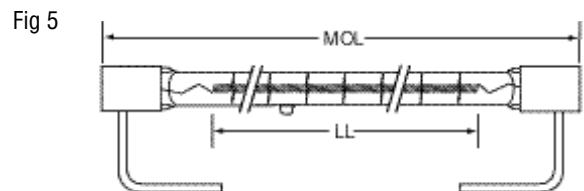
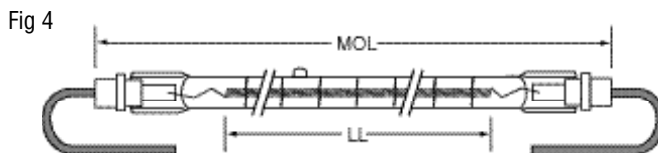
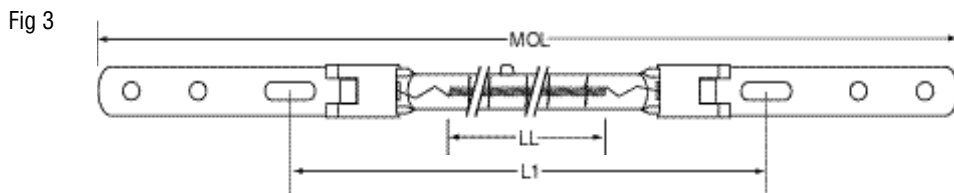
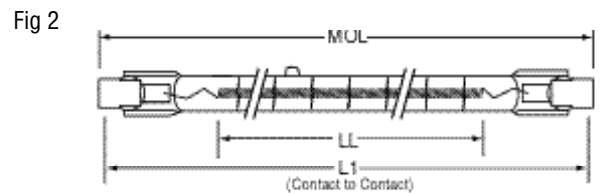
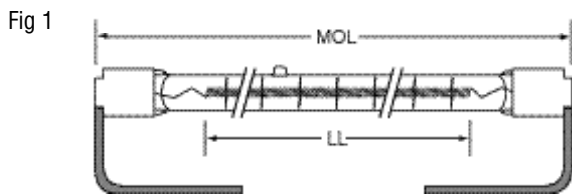


QUARTZ INFRARED HEATER LAMPS • 300W - 900W

Design Voltage	Ushio Ordering Code	Ushio Lamp Code	Dimensions			Color Temp (K)	Avg Life (h)	Fig No	Alternate Designation	Lamp Notes
			MOL (mm)	LL (mm)	L1 (mm)					
300 Watts										
120	1001288	QIH120-300T/S	214.0	106	—	2450	6000	1	QH300T3	
375 Watts										
120	1001289	QIH120-375T/E	219.0	128	215	2500	6000	2	QH375T3/7	
120	1001290	QIH120-375T/S	223.0	128	—	2500	6000	1	QH375T3	
500 Watts										
105	1001286	QIH105-500T/S	223.0	127	—	2500	6000	1	QH500T3	
120	1001292	QIH120-500/B	356.0	142	241	2500	6000	3	13169X	
120	1001293	QIH120-500/L	223.0	127	—	2500	5000	4	QH500T3/CL	
120	1001294	QIH120-500/S	223.0	127	—	2500	6000	1	QH500T3/CL	
120	1001295	QIH120-500/S2	221.0	142	—	2500	5000	1	13169Y	
120	1001296	QIH120-500/ZB	356.0	142	241	2500	5000	3	13169X/98	
120	1001297	QIH120-500T/E	220.0	127	216	2500	6000	2	QH500T3/7	
120	1001298	QIH120-500T/S	223.0	127	—	2500	6000	1	QH500T3	
240	1001352	QIH240-500/D	227.5	165	—	2600	4000	5	13169Z	IW,S
240	1001353	QIH240-500/ZD	227.5	165	—	2600	4000	5	13169Z/98	IW,S
600 Watts										
104	1001285	QIH104-600/S	303.0	152	—	2500	6000	1	600T3/CL/12	
800 Watts										
120	1001299	QIH120-800T/S	303.0	203	—	2500	6000	1	QH800T3	
900 Watts										
216	1001310	QIH216-900/S	405.0	229	—	2500	6000	1	900T3/CL/16	



Dimensions

- MOL = Maximum Overall Length
- LL = Lighted Length (filament length) (avg.)
- L1 = Designated Length (avg.)
- Maximum bulb diameter: 11mm
- All dimensions are in millimeters (mm)

QUARTZ INFRARED HEATER LAMPS • 1000W - 1500W

Design Voltage	Ushio Ordering Code	Ushio Lamp Code	Dimensions			Color Temp (K)	Avg Life (h)	Fig No	Alternate Designation	Lamp Notes
			MOL (mm)	LL (mm)	L1 (mm)					
1000 Watts										
208	1001304	QIH208-1000T/S	351.0	254	—	2500	5000	1	QH1000T3	
240	1001315	QIH240-1000/B	485.0	272	370	2500	5000	3	13195X	
240	1001316	QIH240-1000/L	350.0	254	—	2500	5000	4	—	
240	1001317	QIH240-1000/S	351.0	254	—	2500	5000	1	QH1000T3/2CL/HT	
240	1001318	QIH240-1000/S2	303.0	254	—	2500	5000	1	QH1000T3/CL	
240	1001319	QIH240-1000/S3	351.0	272	—	2500	5000	1	13195Y	
240	1001320	QIH240-1000/VB	485.0	272	370	2500	5000	3	13713X	
240	1001321	QIH240-1000/VD	357.5	272	—	2500	5000	5	13713Z	IW,S
240	1001322	QIH240-1000/VZD	357.5	272	—	2500	5000	5	13713Z/98	IW,S
240	1001323	QIH240-1000/ZB	485.0	272	370	2500	5000	3	13195X/98	
240	1001324	QIH240-1000/ZD	357.5	272	—	2500	5000	5	13195Z/98	IW,S
240	1001325	QIH240-1000T/S	351.0	254	—	2500	5000	1	QH1000T3	
1200 Watts										
144	1001300	QIH144-1200/S*	224.0	155	—	2500	5000	1	QH1200T3/CL	
144	1001301	QIH144-1200/S2	228.0	155	—	2500	5000	1	13561Y/00	IW,R
1350 Watt										
115	1001287	QIH115-1350/L	317.0	256	—	2750	3000	4	13381/99	IW
220	1001311	QIH220-1350/L	317.0	256	—	2750	3000	4	13381/99	IW
1500 Watts										
225	1001312	QIH225-1500/S	557.0	381	—	2500	5000	1	1500T3/CL/22	
230	1002183	QIH230-1500/E	370.0	317	366	3100	400	2	—	
240	1001327	QIH240-1500/S	303.0	235	—	2500	5000	1	1500T3/CL/HT	

* for plastic blow molding

Fig 1

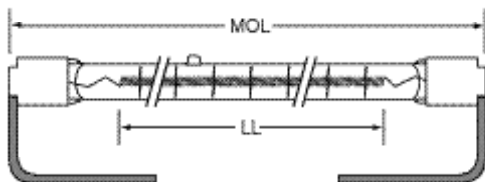


Fig 2

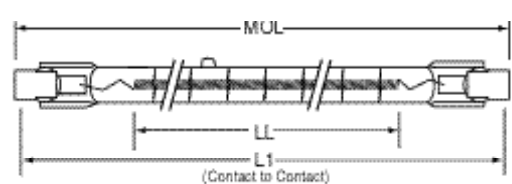


Fig 3

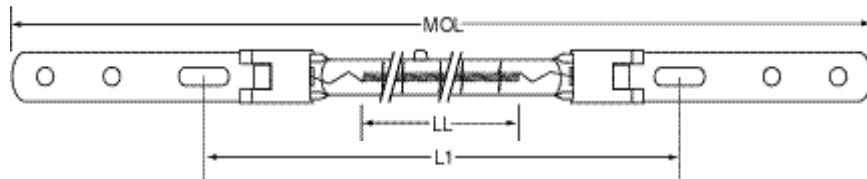


Fig 4

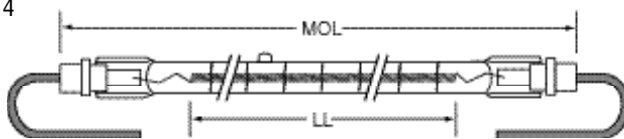
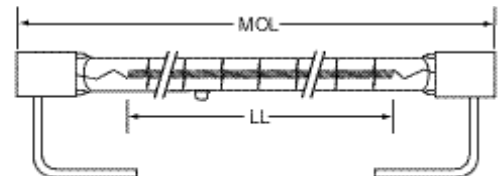
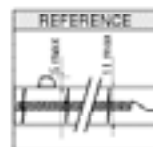


Fig 5



Lamp Notes

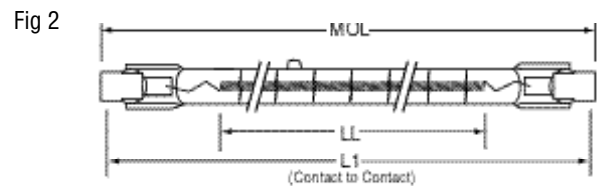
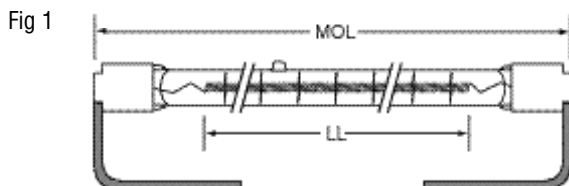
- IW = Insulated Wire
- R = Ring Tongue Terminal
- S = Spade Tongue Terminal (lead wire length: 200mm)
- Standard Lead Wire Length: 145mm



QUARTZ INFRARED HEATER LAMPS • 1600W - 1900W

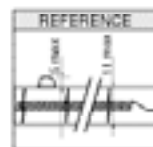
Design Voltage	Ushio Ordering Code	Ushio Lamp Code	Dimensions			Color Temp (K)	Avg Life (h)	Fig No	Alternate Designation	Lamp Notes
			MOL (mm)	LL (mm)	L1 (mm)					
1600 Watts										
144	1001302	QIH144-1600/S*	229.0	150	—	2650	3000	1	13568Y/00	IW,R
208	1001305	QIH208-1600/L	502.0	407	—	2500	5000	4	—	
208	1001306	QIH208-1600T/E	499.0	407	495	2400	6000	2	QH1600T3/7	
208	1001307	QIH208-1600T/S	503.0	407	—	2400	6000	1	QH1600T3	
240	1001328	QIH240-1600/E	495.0	407	—	2500	5000	2	—	
240	1001329	QIH240-1600/L2	502.0	407	—	2500	5000	4	—	
240	1001330	QIH240-1600/S	503.0	407	—	2500	5000	1	QH1600T3/CL	
240	1001331	QIH240-1600/S2	455.5	407	—	2500	3000	1	1600T3/1CL/HT	
240	1001332	QIH240-1600/VL2	502.0	407	—	2500	5000	4	—	
240	1001333	QIH240-1600T/E	499.0	407	495	2500	5000	2	QH1600T3/7	
240	1001334	QIH240-1600T/L	502.0	407	—	2500	5000	4	1600T3/5	
240	1001335	QIH240-1600T/S	503.0	407	—	2500	5000	1	QH1600T3	
277	1001355	QIH277-1600/L	502.0	407	—	2500	5000	4	—	
277	1001356	QIH277-1600T/E	499.0	407	495	2500	5000	2	QH1600T3/7	
277	1001357	QIH277-1600T/S	503.0	407	—	2500	5000	1	QH1600T3	
1900 Watts										
225	1001313	QIH225-1900/S	658.0	482	—	2500	5000	1	QH1900T3	

* for plastic blow molding



Dimensions

- MOL = Maximum Overall Length
- LL = Lighted Length (filament length) (avg.)
- L1 = Designated Length (avg.)
- Maximum bulb diameter: 11mm
- All dimensions are in millimeters (mm)



QUARTZ INFRARED HEATER LAMPS • 2000W

Design Voltage	Ushio Ordering Code	Ushio Lamp Code	Dimensions			Color Temp (K)	Avg Life (h)	Fig No	Alternate Designation	Lamp Notes
			MOL (mm)	LL (mm)	L1 (mm)					
2000 Watts										
240	1001336	QIH240-2000/B	485.0	280	370	2500	5000	3	13213X	
240	1001337	QIH240-2000/C	350.0	280	—	2500	5000	6	13213Y/00	IW,R
240	1001996	QIH240-2000/E	357.0	271	351	2550	3000	2	—	
240	1001338	QIH240-2000/L	350.0	254	—	2500	5000	4	—	
240	1001339	QIH240-2000/S	303.0	248	—	2500	5000	1	QH2M/T3/1CL/HT	
240	1001340	QIH240-2000/S2	351.0	254	—	2500	5000	1	QH2M/T3/CL/HT	
240	1001341	QIH240-2000/VB	485.0	280	370	2500	5000	3	13168X	
240	1001342	QIH240-2000/VC	350.0	280	—	2500	5000	6	13168V	IW,R
240	1001314	QIH240-2000/VD	357.0	280	—	2500	5000	5	13168Z	IW,S
240	1001343	QIH240-2000/VS	303.0	248	—	2500	5000	1	QH2M/T3/1CL/HT/VB	
240	1001344	QIH240-2000/VZD	357.0	280	—	2500	5000	5	13168Z/98	IW,S
240	1001346	QIH240-2000/VZD2	357.0	280	—	2500	5000	5	—	IW
240	1001348	QIH240-2000/ZD2	357.0	280	—	2500	5000	5	—	IW
240	1001349	QIH240-2000JJ1	350.0	270	—	2500	5000	6	—	IW,R
240	1002144	QIH240-2000SEC1*	354.0	290	—	2400	5000	5	(glueless base)	IW
240	1002145	QIH240-2000SEC2*	354.0	290	—	2400	5000	5	(fixed base)	IW
240	1001350	QIH240-2000T/S	603.0	508	—	2500	5000	1	2000T3/524	
277	1001358	QIH277-2000/S	351.0	248	—	2500	5000	1	QH2M/T3/CL/HT	
400	1001361	QIH400-2000/B	623.0	410	508	2500	5000	3	13245X	
400	1001345	QIH400-2000/VB	623.0	410	508	2500	5000	3	13765X	
400	1001362	QIH400-2000/ZB	623.0	410	508	2500	5000	3	13245X/98	

* for plastic blow molding

Fig 1

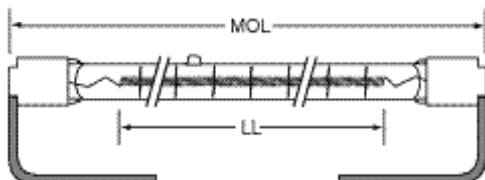


Fig 2

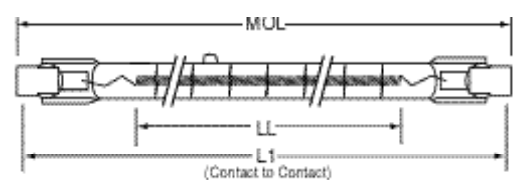


Fig 3

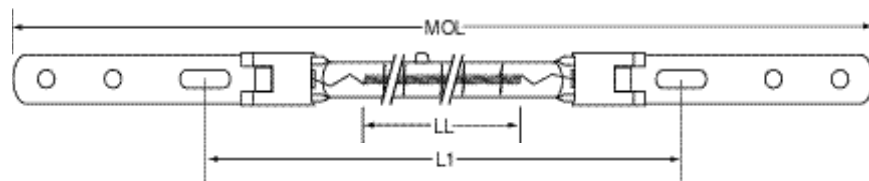


Fig 4



Fig 5

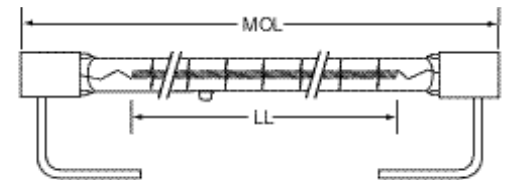
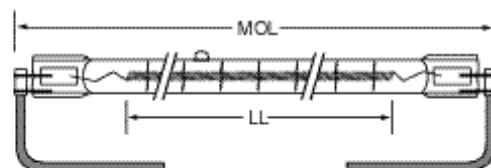


Fig 6

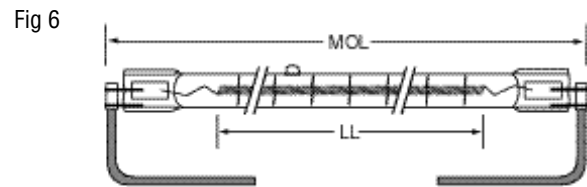
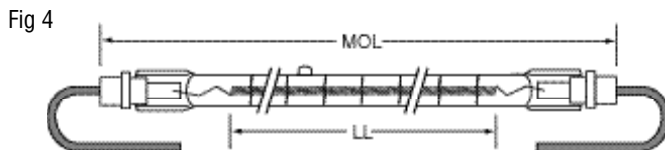
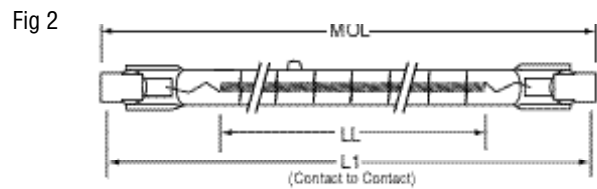
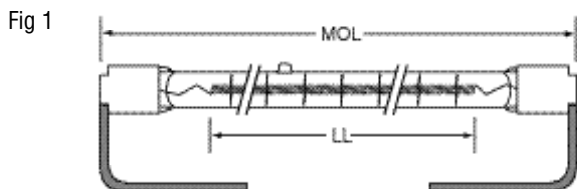


Lamp Notes

- IW = Insulated Wire
- R = Ring Tongue Terminal
- S = Spade Tongue Terminal (lead wire length: 200mm)
- Standard Lead Wire Length: 145mm

QUARTZ INFRARED HEATER LAMPS • 2200W - 2500W

Design Voltage	Ushio Ordering Code	Ushio Lamp Code	Dimensions			Color Temp (K)	Avg Life (h)	Fig No	Alternate Designation	Lamp Notes
			MOL (mm)	LL (mm)	L1 (mm)					
2200 Watts										
250	1001354	QIH250-2200/C	303.0	248	—	2500	3000	6	2200T3/CL/H	R
2400 Watts										
461	1001370	QIH461-2400/S	786.0	610	—	2500	5000	1	2400T3/CL/31	
2500 Watts										
240	1003033	QIH240-2500ME	729.0	635	—	2500	5000	4	—	
461	1001371	QIH461-2500/S	810.0	635	—	2500	5000	1	QH2500T3/R	
480	1001372	QIH480-2500/L	731.0	635	—	2500	5000	4	—	
480	1001373	QIH480-2500/S	732.0	635	—	2500	5000	1	QH2500T3/CL	
480	1001375	QIH480-2500/VL	731.0	635	—	2500	5000	4	—	
480	1001376	QIH480-2500/VS	732.0	635	—	2500	5000	1	2500T3/CL/VB	
480	1001379	QIH480-2500T/E	727.0	635	724	2500	5000	2	QH2500T3/7	
480	1001380	QIH480-2500T/L	729.0	635	—	2500	5000	4	—	
480	1001381	QIH480-2500T/S	732.0	635	—	2500	5000	1	QH2500T3	
480	1001382	QIH480-2500T/VS	732.0	635	—	2500	5000	1	QH2500T3/VB	
575	1001399	QIH575-2500/S	732.0	635	—	2500	5000	1	2500T3/HT	
600	1001400	QIH600-2500/L	731.0	635	—	2500	5000	4	—	
600	1001401	QIH600-2500/VL	731.0	635	—	2500	5000	4	—	



Dimensions

- MOL = Maximum Overall Length
- LL = Lighted Length (filament length) (avg.)
- L1 = Designated Length (avg.)
- Maximum bulb diameter: 11mm
- All dimensions are in millimeters (mm)

QUARTZ INFRARED HEATER LAMPS • 3000W - 3800W

Design Voltage	Ushio Ordering Code	Ushio Lamp Code	Dimensions			Color Temp (K)	Avg Life (h)	Fig No	Alternate Designation	Lamp Notes
			MOL (mm)	LL (mm)	L1 (mm)					
3000 Watts										
240	1001351	QIH240-3000/S	503.0	410	—	2500	5000	1	3000T3/CL	
400	1001364	QIH400-3000/B	913.0	700	798	2450	5000	3	13215X	
400	1001366	QIH400-3000/VB	913.0	700	798	2450	5000	3	13230X	
400	1001367	QIH400-3000/VZB	913.0	700	798	2450	5000	3	13230X/98	
3200 Watts										
384	1001360	QIH384-3200/S	456.0	406	—	2500	3000	1	3200T3/CL/HT	
3650 Watts										
480	1001385	QIH480-3650/L	1062.0	965	—	2500	5000	4	—	
480	1001386	QIH480-3650/S	1059.0	965	—	2500	5000	1	3650T3/CL	
480	1001387	QIH480-3650T/L	1060.0	965	—	2500	5000	4	QH3650T3/5	
3800 Watts										
420	1001369	QIH420-3800T/S	1062.0	965	—	2500	5000	1	3800T3/HT	
570	1001392	QIH570-3800/L	1062.0	965	—	2500	5000	4	—	
570	1001393	QIH570-3800/S	1062.0	965	—	2450	5000	1	QH3800T3/CL	
570	1001394	QIH570-3800/VL	1062.0	965	—	2500	5000	4	—	
570	1001395	QIH570-3800/VS	1062.0	965	—	2450	5000	1	3800T3/CL/VB	
570	1001397	QIH570-3800T/S	1062.0	965	—	2450	5000	1	QH3800T3	
570	1001398	QIH570-3800T/VS	1062.0	965	—	2450	5000	1	QH3800T3/VB	

Fig 1

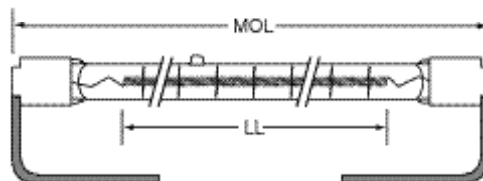


Fig 3

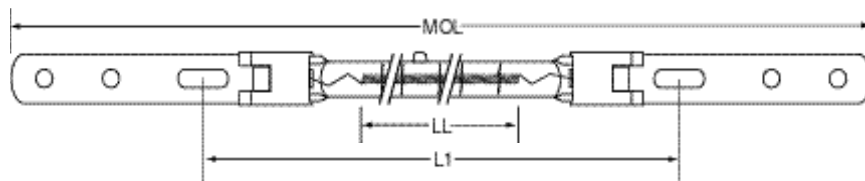
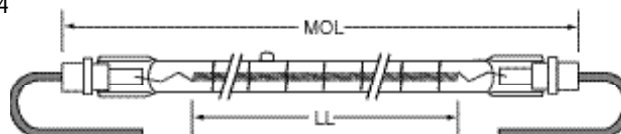
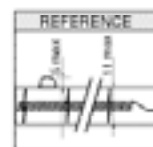


Fig 4



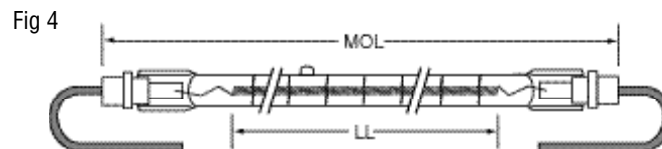
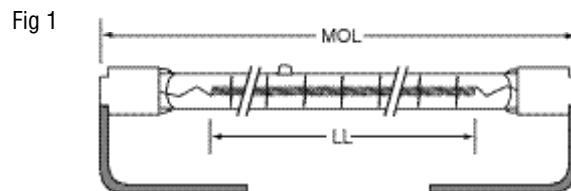
Lamp Notes

- IW = Insulated Wire
- R = Ring Tongue Terminal
- S = Spade Tongue Terminal (lead wire length: 200mm)
Standard Lead Wire Length: 145mm



QUARTZ INFRARED HEATER LAMPS • 4900W - 5800W

Design Voltage	Ushio Ordering Code	Ushio Lamp Code	Dimensions			Color Temp (K)	Avg Life (h)	Fig No	Alternate Designation	Lamp Notes
			MOL (mm)	LL (mm)	L1 (mm)					
4900 Watts										
480	1001388	QIH480-4900/VL	1341.3	1245	—	2500	5000	4	—	
5000 Watts										
480	1001389	QIH480-5000/S	1559.0	1496	—	2300	5000	1	5000T3/NBL	
600	1001402	QIH600-5000/S	732.0	638	—	2500	5000	1	QH5M/T3/1CL/HT	
960	1001403	QIH960-5000/S	1367.0	1270	—	2500	5000	1	QH5M/T3/CL	
5800 Watts										
480	1001390	QIH480-5800/VL	1621.0	1524	—	2500	5000	4	—	



Dimensions

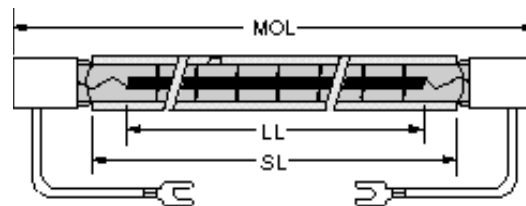
- MOL = Maximum Overall Length
- LL = Lighted Length (filament length) (avg.)
- L1 = Designated Length (avg.)
- Maximum bulb diameter: 11mm
- All dimensions are in millimeters (mm)

QUARTZ INFRARED HEATER LAMPS with JACKET

Design Voltage	Ushio Ordering Code	Ushio Lamp Code	Jacket Type	Dimensions			Lead Wire Length (mm)	Color Temp (K)	Avg Life (h)	Fig No
				MOL (mm)	LL (mm)	L1 (mm)				
500 Watts										
240	1001409	QIH240-500C/D	Clear	227.0	162	176	230	2500	7500	7
1000 Watts										
240	1001404	QIH240-1000R/D	Ruby	357.0	280	306	230	2450	7000	7
1500 Watts										
240	1001405	QIH240-1500G/D	Gray	357.0	280	306	230	2450	7000	7
240	1001406	QIH240-1500R/D	Ruby	357.0	280	306	230	2450	7000	7
2000 Watts										
240	1001407	QIH240-2000R/D	Ruby	357.0	280	306	230	2450	7000	7
2600 Watts										
240	1001408	QIH240-2600R/D	Ruby	583.0	500	533	400	2450	7000	7

This series of Quartz Infrared Heater lamps increase thermal generation through selective IR Banding. They are available with Ruby, Gray and Clear Jackets.

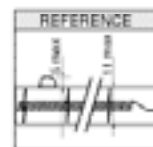
Fig 7



Base: Flat ceramic base with Lead Wire and Spade Tongue Terminal

Dimensions

- MOL = Maximum Overall Length
- LL = Lighted Length (filament length) (avg.)
- SL = Sleeve Length (avg.)
- Maximum bulb diameter: 11mm
- All dimensions are in millimeters (mm)



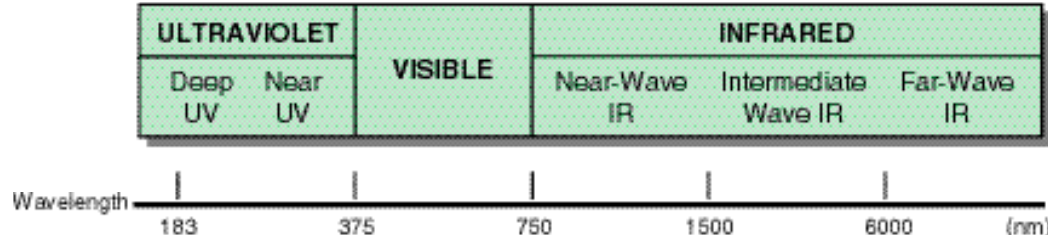
I. QUARTZ INFRARED HEATER - INFRARED RADIATION

1.1 ELECTROMAGNETIC SPECTRUM

Light can be defined as an electromagnetic wave within the range of 100nm-100000nm (1mm). The boundaries for the spectrum for visible light are 380nm-750nm; IR radiation is divided up into Near-Wave, Intermediate-Wave, and Far-Wave Infrared Radiation.

Near-Wave is less than 2000nm, Intermediate-Wave is between 2000 and 4000nm, and Far-Wave IR is above 4000nm.

FIGURE 1 The Electromagnetic Spectrum



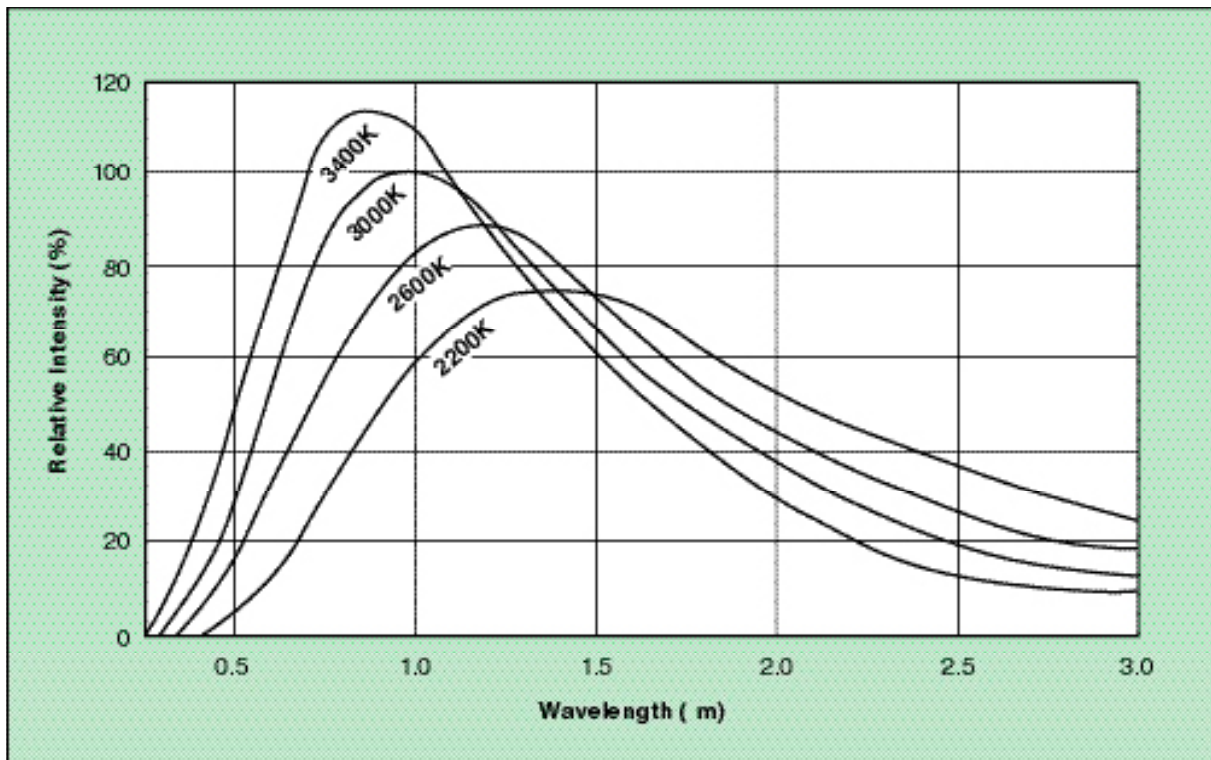
1.2 THE DISTRIBUTION OF QUARTZ INFRARED HEATER (QIH) LAMPS

Several types of halogen lamps with color temperatures ranging from 2000-3400K are available. QIH lamps have a high intensity in Near-Wave radiation, with a color temperature ranging from 2300K to 2700K. IR-Wave radiation produces more effective heating; QIH lamps are specifically designed to use for heating products.

Figure 1.2 illustrates the color temperature and spectrum distribution of the QIH lamp. The relative energy increases as the temperature rises with the peak, moving toward the shorter range of the wavelength (visible light range).

The wavelength at the point of the peak of the curve can be calculated by dividing 2897 by the color temperature(K).

FIGURE 1.2 Color Temperature and Spectrum Distribution



II. QUARTZ INFRARED HEATER - HEAT TRANSFER

The transfer of heat is achieved by three different methods: conduction, convection, and radiation.

2.1 CONDUCTION

Occurs when an object is placed in direct contact to a heat source in which the heat is transferred from the source to the object. This can be observed by placing a pan on a hot stove.

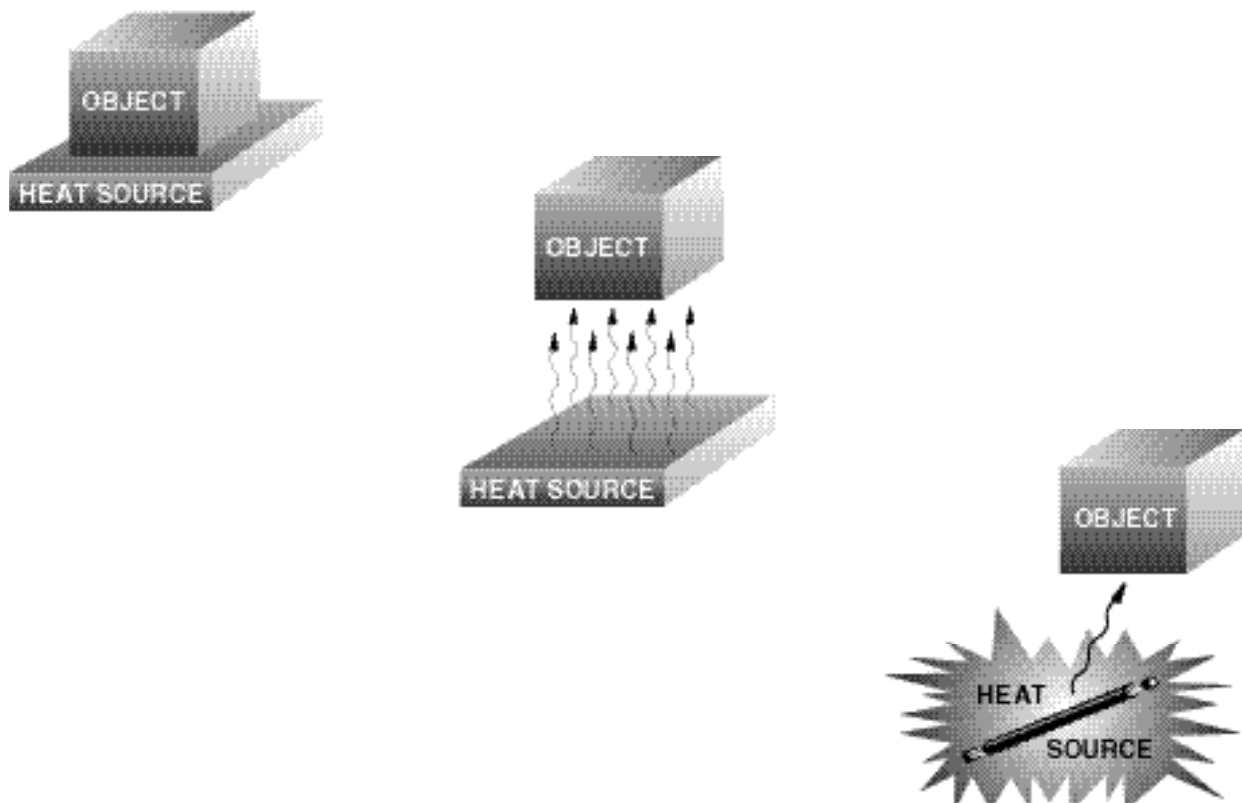
2.2 CONVECTION

Occurs when a heat source transfers heat to the surrounding atmosphere which in turn, transfers heat to the object it comes in contact with. This is how a hair dryer, conventional oven and home heating works.

2.3 RADIATION

Occurs when a heat source emits infrared electromagnetic waves which when striking and absorbed by an object, cause its temperature to rise. This is the way heater lamps and microwave ovens work and also the way the sun heats the earth.

FIGURE 2 Heat Transfer



III. QUARTZ INFRARED HEATER - DESCRIPTION

3.1 HIGH EFFICIENCY

The lamp envelope is of quartz glass. The compact bulb supplies a high luminous output per watt. The "Halogen Cycle" minimizes evaporation of the tungsten filament.

3.2 STABLE COLOR TEMPERATURE

Thanks to the "Halogen Cycle" — a chemical reaction whereby evaporated tungsten particles are returned to the filament —blackening of the bulb wall and thinning of the tungsten filament are kept to a minimum. Light intensity and color temperature remain stable throughout the life of the lamp.

3.3 LONG LIFE

The "Halogen Cycle" guarantees extremely long lamp life. Service life is about twice that of an ordinary incandescent lamp.

3.4 ECONOMY

Compact and lightweight, halogen lamps have made it possible to design very compact lighting or heating fixtures and equipment, allowing for a reduction in the cost of production facilities. Additionally, the long life of halogen lamps permits a further reduction in maintenance and related expenses.

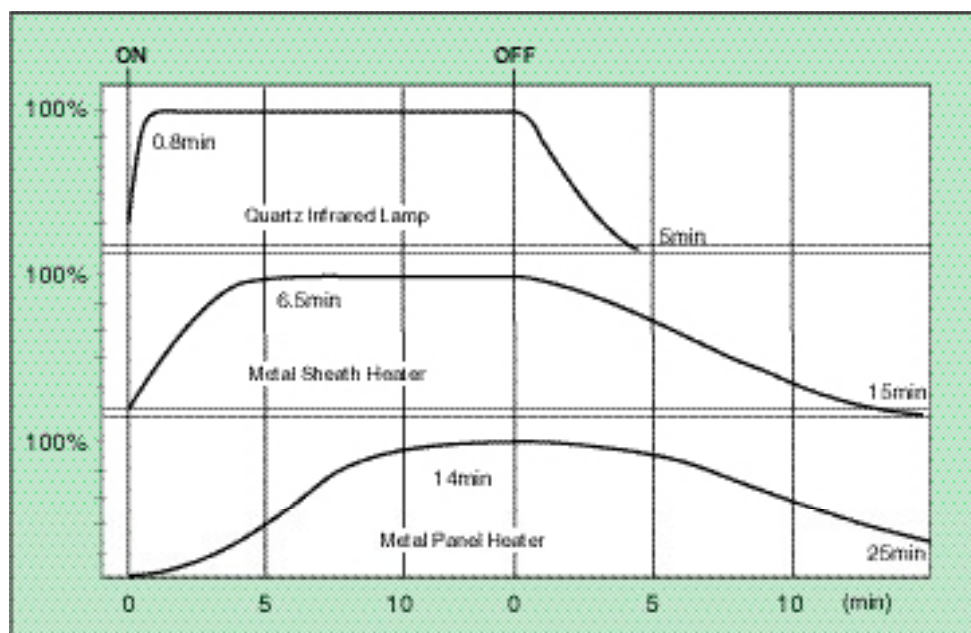
3.5 HEAT IMPACT RESISTANCE

With their quartz glass envelope, halogen lamps are much more resistant to heat impact than ordinary incandescent lamps. It is very unlikely that a halogen lamp will break should it come into contact with cold water.

3.6 WARM UP AND COOL DOWN

When a Quartz Infrared Heater lamp is turned on, it will be able to achieve its maximum radiation (heat energy) in the shortest time when compared with other heaters. The length of time it takes to achieve the maximum radiation output is 40-50 seconds; it also has a rapid cool down when the lamp is switched off.

FIGURE 3 Warm-Up and Cool-Down Times



IV. QUARTZ INFRARED HEATER - CHARACTERISTICS

4.1 VOLTAGE VARIATIONS AND VARIATIONS OF OTHER FACTORS

There are several factors (F), as shown in Fig. 4.1, that are inherent to the characteristics of halogen lamps. The change ratio (F/Fo: F is the actual value and Fo is the rated value) for their factors is approximate and expressed as: $F/F_o = (V/V_o)^k$ or $F = F_o \times (V/V_o)^k$

FIGURE 4.1 Index K

F	Current	Wattage	Lumen	Color Temp.
K	0.54	1.54	3.19	0.37

4.2 VOLTAGE VARIATION AND LIFE VARIATION

Voltage Variation and Life Variation is illustrated in Figure 4.2. If 90% of the rated voltage is supplied, the lamp life will be extended by 3.5 times. If 110% of the rated voltage is supplied, the life will be $1/3$; however, halogen lamps are made with an amount of halogen gas appropriate to the specific designed filament temperature. If the lamp is operated at a lower voltage, insufficient to raise the temperature of the filament to its optimum value, excess halogen gas will damage the filament. This process works to shorten lamp life. On the other hand, if the lamp is operated at a higher voltage, the bulb wall will darken with excess tungsten vapor.

FIGURE 4.2 Voltage Variation vs. Variation of Factors

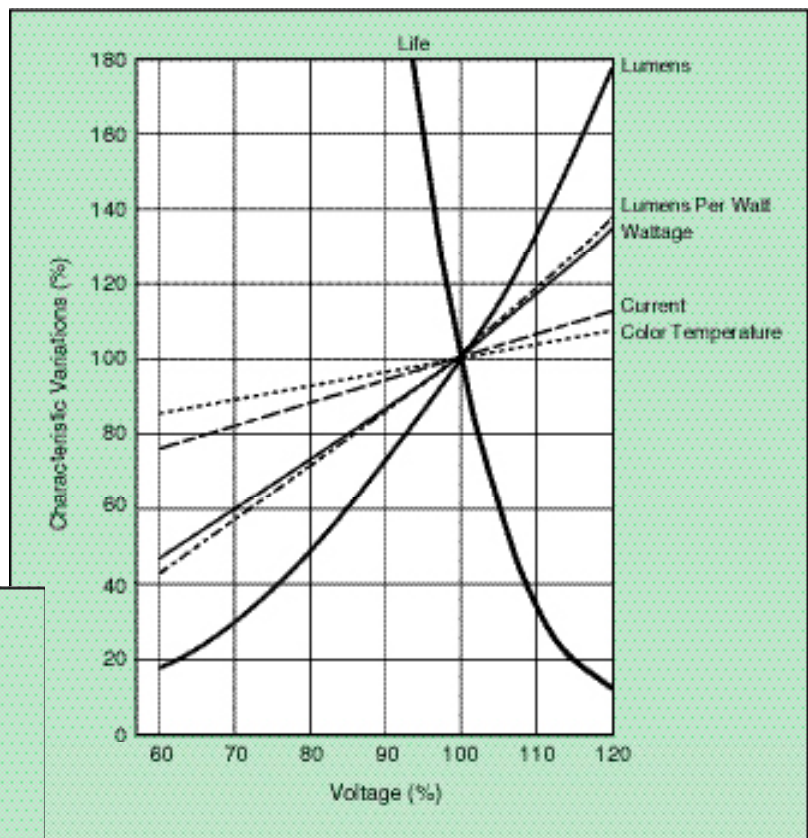
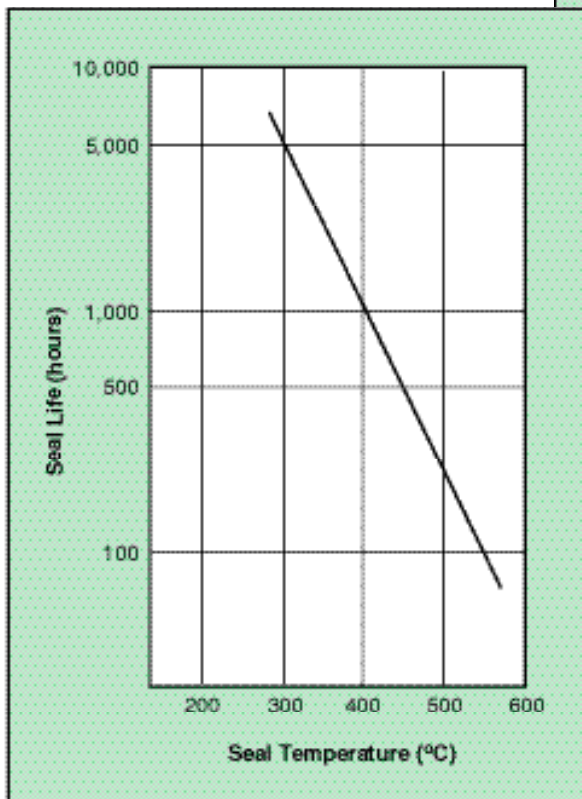


FIGURE 4.3 Seal Temperature vs. Seal Life

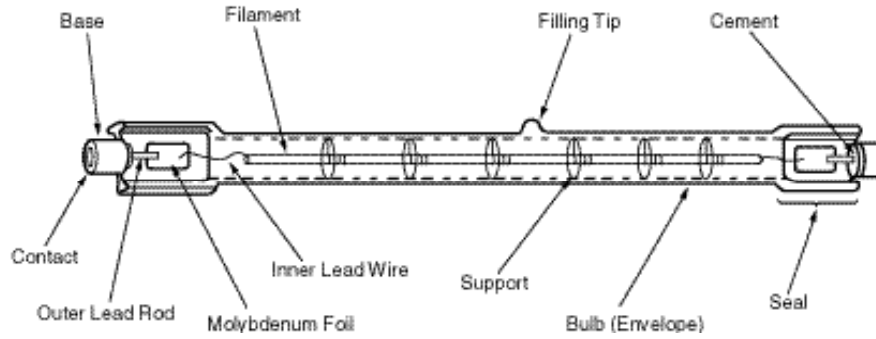


4.3 SEAL TEMPERATURE AND SEAL LIFE

Another cause of shortened lamp life involves damages to the seal. Figure 4.3 shows the relationship between seal temperature and seal life. This graph may vary according to the type of lamp. At high temperature ranges, life values are widely scattered. A molybdenum foil is used at the seal; however, the foil is not completely air tight. There is a very small gap between the quartz seal and the outer lead which enters through the quartz. Through this gap, very small quantities of air can be introduced into the seal area. Molybdenum easily oxidizes when temperatures rise above 350 degrees C. Measurement of the temperature at the seal can be made by using a thermocouple.

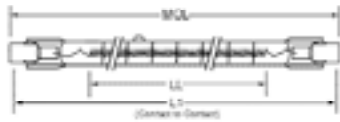
V. QUARTZ INFRARED HEATER - CONSTRUCTION

5.1 GENERAL VIEW OF LAMP

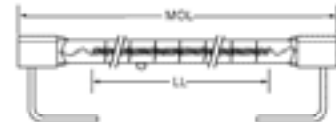


5.2 BASE TYPE OPTIONS

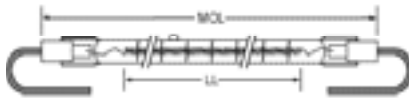
R7S Contact



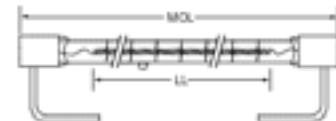
Flat Ceramic with Lead Wire (with Glue)



Ceramic with Lead Wire



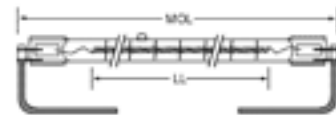
Flat Ceramic with Lead Wire (without Glue)



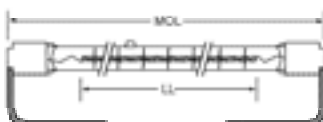
Round Ceramic with Lead Wire



Lead Wire w/o Metal Sleeve



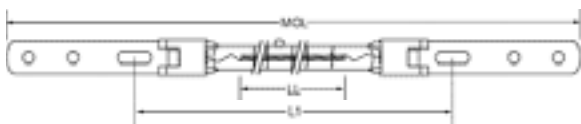
Metal Sleeve with Lead Wire



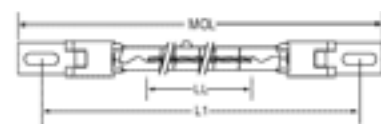
Lead Wire w/o Metal Sleeve



Metal Clip Base



Metal Clip Base



VI. QUARTZ INFRARED HEATER - MATERIALS

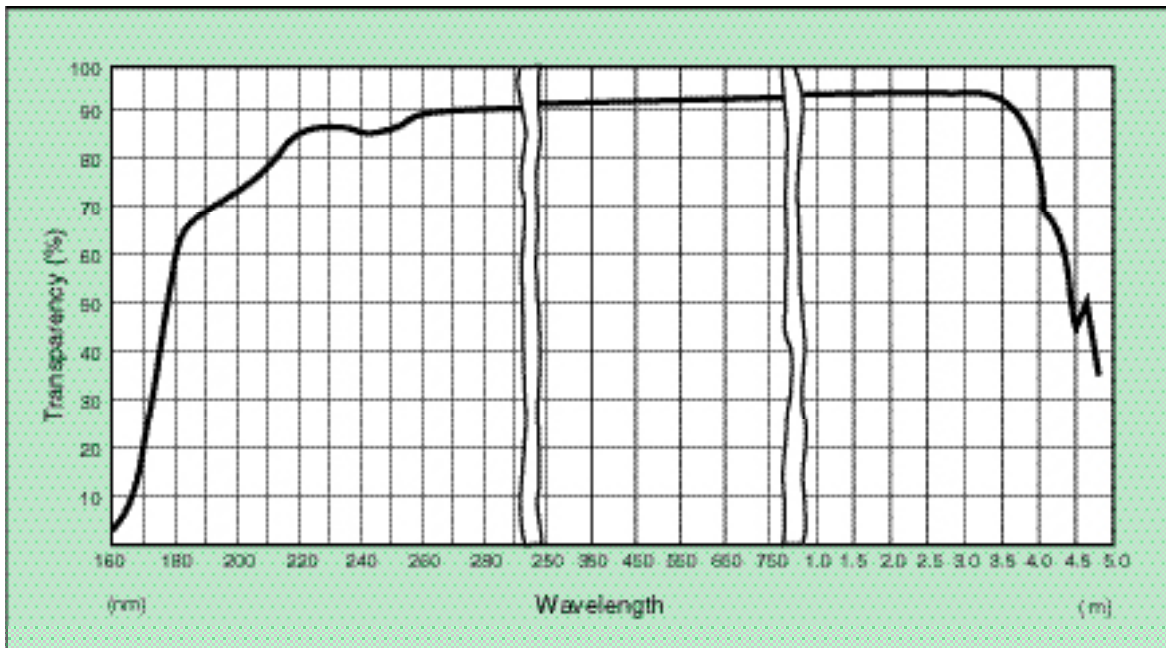
6.1 QUARTZ BULB

Quartz bulbs are indispensable due to the high temperature tolerance requirement of halogen cycles. There are two kinds of quartz bulbs—transparent and translucent. Translucent quartz bulbs are limited to use in certain heaters. For other types of lamps, frosted transparent quartz bulbs are also popular, as they diffuse the filament image providing a wider distribution of light radiation.

TABLE 1 Physical Properties of the Transparent Quartz Bulb

ITEM	UNIT	
Density	kg/m ³	2.20 x 10 ³
Young's Modulus	Pa	7.2 x 10 ¹⁰
Rigidity Modulus	Pa	3.1 x 10 ¹⁰
Poisson's Ratio		0.16
Compressive Resistance	Pa	1.1 x 10 ⁹
Bending Resistance	Pa	6.2 x 10 ⁵
Tension	Pa	4.8 x 10 ⁷
Softening Point	K	2086
Annealing Point	K	1486
Distortion Point	K	1380
Coefficient of Thermal Expansion	m/m • K	5.5 x 10 ⁻⁷ (293-593K)
Rate of Resistance	Ω • m	7x10 ⁷
Dielectric Constant		3.75 (293K, 1MHz)
Dielectric Resistance		< 4 x 10 ⁻⁴ (293K, 1MHz)

FIGURE 6.1 Transmittance Curve (Transparent Quartz Bulb)



VI. QUARTZ INFRARED HEATER - MATERIALS

6.2 FILAMENT (TUNGSTEN) AND MOLYBDENUM FOIL

Quartz Infrared Heater lamps use tungsten filaments because of their high flexibility and low rate of evaporation at high temperatures. Tungsten wire used in the filament is composed of recrystallized particles which are extended along the length of the wire and are interlocked. This specially made tungsten wire makes it possible to produce filaments that are distortion free (non-sagging) and have long life. Known as doped tungsten, this sag resistant filament is in the $K_2O-SiO_2-Al_2O_3$ family.

Molybdenum foil is used as a conductor through the seal area of the Quartz Infrared Heater lamp. The foil, which ensures a hermetic sealing of the lamp, has a configuration as shown in Figure 6.2A. Table 2 lists the characteristics of tungsten and molybdenum.

FIGURE 6.2 Interlocked Recrystallized Particles in the Doped Tungsten



FIGURE 6.2A Cross Section of Molybdenum Foil



TABLE 2 Properties of Tungsten and Molybdenum Elements

	TUNGSTEN	MOLYBDENUM
Atomic Number	74	42
Atomic Weight	183.92	95.95
Specific Heat	1.4×10^{-4} J/(kg·k)	2.5×10^{-4} J/(kg·k)
	1.5×10^{-4} J/(kg·k)	3.3×10^{-4} J/(kg·k)
Melting Point	3395±15°C	2620±10°C
Boiling Point	5530°C	4800°C
	2.57×10^{-13} Pa (1530°C)	8.53×10^{-7} Pa (1530°C)
	1.05×10^{-6} Pa (2130°C)	1.07×10^{-4} Pa (1730°C)
Vapor Pressure	8.73×10^{-3} Pa (2730°C)	5.33×10^{-3} Pa (1930°C)
	6.24×10^{-1} Pa (3230°C)	1.33×10^{-2} Pa (2035°C)
		1.33×10^{-1} Pa (2295°C)
		1.33 Pa (2535°C)
Specific Gravity	19.3	10.2 (Casting)
	5.5×10^{-8} Ω·m (27°C)	5.78×10^{-8} Ω·m (27°C)
Volume Resistivity	2.6×10^{-7} Ω·m (750°C)	2.39×10^{-7} Ω·m (727°C)
	4.0×10^{-7} Ω·m (1200°C)	3.52×10^{-7} Ω·m (1127°C)
	8.5×10^{-7} Ω·m (2400°C)	4.72×10^{-7} Ω·m (1527°C)
Thermal Conductivity	1.67×10^2 w/(m·k)(0°C)	1.34×10^2 w/(m·k)(0°C)

6.3 FILLING GAS

Together with Nitrogen (N_2) and Argon (Ar), a small amount of halogen gas is used to fill the lamp. The most widely used halogen gases are compounds of Bromine (Br) and Chlorine (Cl_2). Selection of the halogen gases are based on conditions relative to the lamp application.

6.4 BASE AND LEAD WIRE

The base of Quartz Infrared Heater lamp is usually made of steatite or heat resistant metal. The lead wire may be nickel stranded, silicon covered, glass braided or Teflon covered.