

ALFA ENGINEERING  
AMERICAN X-RAY TECHNOLOGIES

# TECHNICAL SPECIFICATIONS AND OPERATING MANUAL

X-RAY TUBE MODEL HX-600

Release 1.0

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**1. SAFETY INFORMATION**

**1.1 WARNINGS**

X-RAYS: This X-Ray tube produces X-Rays when energized. X-Rays are a hazard to human health. This X-Ray tube must be operated only in a safe X-Ray shielded environment. All local safety regulations must be followed.

HIGH VOLTAGE: The High Voltage cable retains a charge. Do not handle the X-Ray tube or cable while in operation. Allow the cable to discharge through the generator before handling.

BERYLLIUM: This tube contains a Beryllium window. Beryllium dust is a hazard to human health. Do not scratch, touch, remove or machine the Beryllium window.

CRYSTALLINE SILICA: This tube contains solid white crystalline silica. Dust of this silica is a hazard to human health. Do not scratch or touch this silica.

**1.2 OPERATION PRECAUTIONS**

FRAGILE: This X-Ray tube is fragile. The tube and cable must be handled with care. Do not drop or subject to shock. Even a minor shock can cause damage to the tube.

ENVIRONMENT: This X-Ray tube must be operated in an X-Ray shielded environment.

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**2. X-RAY TUBE DESCRIPTION**

- Vacuum sealed tube with grounded anode and ceramic insulator
- One, two and four window versions
- Water cooled anode
- Designed for powder diffraction and single crystal diffraction
- Weight: 1.8 Kg
- Targets available: Cu, Cr, Co, Mn, Fe, Mo, Ag, W
- Focal sizes available: Normal, Broad, Fine, Long Fine, Micro
- Available with long or short anode
- Window thickness: 0.25 mm
- Window diameter: 16.0 mm
- Target angle: 0 degrees
- Take-off angle with no intensity loss over range:  
Point Focus: 0 – 20 degrees  
Line Focus: 0 – 12 degrees
- Power Characteristics  
Maximum Voltage: 60 kV  
Maximum Current: 60 mA

### 3. CONTENTS AND HANDLING INSTRUCTIONS

#### **Receipt of the tube**

On receipt of the tube, check for any damage that may have occurred during transportation:

- inspect the outside and inside of the package
- check for any visible damage

Note: In the event of damage, claims are to be made with the shipper.

#### **Contents**

The following items are included in the shipment:

1. The shipping / storage material
2. This Instruction Manual
3. X-Ray tube
4. Warning stickers
5. Tube Report Form
6. Two M6 X 20 screws

#### **Handling**

Only remove the tube from its packaging when ready to install.

Follow the installation directions. The X-Ray tube is fragile. Do not drop the tube or subject to shock.

#### **Storage**

Store the tube in its original packaging in a clean, dry environment. Before storing, drain all water from the cooling head. Use compressed air to dry the cooling head.

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**4. INSTALLATION**

- Do not use force when mounting the X-Ray tube. Make sure to protect the Beryllium window against damage.
- Place lead shields in place over unused windows when mounting. Neglecting to install these lead shield will result in unnecessary and dangerous X-Ray emission.
- The mechanical connections to the tube must be secure. Two screws attach the tube to the mount. See the Assembly Schematic for proper tube orientation.
- To change the spot focus, the cooling head must be removed and the tube rotated. The cooling head can only be oriented in one direction in the housing.
- Slide the tube in and secure with screws. Do not over-tighten the screws or put stress on the tube.
- Check that all cooling connections are correct and secure. If the cooling connections are incorrect, the tube will not be cooled properly and damage will result. The water cooling must be operational before the tube is switched on, and be maintained at least five minutes after the tube is shut down.
- To prevent condensation, the cooling water temperature should be set at 25° C.
- See Maintenance and General Specifications for more information on cooling.

## 5. OPERATING INSTRUCTIONS

### 5.1 General

Do not exceed the maximum ratings for the tube. See the Power Characteristics. Exceeding these limits will cause heat damage to the target and cause other damage. When increasing the power, increase the kV first, then the mA. When decreasing the power, decrease the mA first, then the kV. Do not run the tube at low kV and high mA, as this will reduce the lifetime of the filament.

### 5.2 Warmup Procedure

Before being used, an X-Ray tube must first be warmed up. An automatic or manual warm-up routine should follow the following procedure.

- a) New tubes and tubes that have **not** been used for more than 100 hours.
  - Switch on the high voltage and set at 10 kV with the tube current set 1 mA.
  - Increase the voltage in 5 kV steps to the value you wish to use. Wait 10 minutes between each step.
  - Increase the current in 5 mA steps to the value you wish to use. Wait 10 minutes between each step.
- b) Tubes that have **not** been used for 24 h to 100 h.
  - Switch on the high voltage and set at 10 kV with the tube current set 1 mA.
  - Increase the voltage in 5 kV steps to the value you wish to use. Wait 5 minutes between each step.
  - Increase the current in 5 mA steps to the value you wish to use. Wait 5 minutes between each step.
- c) Tubes that have been used within 24 h.
  - Switch on the high voltage and set at 10 kV with the tube current set 1 mA.
  - Increase the voltage in 5 kV steps to the value you wish to use. Wait 2 minutes between each step.
  - Increase the current in 5 mA steps to the value you wish to use. Wait 2 minutes between each step.

If the generator switches off automatically during the warm-up period, the tube voltage has to be lowered by at least 5 kV. If shut downs no longer occur during 15 minutes at this reduced voltage, the warm-up procedure should continue according to the above instructions.

Do not exceed the maximum voltage and current values.

## **6. MAINTENANCE**

### **6.1 General**

Keep the ceramic insulator clean and dry. Do not scratch the ceramic surface. Use methanol for cleaning the ceramic and electrical contacts.

### **6.2 Cooling System Cleaning**

- The cooling system should be cleaned at least once a month. Refer to the Cooling System Layout.
- To access the filter and cooling system, the cooling head must be removed. Four screws hold the head on the tube. Remove these four screws. The head will come off, exposing the inside area, containing a slotted cap, a filter, a large o-ring and a small o-ring.
- Remove the slotted cap. The slot must be kept clean and free of debris.
- Remove the filter and clean under running water. Replace the filter if necessary. Check the large and small o-ring seals. Replace the seals if damaged or deteriorated.
- When reassembling the cooling system, lightly grease the o-rings for a good seal. Check that there are no leaks.

### **6.3 Removal of Deposits In the Cooling System**

- Remove the X-Ray tube from its mount.
- Remove the four screws holding the cooling head to the tube.
- Place the tube upright and fill the hole in the anode with 10 % Acetic Acid ( $\text{CH}_3\text{COOH}$ ) and leave for two hours.
- After two hours, pour the acid out and clean the anode hole with water. Dry the anode out with compressed air.
- Carefully reattach the cooling head in the proper orientation.

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**7. GENERAL SPECIFICATIONS**

7.1 Focal Spot Size

<u>Designation</u>	<u>Thermal Focus Size</u>	<u>Line Focus Size</u>	<u>Point Focus Size</u>
Normal Focus	1.0 x 10 mm <sup>2</sup>	0.1 x 10 mm <sup>2</sup>	1.0 x 1.0 mm <sup>2</sup>
Broad Focus	2.0 x 12 mm <sup>2</sup>	0.2 x 12 mm <sup>2</sup>	2.0 x 1.2 mm <sup>2</sup>
Fine Focus	0.4 x 8 mm <sup>2</sup>	0.04 x 8 mm <sup>2</sup>	0.4 x 0.8 mm <sup>2</sup>
Long Fine Focus	0.4 x 12 mm <sup>2</sup>	0.04 x 12 mm <sup>2</sup>	0.4 x 1.2 mm <sup>2</sup>
Micro Focus	0.15 x 8 mm <sup>2</sup>	0.015 x 8 mm <sup>2</sup>	0.15 x 0.8 mm <sup>2</sup>

7.2 TARGETS AVAILABLE

Cu, Cr, Co, Mn, Fe, Ag, Mo, W

7.3 ENVIRONMENTAL CONDITIONS

Operating Temperature: +5 °C to +40 °C

Storage Temperature: -40 °C to + 70 °C

7.4 COOLING

Cooling Fluid	Clean Water
Minimum Flow Rate	3.5 L/min
Maximum Flow Rate	6.0 L/min
Pressure Drop At 3.5 L/min	Max 2 Bar
Maximum Temperature At Inlet	35 °C
Maximum Water Pressure	8 Bar

Maximum water hardness at 35 °C :

German	5 Grades
US	5 Grades
English	6 Grades
French	9 Grades

Maximum acidity: 6.5 to 9.5 ph - No distilled water

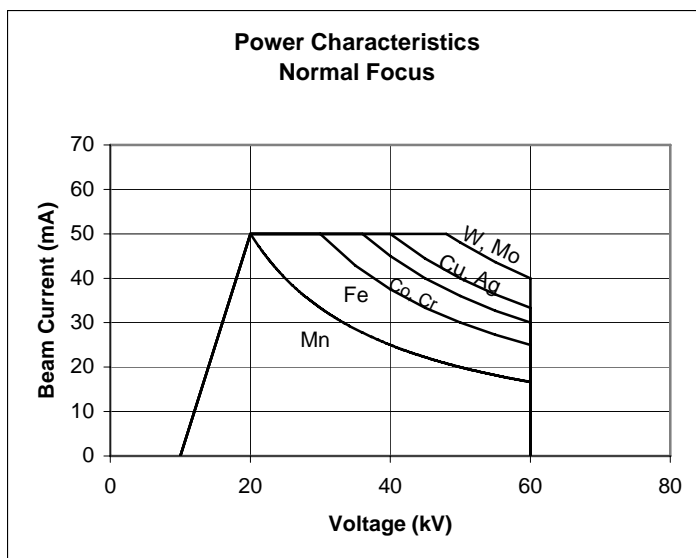
The water must be clean and free from substances which could be deposited in the cooling system. If tap water is used, a filter must be fitted in the cooling water inlet to prevent contamination or blocking of the cooling system.

## 7.1 POWER CHARACTERISTICS

### Normal Focus

Maximum Voltage	60 kV
Maximum Current	50 mA
Maximum Power	
Mo, W	2400 W
Ag, Cu	2000 W
Co, Cr	1800 W
Fe	1500 W
Mn	1000 W

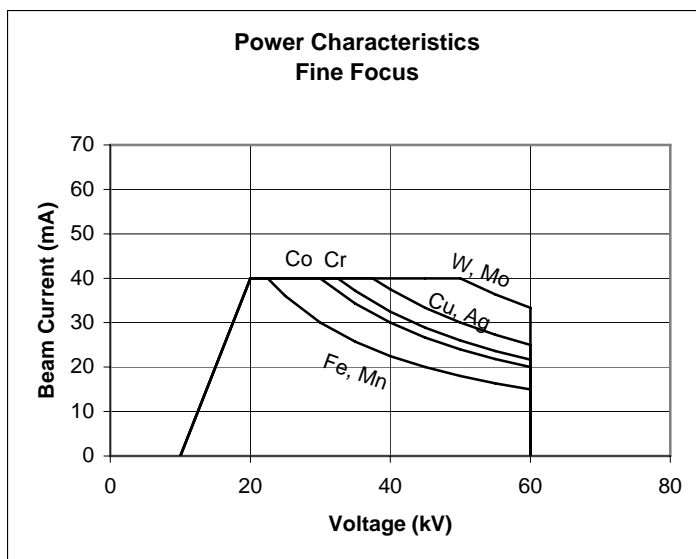
Thermal Focus	1.0 x 10 mm <sup>2</sup>
Min Water Flow	3.5 L / min



### Fine Focus

Maximum Voltage	60 kV
Maximum Current	40 mA
Maximum Power	
Mo, W	2000 W
Ag, Cu	1500 W
Cr	1300 W
Co	1200 W
Fe, Mn	900 W

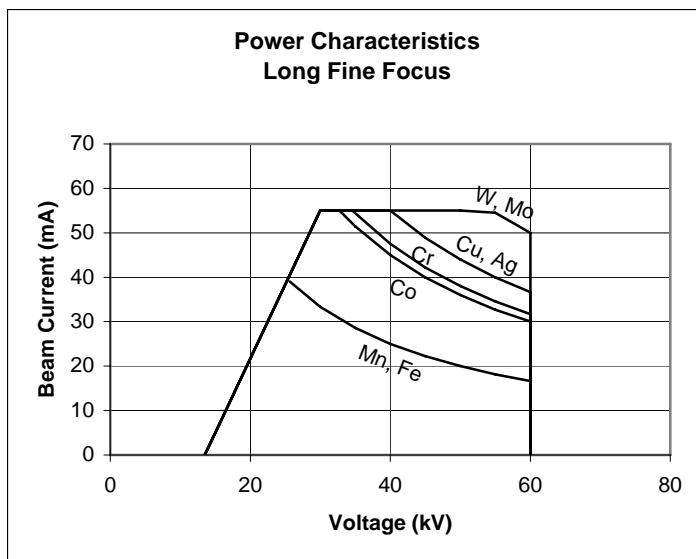
Thermal Focus	0.4 x 8 mm <sup>2</sup>
Min Water Flow	3.5 L / min



### Long Fine Focus

Maximum Voltage	60 kV
Maximum Current	55 mA
Maximum Power	
Mo, W	3000 W
Ag, Cu	2200 W
Cr	1900 W
Co	1800 W
Fe, Mn	1000 W

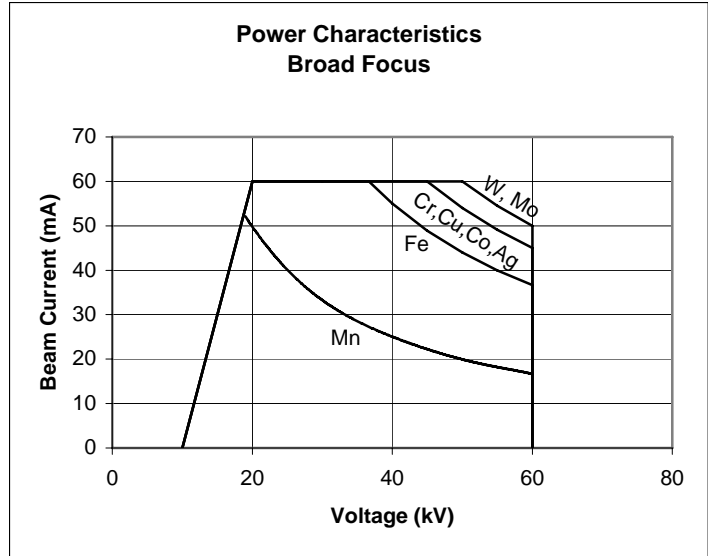
Thermal Focus	0.4 x 12 mm <sup>2</sup>
Min Water Flow	3.5 L / min



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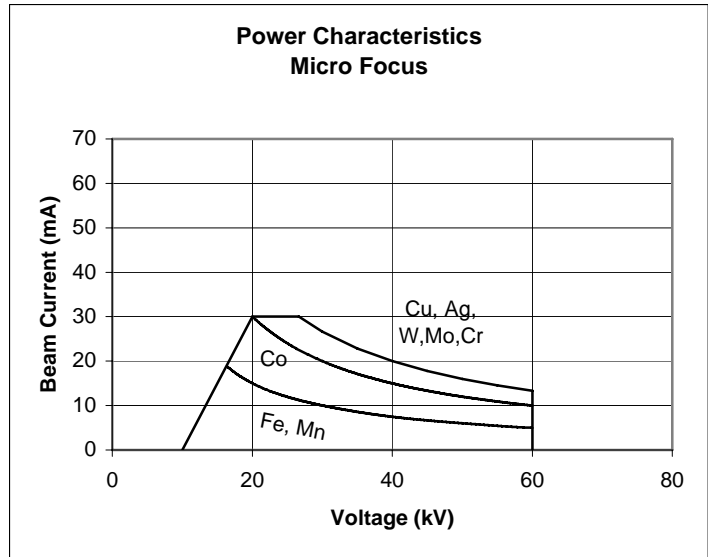
**Broad Focus**

Maximum Voltage	60 kV
Maximum Current	60 mA
Maximum Power	
Mo, W	3000 W
Co, Cr, Cu, Ag	2700 W
Fe	2200 W
Mn	1000 W
Thermal Focus	2.0 x 12 mm <sup>2</sup>
Min Water Flow	3.5 L / min

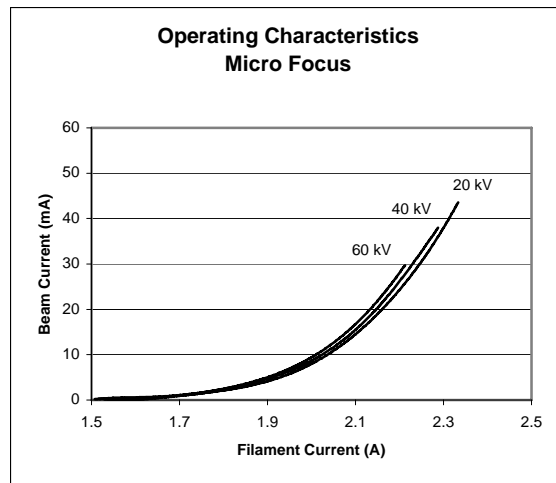
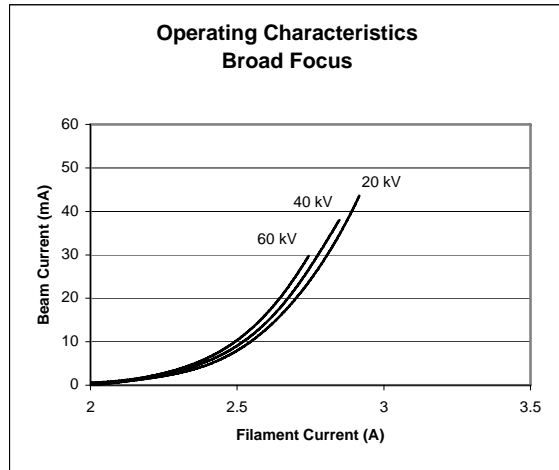
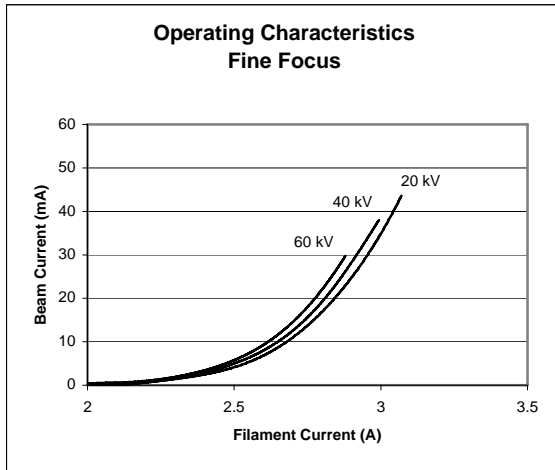
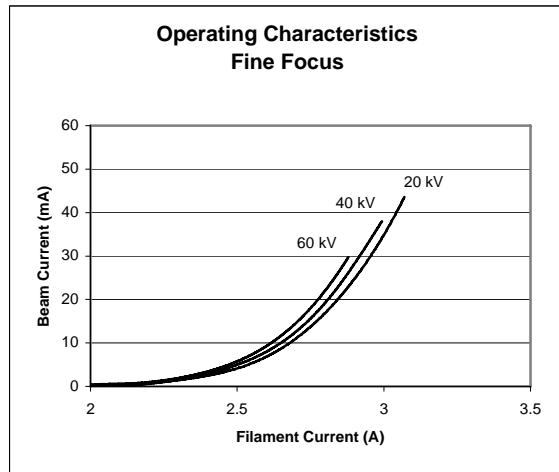
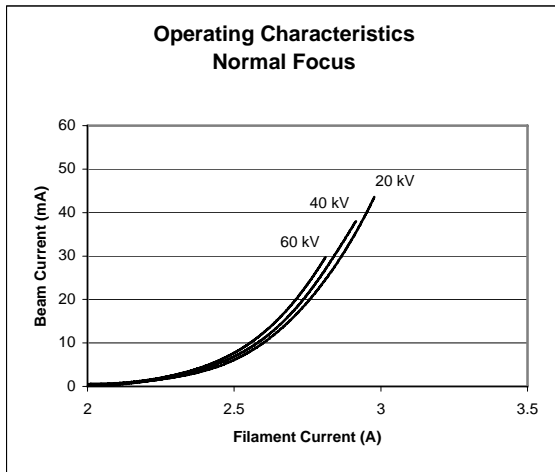


**Micro Focus**

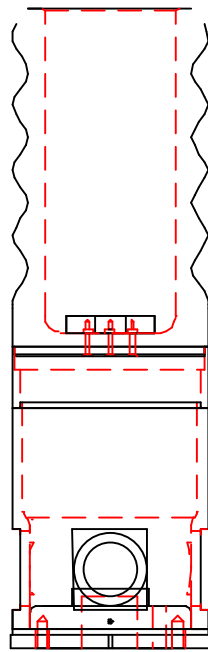
Maximum Voltage	60 kV
Maximum Current	30 mA
Maximum Power	
Mo, W, Ag, Cu, Cr	800 W
Co	600 W
Fe, Mn	300 W
Thermal Focus	0.15 x 8 mm <sup>2</sup>
Min Water Flow	3.5 L / min



## 7.2. OPERATING CHARACTERISTICS



**8. COOLING SYSTEM LAYOUT**



**Replacement Parts List**

<u>Part Number</u>	<u>Description</u>
HX600SP1	M6 X 20 Screw (2)
HX600SP2	M4 X 12 Screw (4)
HX600SP3	Cooling Head
HX600SP4	Large O-Ring
HX600SP5	Small O-Ring
HX600SP6	Filter
HX600SP7	Slotted Cap
HX600SP8	Silicone Grease
HX600SP9	Complete Package SP1-SP8



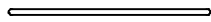
Slotted Cap



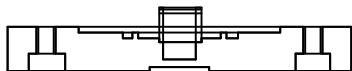
Filter



Small O-Ring



Large O-Ring



Cooling Head



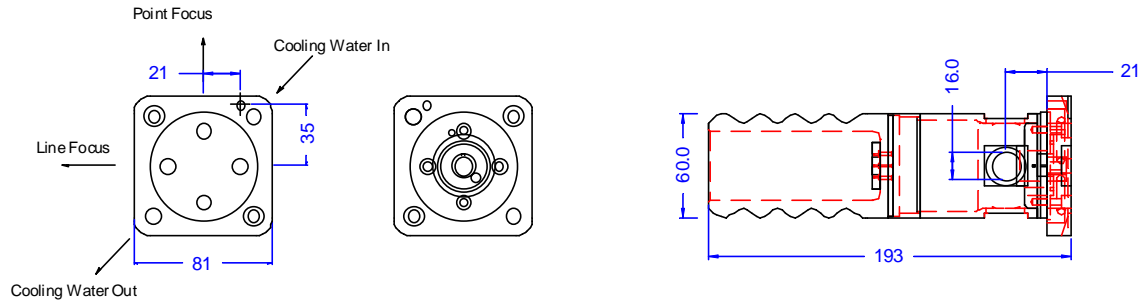
M4 X 12 Screws



M6 X 20 Screws

## 9. ASSEMBLY SCHEMATIC

### Short Anode



### Long Anode

