPECIFIED:
UNITS: ±INCHES [±mm]

TOL in.	TOL [mm]	SURFACE FINISH
.X .1		32 √ FAO
.XX .02	.X .5	
.XXX .005	.XX .13	ANGLE
.XXXX .0005	.XXX .013	± 1 deg.

DIMENSIONED IN ACCORDANCE WITH ASME Y14.5M–1994 STANDARDS
REMOVE ALL BURRS AND SHARP EDGES
ALL THREADS CLASS 2

		DATE
DRAWN	SAT	10-12-05
CHECK		
ENGR	SAT	11-2-05
MFG ENGR	JCS	
PROJ MGR	DB	

TITLE: MARK II+ FLUID COOLED SOURCE ASSEMBLY (HCES)

DO NOT SCALE DRAWING

SCALE 1:1 — SHEET 1 OF 3

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SIZE	PART NUMBER	REV
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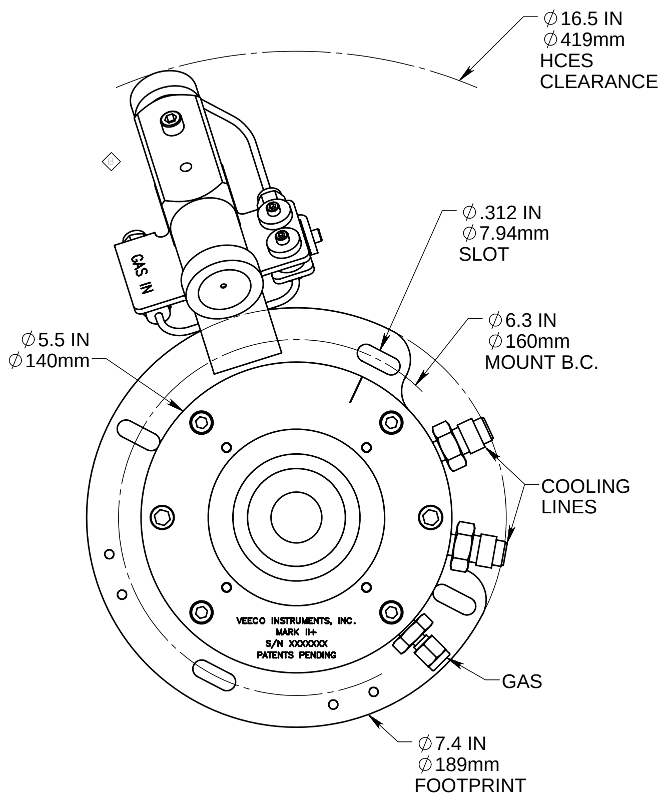

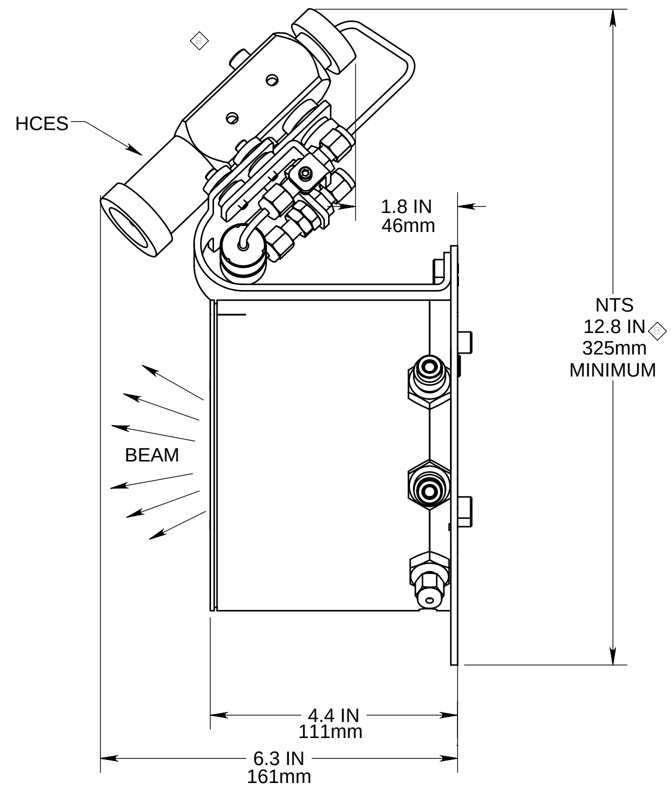

THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED:
UNITS: ±INCHES [±mm]

TOL in.	TOL [mm]	SURFACE FINISH
.X .1		32 FAO
.XX .02	.X .5	
.XXX .005	.XX .13	
.XXXX .0005	.XXX .013	ANGLE ± 1 deg.

DIMENSIONED IN ACCORDANCE WITH ASME Y14.5M−1994 STANDARDS
REMOVE ALL BURRS AND SHARP EDGES
ALL THREADS CLASS 2

DRAWN SAT	DATE 10-12-05	
CHECK	DATE	
ENGR SAT	DATE 11-2-05	
MFG ENGR JCS	DATE	
PROJ MGR DB	DATE	

TITLE
MARK II+
FLUID COOLED
SOURCE ASSEMBLY
(HCES)

DO NOT SCALE DRAWING

SCALE 1:2 | SHEET 2 OF 3

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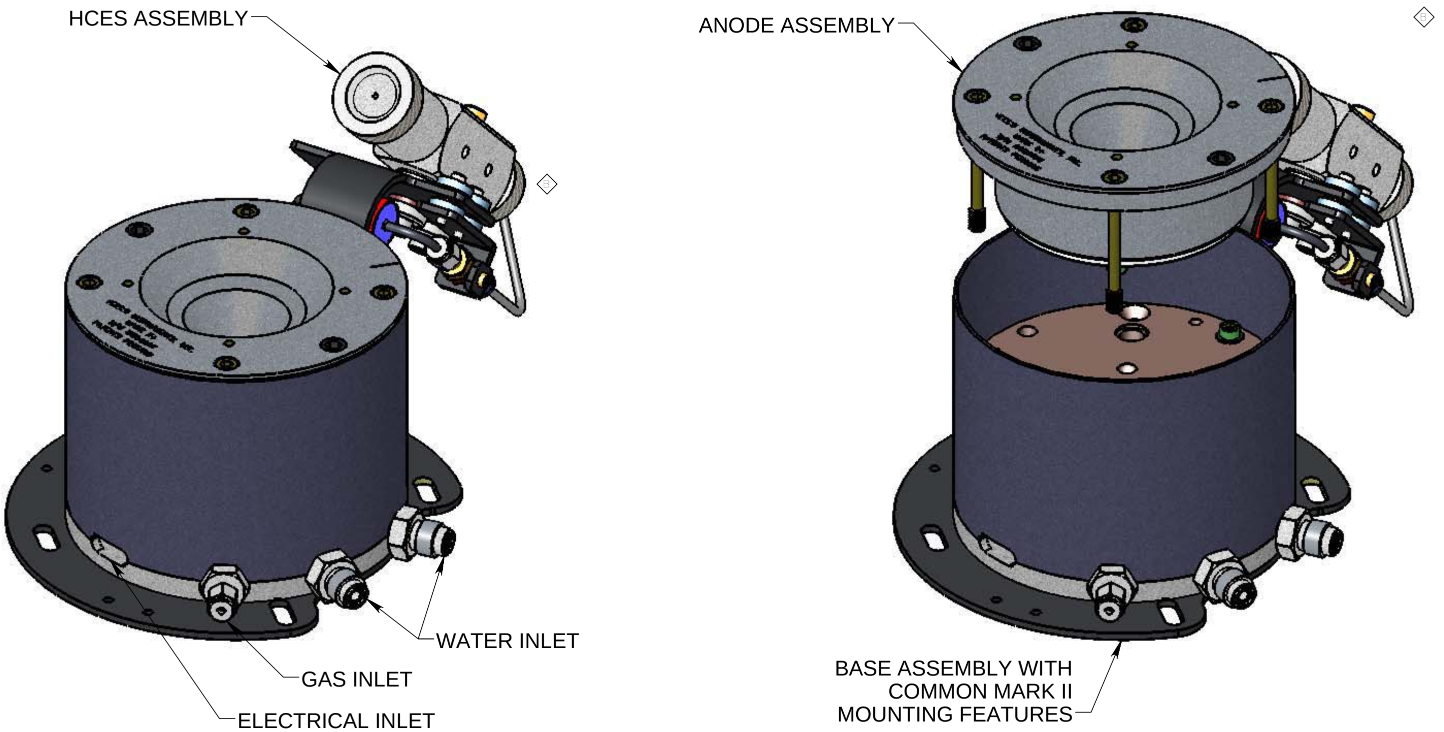
SIZE	PART NUMBER	REV
B	427073	B



THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED:
UNITS: ±INCHES [±mm]

TOL in.	TOL [mm]	SURFACE FINISH
.X .1		32 √ FAO
.XX .02	.X .5	
.XXX .005	.XX .13	ANGLE
.XXXX .0005	.XXX .013	± 1 deg.

DIMENSIONED IN ACCORDANCE WITH ASME Y14.5M–1994 STANDARDS

REMOVE ALL BURRS AND SHARP EDGES

ALL THREADS CLASS 2

DRAWN SAT	DATE 10-12-05	
CHECK	DATE	
ENGR SAT	DATE 11-2-05	
MFG ENGR JCS	DATE	
PROJ MGR DB	DATE	

TITLE
MARK II+
FLUID COOLED
SOURCE ASSEMBLY
(HCES)

DO NOT SCALE DRAWING

SCALE 1:2 | SHEET 3 OF 3

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SIZE	PART NUMBER	REV
B	427073	B

Mark II⊕–HCES Fluid Cooled Wiring Diagram