International Tables for Crystallography (2006). Vol. C, Table 4.2.1.3, p. 194.

Table 4.2.1.3. *Copper-target X-ray tubes and their loading*

X-ray tube	Anode diameter (mm)	Speed		$f_1 \times f_2$ (mm) (mm)	μ	Loading (kW)		Recommended specific loading (kW mm^{-2})
		r min^{-1}	mm s^{-1}			calc.	recommended	
Standard insert	–	–	–	8×0.15	0.295	1.0	0.8	0.67
	–	–	–	8×0.4	0.359	1.2	1.5	0.47
	–	–	–	10×1.0	0.425	1.8	2.0	0.20
	–	–	–	12×2.0	0.493	2.5	2.7	0.11
AEI-GX21	89	6000	28000	1×0.1	0.425	1.4	1.2	12.0
				2×0.2	0.425	3.95	3.2	8.0
				3×0.3	0.425	7.3	5.2	5.8
				5×0.5	0.425	15.6	15.0	6.0
AEI-GX13	457	4500	108000	1×0.1	0.425	2.7	2.7	27.0
Rigaku-RU200	99	6000	31000	1×0.1	0.425	1.5	1.2	12.0
				2×0.2	0.425	4.2	3.0	7.5
				3×0.3	0.425	7.6	5.4	6.0
Rigaku-RU500	400	1250	26200	10×0.5	0.359	26.8	30	6.0
Rigaku-RU1000	400	2500	52450	10×1	0.425	60	60	6.0
Rigaku-RU1500	250	10000	131000	10×1	0.425	96	90	9.0
KFA-Jülich	250	12000	157000	14×1.4	0.425	173	120	6.1

designing the electron gun to produce a line focus, that is the electron focus on the target face is approximately rectangular with the small dimension equal to the desired effective source size and the large dimension about 10 to 20 times larger. The focus is viewed at an angle between about 2 and 5° to the anode surface to produce an approximately square foreshortened effective source; and the X-ray windows are so positioned as to make these take-off angles possible. For some purposes, very fine line sources are required and windows may be provided to allow the focus to be viewed so as to foreshorten the line width. Higher power dissipation is possible in X-ray tubes in which the anode rotates: the line focus is now usually on the cylindrical surface of the anode with its long dimension parallel to the axis of rotation.

For focal-spot sizes down to about 100 μm, an electrostatic gun is adequate; this consists of a fine helical filament and a Wehnelt cathode, which produces a demagnified electron image of the filament on the anode. For most purposes, the Wehnelt cathode can be at the same potential as the filament but cleaner foci and adjustment of the focal spot size are possible when this electrode is negatively biased with respect to the filament. The filament is nearly always directly heated and made of tungsten. Lower filament temperatures, and smaller heating currents, could be achieved with activated heaters but the vacuum in high-power devices like X-ray tubes is rarely hard enough to permit their use since they are easily poisoned. However, Yao (1992) has reported successful operation of a hot-pressed polycrystalline lanthanum hexaboride cathode in an otherwise unmodified RU-1000 rotating-target X-ray generator.

Very fine focus tubes, with foci in the range between 25 and 1 μm, require magnetic lenses. At one time, the all-electrostatic X-ray tube of Ehrenberg & Spear (1951), which achieved foci between 20 and 80 μm, was very popular.

Sealed-off X-ray tubes for crystallographic use are nowadays made in the form of inserts containing a target of one of a range of standard metals to produce the desired characteristic radiation. A series of nominal focal-spot sizes, shown in Table 4.2.1.3, is commonly available. The insert is mounted inside a standard shield that is radiation- and shock-proof and that is fitted with X-ray shutters and filters and often also with a standardized track for mounting X-ray cameras. The water-cooled anode is normally at ground potential and the negative high voltage for the cathode, together with the filament supply, is brought in through a shielded shock-proof cable. The high voltage is nowadays generally of the constant-voltage type, that is, it is full-wave rectified and smoothed by means of solid-state rectifiers and capacitors housed in the high-voltage transformer tank, which also contains the filament transformer. The high tension and the tube current are frequently stabilized. Only the simplest X-ray generators now employ an alternating high tension that is rectified by the self-rectifying property of the X-ray tube itself.

A demountable continuously pumped form of construction is nowadays adopted mainly for rotating-anode and other specialized X-ray tubes. The pumping system must be capable of maintaining a vacuum of better than 10^{-5} Torr: filament life is critically dependent upon the quality of the vacuum.

Rotating-anode tubes have been reviewed by Yoshimatsu & Kozaki (1977). The first successful tube of this type that incorporated a vacuum shaft seal was described by Clay (1934). Modern tubes mostly contain vacuum-oil-lubricated shaft seals of the type due to Wilson (1941) and are based on, or are similar to, the rotating-anode tubes described by Taylor (1949, 1956). In some tubes, successful use has been made of ferro-fluidic vacuum seals (see Bailey, 1978). The main problems in the operation of rotating-anode tubes is the lifetime of the seals and of bearings that operate *in vacuo*. In successful tubes, *e.g.* those